DROUGHT COPING MECHANISMS: A CASE STUDY OF SMALL SCALE FARMERS IN MOTHEO DISTRICT OF THE FREE STATE PROVINCE

by

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DECLARATION

I hereby declare that "Drought coping mechanisms: A case study of small scale farmers in Motheo district of the Free State Province" is my own research work and that all sources that I have used have been indicated and acknowledged by means of complete references.

SIGNATURE_____ DATE: 6th September 2010

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ABSTRACT

A case study on drought coping mechanisms was conducted among small-scale farmers in the Motheo District of the Free State Province in Republic of South Africa, to determine how farmers cope with drought effects with or without external influence in terms of drought relief packages from the government and non-governmental organizations. Data was collected by administering a semi-structured questionnaire to 200 farmers. The data were captured and analysed using SPSS to obtain frequency, cross-tab, univariate ANOVA as well as logistic regression analysis.

Findings of the study revealed that only 12.5 percent of the respondents were aware of drought, while a larger percentage of 87.5 of the respondents were not aware of a drought incidence before its onset, which made them more vulnerable to the drought disaster; 8.5 percent of them protected water sources for livestock while 91.5 percent of the farmers did not protect water sources for their livestock because they farm on a communal land; 42.5 percent provided supplementary feeds to livestock during the drought, but 57.5 percent did not provide supplementary feed for their animals for lack of funds.

Ninety-nine (99.0) percent of the respondents shared grazing lands while only 1 per cent did not because most farmers operates on a communal system of farming; 35.5 percent changed cropping systems; 50.5 percent had alternative water sources for crops which included mini and hand irrigation systems while 49.5 percent of the respondents depended solely on streams and rivers available in the villages; 19.3 percent sold or pledged assets in order to be able to cope with drought effects while most farmers did not pledge or sell assets not because they did not want to, but because they did not have assets to sell.

Twenty-one (21.5) percent sought new sources of food which did not include wild plants or animals like in various studies, 31.0 percent were forced to seek employment elsewhere while the remainder of the farmers were unable to seek employment elsewhere mainly because they could not leave their local communities; and 23.5 percent received aid or assistance from friends and

families as well as government and non-governmental organizations. In all the 200 farmers interviewed, only 2.0 percent of the farmers migrated from their villages during the drought period as opposed to other evidence from similar studies, 73.5 percent of the farmers interviewed concluded that they were unable to cope with drought effects while 26.5 percent concurred that measures taken during the drought helped them to reduce their vulnerability to drought.

In the ANOVA and logistic regression analysis, the independent variable which was preparation for drought before onset exhibited a significant relationship statistically with dependent variables such as sharing grazing lands before and during drought periods, drawing upon stored foods during the drought period sale or pledge of asset achieving aim of sales and many others.

We concluded that due to lack of awareness, most farmers were not prepared for drought before the onset, which made them more vulnerable. We also suggested ways by which the government could prepare farmers before and during a drought in order to reduce drought impacts on farmers.

Key words: Global warming, drought coping mechanisms, household, small-scale farmers.

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CHAPTER 1

BACKGROUND

1.1 INTRODUCTION

Drought affects more people than any other disaster in Africa (Rekacewicz, 2002). The consequences of drought are as a result of many interacting factors such as poverty, wars and pandemics, high dependency on rain-fed agriculture, population growth, climatic change and variability, land use, increased water demand, lack of water resource management and inadequate economic development.

Drought is caused by too little precipitation over an extended period. It could also be the result of increased demand for the available supply of water during periods of average or above average precipitation. Among these factors, rapid population growth and inadequate economic development are common denominators in most developing countries. These pressures are often translated into increased continuous demand for land and water resources, usually exacerbating the influence of climatic change and rainfall seasonality (Fitzgibbon and Hennessy, 2003).

The root causes of vulnerability to drought disaster in South Africa remain low average rainfall, poverty and inequitable development in rural areas. Rapid population growth and urbanisation, inequitable land distribution, lack of education and subsistence agriculture on marginal land lead to deforestation and environmental degradation, malnutrition and unemployment, all of which bring about increased vulnerability to drought (South African Government gazette, 2005).

Drought can be defined in many ways that are used to meet specific goals such as agricultural development planning or water resources management (Giambelluca *et* al., 1998). Literarily, drought simply means a long period of dry weather. Meteorologists consider drought to be the result of persistent large scale fluctuations in atmospheric

circulation causing subsidence over an area (Agnew, 1989; Wilhite and Glantz, 1985), which may bring little or no rainfall to an area (Mather, 1984).

What is missing from the meteorologist definition of drought is the economic and social manifestation brought about by drought. Wilhite (1999) indicates that drought agricultural drought is not significant unless crop production suffers sufficiently to result in considerable livelihood loss, which is then termed socio-economic drought and that deals with drought in terms of supply and demand for goods and services. The physical water shortage starts to affect people and the ripple effects can therefore be traced through economic systems.

These effects of drought and associated pressures disrupt the functioning of a society causing widespread human and material or environmental losses that sometimes exceeds the ability of the affected society to cope using its own resources (Fitzgibbon and Hennessy, 2003). In these situations, un-usual measure or external interventions are required to support people's ability to cope with the specific vulnerability.

According to the South African Government gazette (2005), drought is a major feature of the climate of Southern Africa and often has a devastating impact. Thus the South African Government needs capacity and expertise to respond timely and effectively to drought across various farming communities, especially those with poor resources. Currently, response to drought is reactive due to lack of proactive measures.

Kivaria (2007) described coping mechanisms as responses of an individual, group or society to challenging situations. The coping mechanisms lie within the framework of the individuals, groups or society's risk aversion or tolerance level, i.e. they are instituted to minimize risk or to manage loss. While some coping mechanisms may be brought into play by a stress factor, other coping mechanism may be an intensification of an already in-built mechanism. Coping strategies are also a short-term response in securing livelihood system to periodic stress. These represent the actual measures to adjust the event that occurred (Davies, 1993).

Paul (1998) in his work (coping mechanisms practiced by drought victims (1994/95) in north Bengal, Bangladesh) both agricultural and non-agricultural measures were taken against drought. People consumed wild plants, tubers and leaves that are not normally eaten, while others seek help from friends and families living outside the drought affected areas.

Eriksen *et al.* (2005) in their own study (on the dynamics of vulnerability by locating coping strategies practiced by drought victims in Kenya and Tanzania) basically describe coping strategies as principal and complementary. According to them, households generally cope by engaging in a few farming activities, which was one principal activity or a multitude of less favoured activities that often complement each other. The household seek one principal coping mechanism, which can substitute for farming as a major regular source of food or income earner for food and other expenses and to switch to complementary activities if the principal activity failed.

A comprehensive drought management approach clearly needs to cover all aspects of the drought cycle. To develop sound drought management, it is important to understand different coping strategies exhibit by farmers with or without external influences or relief measures during a drought cycle.

1.2 MOTIVATION

It is widely believed that government's response to relief packages in times of hazards and natural disasters are usually either late, inadequate or non-existence. In spite of the fact that drought are well suited to early warning systems because the disaster have a slow outset, yet, the start of drought is difficult to define, even when variety of data is available (Monnik **,** 2000).

Most early warning systems focus on the hazards of impending disaster, and not on the vulnerability of farming systems and rural communities. And in the face of government's changing policies, which places more responsibilities on the farmers to plan and survive drought with minimum intervention from the state, not minding their literacy level and

financial backgrounds. How then do these rural farmers manage to cope with the consequences of drought?

1.3 PROBLEM STATEMENT

Studies of past famines suggest that a drought can affect different areas and people within the same stricken area very differently (Jaspars and Young, 1995), and the subsequent effects felt by households or individuals and their coping strategies or mechanisms could greatly be influenced by their previous status in terms of wealth, access to aids and loans.

Like in many other developing worlds, most rural households in South Africa depend largely on agriculture for their source of food and income. Agriculture thus plays a prominent role in the stability of rural communities. During drought periods and beyond, these communities are often left without their livelihood and investment in agriculture. Until recently, response to drought in South Africa has been reactive and the procedures have followed inconsistent patterns (South African Government Gazette, 2005). Against this background, this study is expected to provide answers to the following questions among others:

1. How do farmers perceive and cope with drought?
2. Do the coping mechanisms adopted reduce drought vulnerability?
3. What factors bring about the need to change and adopt coping mechanisms before, during and after drought?
4. What are the differences between coping strategies adapted from one farming family to the other?
5. What are the effects of coping strategies on farmers and their households during the process?
6. What are the constraints to successful response to drought?

1.4 THE HYPOTHESIS

The research hypothesis is as follows:

i In periods of natural disasters such as drought, small scale farmers cannot manage or cope with drought without external influence in terms of assistance or relief packages from governmental and non-governmental agencies.

ii Due to some factors such as education, finances and affiliations with political or other organisation, farmers tend to find it difficult to cope in times of disasters such as drought without external help even with or without prior preparation to such disaster.

1.5 AIMS AND OBJECTIVES

The primary aim of the research was to study drought coping mechanisms exhibited by farmers, by investigating their actions and inactions before, during and after drought.

1. These aims were addressed through investigating the following objectives which were:To explore the farmers' strategies in response to disturbances and changes during drought
2. To determine the differences between coping strategies adopted by different farming-families
3. To identify the effects of drought and coping mechanisms adopted by farmers on their families during the process.

1.6 SCOPE OF THE STUDY

This study was conducted in the Free State Province, but the research only focused on Thaba'Nchu local municipality of Motheo District. With the help of extension officers in Thaba "Nchu, rural farming areas dominated by subsistence farmers facing drought problems on a regular basis were selected. These villages include: Ratau, Motlatla, Tabane, Seroalo, Talla, Middledeel, Sediba and Rakhoi.

1.7 LIMITATIONS OF THE STUDY

The study was confined to Thaba ‘Nchu local municipality of Mangaung district boundaries and to the exclusion of areas beyond this place. The study did not look into how vulnerable small scale farmers are to drought incidences, but considered the effect and subsequent measures taken by farmers to combat such effects of drought.

1.8 STRUCTURE AND PRESENTATION OF THE STUDY

The chapters of this study are organised as shown below:

Chapter 1: General introduction

Chapter 2: Literature review

Chapter 3: Demarcation of the study area

Chapter 4: Research methodology

Chapter 5: Research result and discussion

Chapter 6: Conclusion and recommendation

CHAPTER 2

LITERATURE REVIEW

In this chapter, various literatures relevant to the topic of the research were reviewed. This includes the concept of drought, different definitions of drought, coping mechanisms, drought impacts and vulnerability, history of drought in South Africa, drought legislation in South Africa, the early warning systems of drought, drought indices used around world as well as the one presently used in South Africa.

2.1 THE CONCEPT OF DROUGHT

Establishing a universal view about drought might be difficult. Drought is a normal, recurrent feature of climate that affects virtually all countries to some degree (Wilhite, 1996). Hisdal and Tallaksen (2000) consider drought to be extreme rainfall deficits and the resulting periods of low flow of water, which can have severe effects on water managements in terms of river pollution, reservoir design and management, irrigation and drinking water supply.

Wilhite *et al.* (2000) also described drought as a natural hazard that differs from other hazards because it has a slow onset, progresses over months or even years, affects a large spatial region and causes little cultural damage. According to them, its onset and end are often difficult to determine, just as its severity.

The quantification of impacts and provision of disaster relief is a far more difficult task on drought than it is for other natural hazards (Wilhite, 1996), which are based on three reasons. First, drought is a creeping phenomenon, the effects of drought accumulates slowly over a considerable period of time and may linger for years after the termination of the event. Second, the absence of a precise and universally accepted definition of drought adds to the confusion about whether or not a drought exists and if it does, what is its severity. Third, drought impacts are less obvious and spread over a larger geographical area than the

damages that result from other natural hazards because drought rarely results in structural damage.

Hisdal and Tallaksen (2000) believe that drought is by no means unusual or unnatural; their conclusion is that drought is by far the most costly to our society in comparison to all the natural disaster. It kills more people and animals than the combined effect of hurricanes, floods, tornadoes, blizzards, and wildfires. Unlike other disasters that quickly come and go, drought long-term persevering damage has been responsible in the past for man migration and lost of civilizations. The amount of drought induced natural disasters has grown drastically since the 1960s. This is a result of increase vulnerability to prolonged periods of precipitation deficiency rather than because of an increase in the frequency of meteorological drought (Wilhite, 1996).

Drought affects practically all climatic regions and more than one-half of the earth is prone to drought each year (Kogan, 1997; Wilhite, 2000). Hisdal and Tallaksen (2000) state further that all climatic zones might experience drought; however, the feature can vary significantly between regions. Drought is more prominent when it occurs in potential high and medium rainfall areas; however, the most vulnerable regions are described as arid and semi-arid lands of the world, with those in Africa high on the list.

The degree of drought and the resultant land and resources degradation are said to be greater in those countries whose social and economic support systems cannot endure the effects of drought. This includes the fragile environments in dry eco-system where people have few and limited coping strategies.

2.2 DEFINITION OF DROUGHT

According to Wilhite (1996), because drought affects so many economic and social sectors, many definitions have been developed by a range of disciplines. In addition, drought occurs with varying rates in nearly all regions of the globe. In all types of economic systems and in developing and developed countries alike, the approaches taken to define drought should be impact and region specific. Unavailable specific and objective definition in certain

situations has been an obstacle to understanding drought, which has led to indecision and/or inaction on the part of mangers, policy makers, and others. It must be accepted that the importance of drought is dependent on its impacts.

People should be concerned more by impacts of drought rather than its causes. Impacts are region and user specific; however, a simple definition of drought is given as “a prolonged and abnormally dry period when there is not enough water for normal needs”. Defining drought according to Moneo and Iglesias (2004) said defining drought is hard. Their reason is based on different meaning given to drought in different areas of the world. According to them, there are climates with variable characteristics all around the world and the meaning attached to drought in these different climates differ.

Moneo and Iglesias (2004) pointed out that the definition of drought depends on the place on the earth where we are, as well as the demand that people place on water, if there is such people. For instance, if there is a period of reduced rainfall, but there is no one around the affected areas using water, could this be said to be a real drought? Yes, because precipitation has been affected by this reduction. On the other hand, there might be a reduction in rainfall in a very populated area where agriculture is covering a big extension. This area could be considered as drought infested and consequences would be harder in this case than in the first one as there is a need of water for human needs and for watering plants.

Whatever the definition of drought is, it is clear that it cannot be viewed as a solely physical phenomenon, since it depends on how much water is needed by the society. Wilhite and Glantz (1985) categorized drought definition into two, which are conceptual definition formulated in general terms (which is not applicable to current, i.e. real time drought assessments) and operational definition.

2.2.1 Conceptual definition of drought

Conceptual definition is devised in general terms to help people understand the concept of drought as well as its effects. Wilhite and Glantz (1985) describe drought as a lengthened period of rainfall deficiency, which causes widespread damage to crops, resulting in low yield. According to them, conceptual definition of drought may also be important in establishing drought policy.

For example, Australia drought policy incorporates an understanding of Normal Climate Variability into its definition of drought. The country provides financial assistance to farmers only under "exceptional drought circumstances", when drought conditions are beyond those that could be considered part of normal risk management. Declaration of exceptional drought is based on science-driven assessments. Previously, when drought was less well understood by farmers, some farmers in the semi-arid Australia claimed assistance every few years (NDM, 2006).

2.2.2 Operational definition of drought

Various authors believe that operational definition of drought helps people to identify the beginning, end and degree of severity of a drought. Operational definitions specify the degree of departure from average of precipitation or some climatic variable over some time period (NDM, 2006). This is usually done by comparing the current situation to historic average, often based on a 30-year period of record. The threshold identified as the usual established somewhat arbitrary, rather than on the basis of its precise relationship to specific impacts. In some publications, the terms operational drought is applied equivalent to water resource indicators, hence not consistent with the broad definition of Wilhite and Glantz (1985).

2.2.3 Disciplinary definition of drought

Drought is also defined by classification based on disciplinary perspectives (Dracup *et al.*, 1980; Wilhite and Glantz, 1986; Wilhite, 1996; Byun and Wilhite, 1999; Rouault and Richard, 2003), which include: meteorological drought, agricultural drought, hydrological

drought and socio-economic drought. Each of these different disciplinary definitions is explored in the next sub-sections.

2.2.3.1 Meteorological drought

Wilhite (1999) describe meteorological drought as the first indicator of drought, which is usually a region specific expressions of precipitation departure from normal over some period of time. Meteorological drought is expressed solely on the basis of the degree of dryness (often in comparison to some 'normal' or average amount) and the duration of the dry period (Wilhite and Glantz, 1985). Meteorological Drought is believed to be region specific because the atmospheric conditions that result in deficiencies of precipitation are highly variable from region to region.

According to Byun and Wilhite (1999), the general concepts that are used today as meteorological definitions on dry periods are first, consecutive days with no precipitation, second, consecutive days with little precipitation and third, little precipitation during a specific period of time (Byun and Han, 1994). Furthermore, the definition of "consecutive days", "specific period", "no precipitation" and "little precipitation" are quantified by empirical or subjectively rather than objectively estimated values.

In defining little precipitation, some meteorologists and climatologists generally regard it as "daily precipitation less than 2mm", but some other meteorologists and climatologists regard little precipitation as less than 5mm". On the definition of "no precipitation" on consecutive days in defining meteorological drought, some use a period of more than 15 consecutive days; others use a time frame of 25 days, while some use a monthly unit, seasons or other periods (Byun *et al.*, 1992a and b; Byun and Han, 1994; Byun and Wilhite, 1999).

2.2.3.2 Agricultural drought

According to Backerberg and Viljoen (2003), agricultural drought refers to a situation when the amount of water in the soil no longer meets the need of a particular crop, which measures drought as a physical phenomenon. Kumar and Panu (1997) are of the opinion that a close relationship exists between crop yield and water stress and therefore, crop yield is a reliable indicator of agricultural drought. When assessing and predicting agricultural drought risk, crop yield response to water stress is an essential factor.

Wu and Wilhite (2004) define agricultural drought in terms of plant response by using degree of departure from expected yield as an indicator of weather conditions for a given year on the theory that crops are good indicators of weather and their response presents a reliable tool for measuring drought. Rouault and Richard (2003) gave a time scale (3 to 6 month time scale) for agricultural drought to be the season when deficiency in precipitation results in damage to crop.

2.2.3.3 Hydrological drought

Hydrological drought manifests the effects and impacts of drought; it usually expresses shortages in surface and subsurface water (Hisdal and Tallaksen, 2000). Rouault and Richard (2003) said that hydrological drought is associated with precipitation shortage on a longer scale (12 months to 2 years or more) and its effects on surface and subsurface water supply. According to and Richard (2003), hydrological drought can be out of phase and its effects or impacts on various economic sectors can be appreciably different because it takes longer for precipitation shortage to become evident in soil moisture, stream flow, groundwater and dam levels.

Although Wilhite (2002) describes hydrological drought in terms of deficiencies in surface and subsurface water supplies, he believes that hydrological droughts are concerned more with the effects of periods of precipitation shortfalls on surface and subsurface water supply (i.e. stream flow, reservoir, lake level and ground water) rather than with precipitation shortfalls. Hydrological droughts are usually out of phase or lag the occurrence of meteorological and agricultural droughts.

Water in hydrological storage systems (reservoirs, rivers) is often used for multiple and competing purposes, which further complicates the sequence and quantification of impacts. During droughts, competition for water in these storage systems escalates and brings about increase in conflicts among water users (Wilhite and Glantz, 1985; Wilhite, 1996; West, 2008).

Due to the fact that hydrological systems interconnects regions, occurrence of drought-upstream may results in serious impacts downstream as surface and subsurface water supplies are affected, even though downstream area may not be experiencing drought. Upstream changes in land use (deforestation, changes in cropping patterns) may change runoff and soil infiltration rates, which may affect the rate and severity of drought downstream (Wilhite, 1996).

2.2.3.4 Socio-economic drought

Socio-economic drought simply deals with drought in terms of supply and demand for goods and services. This occurs when the physical water shortage affects people and its effects can be traced to the economic systems (Backerberg and Viljoen, 2003; Wilhite, 1996). In other words, when the supply and demand of some economic is determined by demand of meteorological, hydrological and agricultural droughts.

For example, the supply of an economic good (water, forage, hydroelectric power) depends on weather. In most cases, demand increase as a result of increasing population and/or per capita consumption. Therefore, drought could be defined as occurring when the demand exceeds supply as a result of a weather-related supply shortfall. This concept of drought supports the strong symbiosis that exists between droughts and human activities, reemphasising the importance of managing natural resources in a suitable manner.

2.3 DROUGHT IMPACTS AND RESPONSES

According to Wu and Wilhite (2004), it is difficult to assess drought impacts in various sectors because the impact can be regional or local. In addition, drought may linger for a long time (>1year). Or just last for a very short time (several weeks). According to them, if a short-term drought occurs at critical of crop growth stages, the impacts on agriculture may be severe. Also, it was found that the impact of drought on agriculture is neither immediate nor easily measured.

Byun and Wilhite (1999) state that drought impacts result from a deficiency of water in surface or subsurface component of the hydrologic system. Soil moisture is usually the first component of the hydrologic system to be affected. As the duration of the event continues, other component becomes affected. Thus, the impacts of drought gradually spread from agricultural sector to other sectors and finally a shortage of stored water resources becomes noticeable.

Drought impacts extend beyond the areas physically affected by drought after the event has ended (Coleen *et al.*, 2006). Like other hazards, the impacts of drought are diverse and can be classified broadly as economic, environmental and social in Table 2.1, 2.2 and 2.3. (Paul, 1998; Wilhite *et al.*, 2000; Coleen, 2006).

Table 2.1 Social impacts of drought

Social impacts	Effects
Lack or poor distribution of resources (food and water	Migration, resettlement, conflict between water users
Increased quest for water	Increased conflict among water users
Marginal lands becomes unstable	Poverty and unemployment
Reduced grazing quality and crop yield	Overstocking; reduced quality of living
Employment lay offs	Reduced or no income
Food insecurity	Malnutrition and farming; civil strikes and conflict
Increased pollutant concentration	Public health risks
Inequitable drought relief	Social unrest and distrust
Increased forest and range fires	Increased threat to human and animal life
Urbanization	Social pressure and reduced safety

Source: Coleen *et al.* (2006)

Table 2.2 Economic impacts of drought

Economic impacts	Effects
Reduced business with retailers	Increased prices for farming commodities
Food and energy shortages	Drastic price increase; expensive import/subsidies
Loss of crops for food and income	Increased expense of buying foods from shops
Reduction of livestock quality	Sale of livestock at reduced market price
Water scarcity	Increased transport cost
Loss of jobs, income and property	Deepening poverty; unemployment
Less income from tourism and recreation	Increased capital shortfall
Forced financial loans	Increased debt; increased credits for financial institution

Source: Coleen *et al.* (2006)

Table 2.3 Environmental impacts of drought

Environmental Impacts	Effects
Damage to natural habitats	Loss of Biodiversity
Reduced forests, crop, and range land productivity	Reduced income and food shortages
Reduced water levels	Lower accessibility to water
Reduced cloud cover	Plant scorching
Increased day time temperature	Increased fire hazards
Increased evapotranspiration	Crop withering and drying
More dust and sand storms	Increased soil erosion and increased air pollution
Decreased soil productivity	Desertification and soil degradation (top soil erosion)
Decreased water resources	Lack of feeding and drinking water
Reduced water quality	More water borne disease; increased salt concentration
Increased incidences of animal diseases and mortality	Loss of income and food; reduced breeding stock
Soil desiccation	Increased soil 'blow activities'
Degradation of landscape quality	Permanent loss of biological productivity of the landscape
Species concentration near water	Increased vulnerability to predation

Source: Coleen *et al.* (2006)

Further impacts of drought could be direct or indirect, or are assigned an order of propagation (see first or second order in Fig. 2.1). In a society where agriculture is the primary economic activity, the direct or the first order impact of a drought is detected in the form of a reduction in food production, rangeland and forest productivity; reduced water level; increase in fire hazard; increase in livestock and wildlife death rates; damage to wildlife and fish habitat.

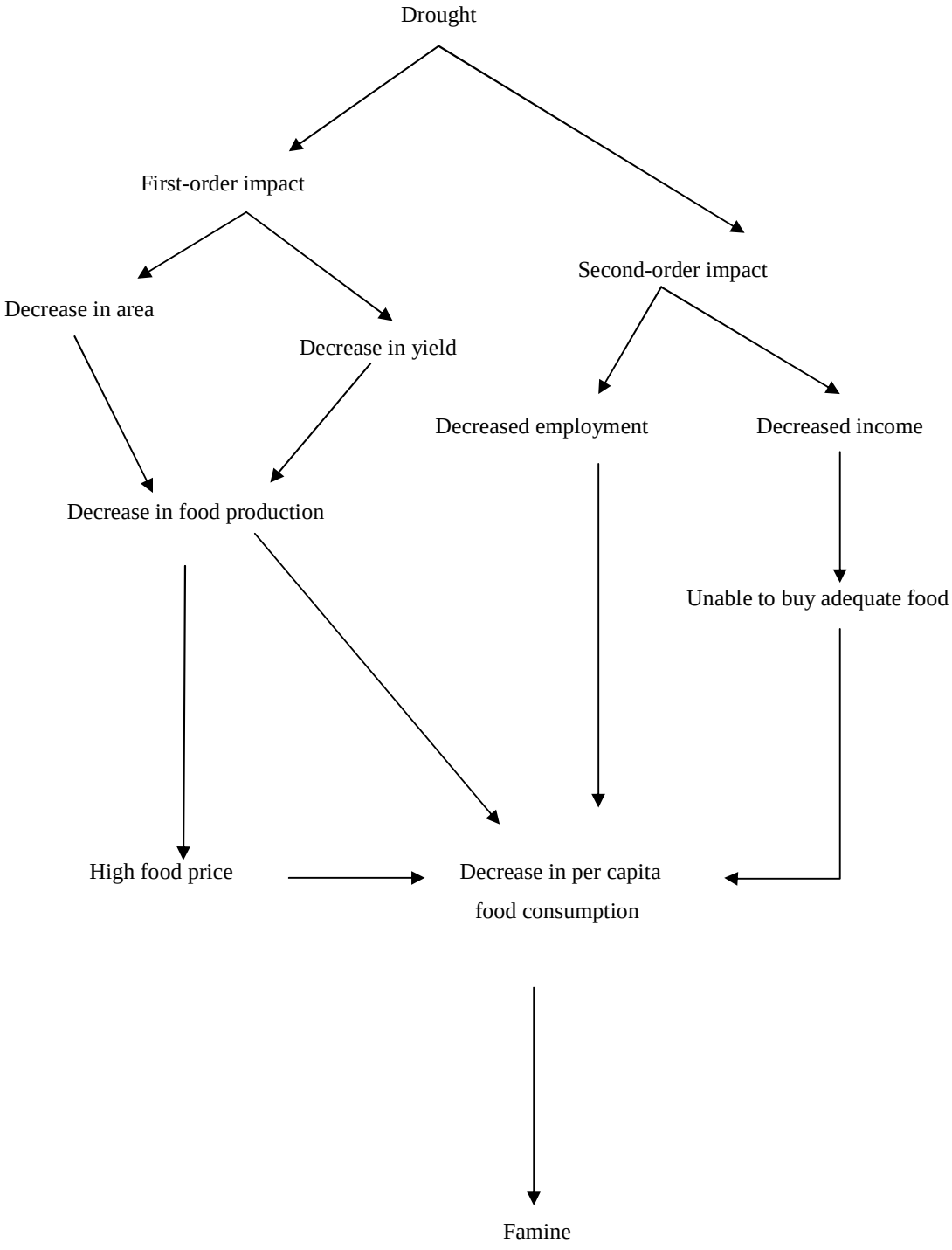

Figure 2.1 Direct and indirect impact of drought on farmers

Source: Paul (1998)

Indirect or second order drought impacts includes reduction in crop productivity, which leads to less income for farmers, increased prices for food, unemployment and migration, decreased food production, abnormal increase in food grain prices and non-availability of jobs reduce the food entitlement of rural people, especially small farmers and landless labourers (Paul, 1998).

At this stage, drought victims adopt various strategies to cope with the effects of the hazard. They are often compelled to borrow money or sell their lands, household goods and/or livestock at miserable prices in order to buy food. These practices were labelled hard options by Karanon (1993) and they are considered as components of non-agricultural adjustments to mitigate drought.

According to Paul (1998), first order effects of drought hazard can be reduced by using drought mitigation techniques in response to the effects of droughts. Agricultural adjustments programmes are usually practiced to compensate for crop loss. Rescuing crops to offset the reduction in crop area and the application of irrigation water to increase crop yield are two examples of agricultural adjustments (Brammer, 1987).

2.4 COPING AND VULNERABILITY WITH DROUGHT

2.4.1 Coping with drought

Eriksen *et al*. (2005) describe coping mechanism as the actions and activities that take place within existing structures, such as production systems. Kivaria (2007) defines coping mechanisms as responses of an individual, group or society to challenging situations. However, the coping mechanisms rest within the framework of the individuals/groups/societies risk aversion or tolerance level. In other words, coping mechanisms are instituted to minimize risk or tolerance level, or manage loss. According to him, some coping mechanisms may be brought into play by a stress factor; other factor may be to strengthen an already in built strategy.

Kivaria (2007) based his view of coping mechanism on livestock herds and broadly grouped it into managerial and community strategies. These managerial strategies includes

movement and migration, various aspects of herd management, supplementation of grazing with other feeds, changes in herding labour with intensification of stress, management of diseases (both human and livestock) and changes in human diet. Community strategies on the other hand includes: sharing, loaning and giving of livestock as gifts and institution of legal restriction necessary because the rangelands resources (forage and water) are shared by parties with conflicting and varied interests.

Adams *et al.* (1998) defines coping as an array of short-term strategies adopted in response to crisis. According to them, the aim of coping is to maintain the various objectives of the households, including livelihood security, consumption, health and status, thus ensuing individual and/or collective well-being. These objectives includes livelihood security and status, which are longer term objectives involving strengthening of assets, income and social position to maximise future claim on resources, the other objectives are immediate and these are food consumption and health objectives, which involves finding sufficient food and income to meet the health and nutritional needs of the household (Adams *et al.*, 1998; Kinsey *et al.*, 1998).

Kinsey *et al.* (1998) noted that financial assets might have negative real returns as a result of non-market interventions (such as interest ceilings) and may, in addition, involve substantial transaction costs. Food stocks are subject to deterioration and livestock face risks of theft, disease and loss from other causes. The result may be that household saving is largely for smoothing consumption rather than for accumulation.

2.4.1.2 Review of coping mechanisms practiced by drought victims around the world

Coping mechanisms practiced by farmers during drought in Africa and some other parts of the world were reviewed below.

2.4.1.2.1 Coping mechanisms practiced by drought victims in 1994/95 in the North Bengal, Bangladesh

Droughts are a recurrent phenomenon in Bangladesh, afflicting the country at least as frequently as major floods and cyclones. Since its independence in 1971, Bangladesh has suffered severe droughts in 1973, 1978, 1981, 1982, 1989, 1992, 1994 and 1995 (Paul, 1998). According to Paul (1998) all areas in Bangladesh are not equally vulnerable to drought. North-western region of Bangladesh, popularly known as North Bengal, experienced a severe drought in 1994/95, which led to the failure of fifteen different crops. A lot of crops were affected because the drought period coincided with the 1994/95 planting seasons.

As a result of the 1994/95 droughts according to Paul (1998) various adjustment measures were taken by the affected farmers, and these includes household level adjustments as well as supports from both formal and informal sources (**Fig. 2.2**).

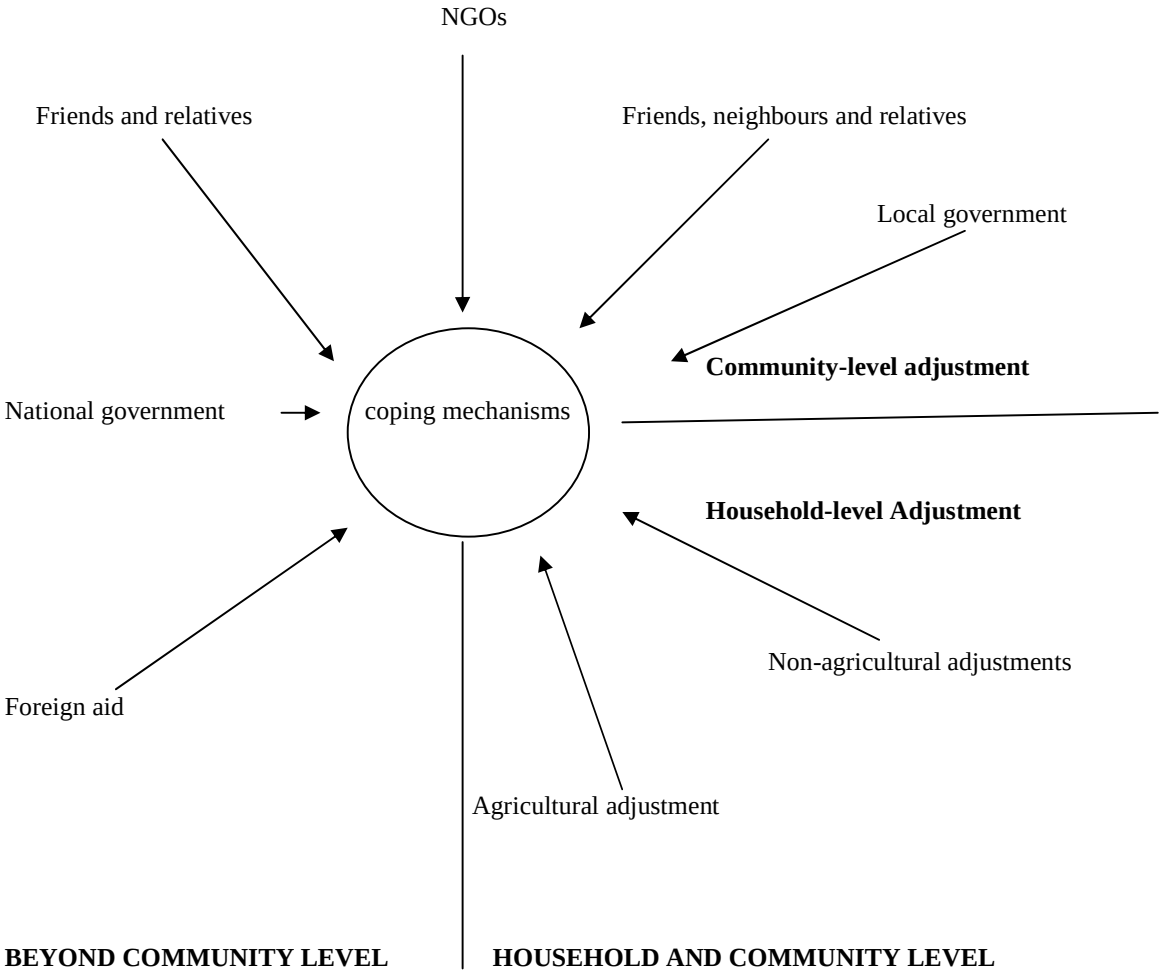

Figure 2.2 Coping mechanisms practiced by drought victims: a conceptual Framework. Source: Paul (1998).

Household-level agricultural adjustments

North Bengal being prone to frequent droughts, the local communities has over the years developed a wide range of long and short term coping mechanisms. These mechanisms include a crop replacement strategy, cultivation of more water-efficient crops such as kaon, jute, wheat and onion instead of the popularly cultivated rice. Some employed irrigation, gap-filling and inter-culture of some crops.

Household-level non-agricultural adjustment

In developing countries, household and personal assets are not generally disposed of under normal circumstances. In times of drought, when domestic food stock becomes exhausted or very low, there comes the need to sell assets to raise cash to buy food. Non-agricultural adjustments practiced in North Bengal during the 1994/95 drought period, according to Paul (1998), includes the sale of household belongings to buy food so as to reduce their vulnerability to the drought, this includes sales of livestock, sale of lands, mortgaging of lands, sales of poultry and housing structures.

Migration was not part of the adjustment, contrary to the expectations; members of only one respondent household migrated. This was contrary to expectation because usually it's a practice for drought affected families to migrate to other areas to seek income-producing employment that can help them to survive the drought period. Out-migration was prevented due to the fact that people living in this area have frequently experienced drought for over two decades and are now used to it. They do not consider migration as an option anymore as they believe that drought period would not persist forever.

Beyond household-level support

Some people who are affected by drought received help and support and sources from the community beyond. Although these supports were delayed and inadequate, some household received financial and other forms of support from various government and non-government services. This assistance includes cash loans, foods, seeds and fertilizers.

2.4.1.2.2 Response to drought among farmers in Southern Kajiado District, Kenya

In areas affected by drought all over the world, responses differ from one place to the other, which may be as a result of religious belief, educational or financial background and association with certain groups or organisations. In Kajiado district of Kenya, the following coping mechanisms to the drought of 1972-1976 and 1994-1995 were established by Campbell (1999). Prayer and payment to a rainmaker, movement of livestock to areas with water and pasture, liquidation of assets, sale of land, use of environmental resources such as

fire wood, use of moral economy, engagement in tourism and wildlife activities, horticultural activities as well as migration in search of jobs.

During the severe drought in Kajiado district, praying for rain which is one of the universal responses to drought was employed, furthermore, rainmakers were paid by both farmers and herders which were seen as an investment and therefore are related to the severity of the circumstances.

Livestock were also moved to areas with secured water and grazing. In times of severe drought sales of livestock were significant among herders while working in town and selling crops was practiced by farmers. This was done so as to meet their various needs for cash which included clothing, animals and school fees, but the most important of all was food. Environmental resources employed included the gathering of wild fruits, hunting and collection of wild plants to supplement food supplies.

During the drought of 1994-95, farmers engaged themselves in various activities such as trading in small stores or running a taxi as well as horticultural activities. Lastly, the increased involvement of the areas affected by drought in cash economy and improved transport links with major cities of Kenya has opened up possibilities for migration in search of employment.

2.4.1.2.3 Response of rural households to risk during drought in Zimbabwe

Kinsey *et al.* (1998) described drought as a major risk facing rural households in Zimbabwe. Rural households whose source of livelihood is dependent on agriculture faces enormous risks, income are highly uncertain as a result of the effect of weather variability.

According to Kinsey *et al.* (1998) the effects of drought of 1991-1992 on food consumption has two components; the first being that consumption was below what it used to be. Secondly, food consumption was maintained partly through government's drought relief programs.

Basically, individual farming household was unable to cope with drought without the help of the national government. The main form of relief provided by the state was household income support operated by the Department of Social Welfare (DSW); this was in two categories; free food distributions for the elderly and the disabled as well as distributions on the basis of participation in food for work program for destitute families with able-bodied members. The food program also targeted children under the age of five. In addition, income support was also provided to needy household in the form of assistance with school and examination fees, seeds and fertilizer packs were also distributed before the subsequent season.

Other coping mechanisms adopted by farmers during these periods includes gardening and selling vegetables, working as casual labourers, selling livestock and livestock products such as milk, little use of credit was employed unlike in other countries of the world, except in rare cases, sale of personal effects (such as jewellery or watches), household effects (such as furniture) or items of agricultural equipment to raise cash during drought emergencies do not occur among farmers in Zimbabwe.

In conclusion, Kinsey *et al.* (1998) described the three most important adjustment mechanisms as sale of livestock, use of financial assets as well as additional employments. From the coping mechanisms exhibited by farmers in the three countries reviewed above, it could be deducted that, apart from lack of migration to seek non-farming employment in Bangladesh, paying rainmaker to ease the effect of drought and refusing to dispose of personal or household effect to meet various needs during drought by farmers in Kenya, as well as a well pronounced help from national government in Zimbabwe, coping mechanism adopted are virtually the same but only differs in application.

2.4.1.2.4 Drought coping mechanism in desert region

According to Bruschweiler and Gabathriler (2006), arid and semi arid regions faces increasing difficulties which includes recurring drought, over-grazing, resource greedy agricultural production and population growth which causes disruptions and severe degradation leading to impoverishment, hunger and distress.

The main activities of this area include agriculture, livestock production, gathering and so on. Various management activities that have been in use for centuries in mitigating drought and decertification effects by indigenous population increasingly proves inadequate. Until recently normadism allows for regeneration and perpetual use of natural resources but this can no longer support livelihood.

As a result of increasing numbers of livestock producers and herds, as well as hazardous climatic conditions, there are conflicts and wars among the locals over access to resources. In traditional practices in these areas, milk is only being produced during the raining season when there is enough fresh grass for the animals. At the end of this season, the grass withers and thus loses its essential nutritional values which is just enough at best for the animals to survive. This does not provide sufficient basis for milk production.

Also, during the dry season or drought periods, pastoralists travel long distance to ensure sufficient grazing opportunity for the herds, which are often very large. Their presence among the sedentary population, which has its own livestock, is often perceived as undesirable leading to conflicts over grazing and water points.

When household strategies are adapted to ecological, economical and social conditions, it enhances the quality of life for household members and also fosters more sustainable use of natural resources. According to the Swiss agency for Development and Cooperation (SDC) in Kirgizstan, household strategies are developed according to existing potentials and promising opportunities. These strategies are oriented towards limiting the risk of total dependency on water and seek to make use of positive synergies between various activities

in order to create substantial added values. Such household strategies used in coping with drought include:

Household strategies for managing water dependence

For households to ensure their access to water, social network is key strategy. Large families with influential social network stand a better chance in negotiating and promoting their interests. The main principle of this strategy which is all understood by participating families is that one good turn deserves another, i.e.; if a family solicits help, they must be able to return it whenever the need arises. A household that does not respect this principle were excluded from such network; the only disadvantage of this strategy is that poor households are being marginalised.

In order to source for needed water, households adhere to formal and informal groups that take care of construction and maintenance work on the distribution system. Allocation of water and defence of their interests vis-avis other groups and state organisations that are in charge of water management and irrigation infrastructure upstream is maintained from distribution systems.

Diversification of agro pastoral production

This is another strategic aspect on the household level which helps to minimise the potential risks that are linked to hazards of climate or economic and social crises. Based on their resources, households invest simultaneously in rain fed and irrigated agriculture. Horticulture and tree growing are two further areas of investment. Others include livestock, which comprises of poultry, small ruminants and for the wealthier households, cattle and horses.

Creation of additional sources of income

This is an increasingly important strategy. The processing of farm products, along with crafts, small scale commerce, tourist accommodation, transport services and seasonal jobs are the main opportunities that enable the households to reduce their dependency on water.

Investment for innovation for rational water use

Various ways are being employed by farmers to produce or supply needed water to plants, for example, perforated bottles or cans filled with water are buried between two plants to supply the roots with water in an economical and targeted manner. Another example is adding clay to soil where trees are planted so as to reduce the need for irrigation water.

In 1989, several Burkinabe's livestock producers, who were involved in a pilot program organised by the Swiss Agency for Development and Cooperation (SDC) created a group called Association for the Promotion of Livestock in the Sahel and Savannah (APESS) with the aim of dissemination of ideas and innovations to improve living conditions for sahelian livestock producers.

According to Bruschweiler and Gabathriler (2006) various activities were put in place to bring about increase in quality of livestock production and farmers' livelihood. Such activities include: hay storage, livestock selection and livestock production system, protection of vegetation cover as well as education and training.

Hay storage, livestock selection and livestock production system

In the ancestral method of livestock production in Burkina Faso, there used to be nothing like hay or pasture production. Animals are fed with naturally grown grass as well as travelling long distances sometimes over the border of Burkina Faso into Angola whenever the need arise.

With the help of APESS, herds men were encouraged and convinced to make hay reserves on managed grazing lands that would be sown with seed and fertilized with animal manure, harvested and stored in sheds; this was a practice that was never part of their ancestral tradition. It also helped to gradually eliminate animals of poor quality and thus reduce the size of their herds. As a result, milk production is possible all year round, improving the food situation and family income, while diminishing the pressure in the natural vegetation.

Protection of vegetation cover

In this area, livestock farmers were shown the importance of the vegetation thereby making them to see reasons why the vegetation has to be protected. Pastoralists were advised to protect vegetation and trees of important and specific values, they were asked to collect their seeds and to multiply them in favourable seasons.

Education and training

Practical research is being carried out with instruments and infrastructure that are technically and economically available to pastoralists who enable them to better manage water resources. Reading and writing courses were also offered along with special training for women that aims to strengthen their role in the development of families and societies as a whole.

In various activities brought about by the Swiss Agency for Development and Cooperation (SDC) to cope with drought in the Sahel and Savannah areas, psycho-cultural forces played a basic role in realisation of their objectives. They realised the fact that every sahelian pastoralist are culturally sensitive to knowledge and beauty, and this was the basis of presentation of coping innovation to livestock producers.

2.4.1.2.5 Coping with drought in Namibia

Sweet (1998) in his study on drought effects and coping mechanisms exhibited by government, communal and commercial farmers touched various aspects of drought in Namibia which includes the effects and impacts of drought on farmers and how these effects were mitigated. A review of his work is as follows:

Drought impacts in Namibia

When drought strikes, it has both immediate and long term impacts, immediate impacts of drought includes shortages of food for people and scarcity of grazing for livestock and wildlife. According to Sweet (1998) the drought of 1992/93 in Namibia affected at least 625,000 of Namibia's population of about 1.4 million. Some 250,000 were classified as

vulnerable but no loss of life was experienced with due credit to all parties involved in relief programs. Nonetheless, the total cost of relief effort was in excess of 60 million US dollars.

Impacts of drought in Namibia include:

Reduced water supply

Reduction in availability of domestic water in major towns was a significant consequence of the drought, in June 1992. The water volume in the country's major catchments dams stood at only 26.8percent of capacity, compared to the same time the previous year. In rural areas, many pan and dams had failed to hold water and there was a significant drop of water table levels in wells and boreholes.

Reduced crop production

In the northern region, the drought experienced was more agricultural than meteorological. This was because the drought was characterised by uneven rainfall distribution in growing season, rather than markedly low rainfall overall. In 1991/92, almost half of the communal farmers that planted maize harvested none at all, while commercial maize farmers registered a mean harvest reduction of 36percent, among millet farmers, there was 75percent failure among the surveyed farmers.

High livestock and wildlife mortalities

According to Sweet (1998), livestock holdings could be reduced by drought in two ways: directly through mortalities and indirectly through distress sales. During these periods of drought in Namibia, some areas suffered livestock loss, while for other areas it was crop failure. The areas that suffered most were the communal areas, some of their suffering includes:

- Eighty (80) percent of livestock owners in community areas suffered losses.
- Due to the fact that communal area livestock owners were unable or unwilling to sell animals in significant numbers before they died or became unmarketable, mortality greatly exceeded sales.There was a significant reduction in herds' size in communal areas compared to commercial farmers.

These were mainly because commercial farmers have better access to grazing land and water. They are also in possession of higher cash reserves to buy in feed or rent grazing land and they also possess greater willingness/ability to sell animals.

Reduced household income

Due to crop losses during the 1992 drought, livestock mortality and reduced employment opportunities, communal area households lost approximately a quarter of their average monthly incomes. There was also a significant widening of urban-rural income gap within the communal areas. Commercial farm owners also experienced a dramatic decline in their average incomes, but this was from a higher initial level than that of the communal farmers.

Response to drought in Namibia

Sweet (1998) states that prior to the drought of 1992/93; there was no institutional capacity to deal with serious drought or other environmental disasters in Namibia. Coupled with various efforts made by communal and commercial farmers to cope with the effect of drought as much as they could, the national drought task force was constituted by government. Activities by communal and commercial farmers as well as government efforts in mitigating the effects of drought are as follows:

Response to drought by communal household

During the period of drought when crop production or household income declines, rural households drew on a number of alternative sources for cash and food, such as livestock sales, assets sales, informal transfer and borrowing. Three related coping strategies practiced are reduction in non-food expenditures, rationing of available foods for both human and livestock consumption, and demographic adjustments. When livestock is threatened by drought, the main option is to sell some animals, buy in feed and/or move some animals.

Not many communal families sold domestic assets because they got free food from the government, but there was outflow of household adults in search of food. Other methods employed by communal households in coping with drought includes; seasonal movements

of animals which was evident in the Northern region where there was significant movement into Angola where less concentration on animals exists and the use of fodder provided by the government.

Communal households were generally reluctant to sell animals in a drought for a number of reasons which are: they are not commercially oriented and have different reasons for keeping livestock, the majority of their herd and flock size are small, by the time drought was apparent, the animals have already lost condition and their sale value reduced, lastly the sale points tend to be few and far between, at least in Northern region communal areas, and stock lose further conditions by the time they reached the sale point.

Response to drought by commercial farmers

The commercial farmers were able to cope and manage the effect of drought better than the communal farmers, measures taken includes: compensation scheme from government, availability of larger resources of capital to draw upon, better access to market and supplies for buying in and selling out, main concern was to avert loss of livestock and wildlife unlike communal farmers who were worried about household daily needs and it was easier to obtain credits to fund mitigating drought activities because they have collaterals.

Response to drought by the National Government

The national government put in place various measures to mitigate drought, these measures include: preparation of an emergency drought budget in 1992, appeal for donor support, increase in allocation for water, food distribution to vulnerable groups i.e. children under 5 years old, pregnant/lactating women, elderly and physically challenged people. This was done to prevent drought relief dependency syndrome because almost half Namibian were at risk.

In trying to execute the above listed measures by the Namibian government failure was encountered and this was due to non availability of guidelines to classify a village or community as drought affected, hence all rural communities were included if they were in a region designated as drought affected. Another reason for the failure was that aids were

targeted at individuals but it was distributed to household for lack of guidelines to screen out wealthier households.

Other measure by the government includes food for work, this is a situation whereby food aids were to be received by able-bodied adults in affected areas through a food-for-work scheme devised and run by local communities. This also failed for lack of adequate coordination during drought as the intervals between submitting projects for approval and the arrival of food were too long, as such discouraging potential participants.

The government also provided fodder and lick subsidies for livestock farmers, grazing lands were purchased from small freeholders to serve as alternative grazing sites for livestock farmers and subsidies on transportation of animals to such areas were also provided. There was also the provision of emergency water supply; the main components of the water assistance offered under the drought relief program are in four categories which are the rehabilitation of disused or faulty boreholes, provision of new boreholes, extension of pipelines and branch lines as well as the provision of water tanker services with priority given to schools, clinics and disadvantage rural communities.

Sweet (1998) concludes that failure was experienced in the drought relief program practiced during these periods, as a result, he recommended that the need for a better targeting for all drought relief subsidies, structure for food-for-work should be put in place before any drought period and above all, an effective early warning system is invaluable for timely implementation of drought mitigation and relief resources, but must be accompanied by an infrastructure for effective implementation.

2.4.2 Drought vulnerability

According to Patrick (2003) the more directly dependent a population is on the natural resources base of an area, the greater their vulnerability when there is interference in the productivity of that natural resources base. This situation is factual in dry lands occupied by people considered the most ecologically and politically marginalized group on the globe. The most limiting natural resources in the dry lands is water, a complete disruption in rainfall can initiate disaster such as famine on a catastrophic scale.

The terms 'vulnerable' and 'vulnerability' are often equated with 'poor' and 'poverty' (World Food Programme, 1996). The most basic definition of vulnerability is derived from its Latin root *vulnerare* which means 'to wound' therefore vulnerability is 'the capacity to be wounded' (Kates, 1985). Gallopin (2006) describes vulnerability as a concept that has been used in different research traditions, but there is no agreement on its meaning. According to Olga and Wilhite (2002), most definitions of vulnerability contain a common thread. They all agree that vulnerability shows the degree of defencelessness of society to a hazard, which could vary either as a result of variable exposure to the hazard, or because of coping abilities. Coping abilities according to Downing and Bakker (2000) include protection and mitigation.

Selvarajan *et al.* (2002) define vulnerability as the extent to which a natural or social system is susceptible to sustaining damage from climate change, Downing (1991) defines it as an aggregate for a given population or region of underlying factors that influence exposure to famine and a predisposition to the consequences of famine. Adger 2000 describes social vulnerability as the exposure of groups or societies to stress resulting from the impacts of environmental change. Social vulnerability generally consists of disruption to livelihoods and loss of security.

Binayak (1996) on the other hand defines vulnerability from two perspectives: the first perspective is the 'risk-centric view' whereby vulnerability is typically defined as variability in the living standard caused by consumption or income shocks, the second is

'right-centric view' whereby vulnerability is said to be caused by lack of social and political rights.

Both views are important when considering the implications of vulnerability for drought reduction. The common understanding of the above definitions is the expression of susceptibility to hazards, either as a result of varying exposure to hazards, or because of variations in the ability to cope with its impacts.

Selvarajan *et al.* (2002) also believe that vulnerability has two sides: an external side of risks shocks to which an individual or household is subjected and an internal side, which is defencelessness, meaning a lack of means to cope without damaging loss. Dow (1993) gives vulnerability factor as characteristics of the environment, individuals and society. These contributing factors include economics, technology, social relations, demographics and health, biophysics, individual perception and decision-making and institutions.

Factors such as economics, technology and infrastructure are better understood, while individual and societal factors are more difficult to understand and conceptualized.
Vulnerability has damaging effects on livelihood and not just life and properties, the more affected people are those that find it hardest to reconstruct their livelihoods following the disaster (Olga and Wilhite, 2002). Olga and Wilhite (2002) state further that vulnerability is closely correlated with human infrastructure and socio-economic conditions.

According to them, as a rule, the poor suffer more from hazards than the rich, although poverty and vulnerability are not always correlated. Drought vulnerability varies for different individuals and nations. In developing countries, drought vulnerability constitutes a threat to livelihood, the ability to maintain productive systems and healthy economics. While in developed economies, drought poses significant economic risks and costs for individuals, public enterprises, commercial organisations and governments (Downing and Bakker, 2000).
The degree to which a population can be affected by drought depends largely on various response or coping options available to them, or their degree of vulnerability, which in turn

can be decreased by adequate pre-drought planning and mitigation of effects during the event or the lack of it. According to Patrick (2003), vulnerability to drought is complex, yet essential to understand so as to be able to design drought preparedness and mitigation strategies, relief policies and programs.

He states further that response options available to less prosperous households or societies are very low. Poverty and vulnerability are not the same, two households or societies may have similar levels of poverty but different levels of vulnerability, for example, one household or society may be primarily dependent on just one or two forms of income generation, such as mono-cropping for exports, while another may depend on diversified livelihoods. Both groups can have the same level of income, yet, when they are both exposed to a shock such as drought, the former will likely become poorer than the later because there is a greater exposure to risk and/or because they have less response option.

Combination of environmental and economic changes is altering the context under which farmers in southern Africa cope with climate vulnerability as stated by Leichenko and O'Brien (2002) and Eriksen *et al*. (2005). In order to be able to design successful strategies for drought preparedness and mitigation, there is need to understand who is vulnerable and why they are vulnerable. Such examination can point to structural, socio-economic issues which present societies with difficult choices between consumption today and investment in crisis for future.

2.5 WATER ISSUES IN SOUTH AFRICA

Although drought incidences are most evident in agriculture on the level of greenness on the field, and this level of greenness is greatly affected by the level of water content in the soil. Lack of water may be the primary cause of drought, but there are other factors which intensifies the effects of lack of water, these factors that intensifies the effects of lack of water, many of which have little to do with water per se, are adequately managed, the

consequences of the lack of water can be greatly reduced and this gives a reason for drought management policy to take into account a wide variety of factors (Abrams, 2001).

2.5.1 The situation in South Africa

According to Abrams (2001) in a document prepared for ministry of agriculture, South Africa, as a contribution towards the development of a national drought management policy, most of South Africa has a mild and temperate climate. Precipitation varies spatially across the country with a high seasonal variability. It also varies annually with cycles of drought.

About 890mm of precipitation falls yearly in the Eastern Low veld and the Eastern Uplands as far west as the Drakensberg. The High veld receives about 380 to 760mm of precipitation annually, the amount diminishing rapidly towards the west. On the western coast rainfall is often as low as 50mm annually. The average rainfall is 500mm per annum which is sixty percent of the world average.

Sixty-one percent of the country receives a rainfall less than 500mm annually which is considered the minimum for successful dry land farming and twenty-one percent receives less than 200mm. The country depends very much on the transfer of bulk water from region dryer, but more highly populated, industrial and mining canters of the country. This is rapidly becoming less feasible; however, the greater attention will has to be paid to the management of demand and more efficient use of water (Table 2.4).

Table 2.4 indicates the sectoral use of water in South Africa and how that is projected to grow in the near future. It is clear that greater attention is going to have to be paid to demand management but a clear commitment to this is not evident in current policy and legislative development.

Table 2.4 Current and projected demand in South Africa by sector

Sector	Demand (x 10^6 m^3)	
	1993	**2010**
Domestic	1516	3000
Industry	1031	2500
Municipal use	90	200
Urban use	280	500
Power generation	224	400
Mining	466	600
Irrigation	8254	11500
Stock watering	264	350
Forestry	1284	1700
Nature conservation	2994	5000

Source: Abrams (2001)

Abrams (2001) also postulates that the demand for water in South Africa as a whole will soon exceed available resources. Already, it is estimated that several river basins experience annual net shortages of water, the magnitude of which varies from year to year depending on the severity of localized drought conditions.

2.5.2 History of drought in South Africa

Traditional response to drought in South Africa according to van Zyl and Vogel (2009) includes 'subsidies' and 'bail outs', but considering the financial crisis as a result of economic recession at present, those types of approaches may not always be suitable.

The story of drought in South Africa began as far back as 1800s (Van Zyl and Vogel, 2009), a number of drought events were noted in the country and then continues to tract responses for over a period of 200 years to date. Van Zyl and Vogel (2009) state in a draft presented for Farmers Weekly Magazine that serious drought spells occurred in the 1800s, these periods includes 1812-1815; 1817-1819; 1827-1829; 1834-1838; 1844-1862; 1866-1869; 1876; 1887-1888 as well as 1896 and 1898.

They state further that in the last century, major drought occurred during 1904-1908; 1912-1916; it was recorded that the drought of 1919 was a very severe one, the record continued from 1922-1924; 1926-1928; 1930-1933; 1935-1938; 1960s; 1970s; 1980s and 1990s. A breakdown of such drought experiences as highlighted by van Zyl and Vogel (2009) is given below.

2.5.2.1 Drought experiences during the early 1800

According to Van Zyl and Vogel (2009), limited official reports of drought, its impacts and associated responses to early drought in the first decade of 19th century were not available. Reachable reports on drought record showed negative impacts on farming activities, among coping mechanisms or responses used include stock movement. In these periods, large numbers of stock mortality were reported, in order to reduce such effects, animals were moved from drought invested areas to areas with better grazing and water availability.

Van Zyl and Vogel (2009) declares that apart from the drought severity itself, there were other driving factors which significantly added to suffering from drought effects by farmers, these factors include lack of clear, official, institutional response to drought. In the review of drought in South Africa by Van Zyl and Vogel (2009), other factors were also noticed to have heightened drought impacts as early as 1800s; human resource-use behaviour; including land-use practices severely impacted on vegetation change which untimely heightened the drought impacts on the farmers.

2.5.2.2 Drought in South Africa from 1900 to 1950

This period was ground breaking in the history of agriculture and understanding the great drought problem in South Africa. According to Van Zyl and Vogel (2009), these periods witnessed researchers bringing about valuable research results about droughts as well as suggestions for policies on drought management, some of which were regarded as still suitable today.

Various investigations on drought phenomenon which include the impacts of drought on agriculture and the economy of the country at large were undertaken during this century. The result from these efforts laid down the stage for drought management practices which still hold today. Van Zyl and Vogel (2009) highlight various committees or reports of committees which were commissioned by the government to look into best possible ways and means by which losses as a result of drought could be reduced or avoided. Such committees include: select committee on drought, rainfall and soil erosion (June 1914), union of South Africa, interim report of the drought investigation commission (1922), final report of the drought investigation commission (1923), national provision against drought (1941), phase drought relief scheme (1946) and the report of the fodder bank committee (1949).

As stated by Van Zyl and Vogel (2009), the report gave the main factor causing drought losses as the kraaling of stock; inadequacy of drinking water facilities, the destruction of vegetation and resulting soil erosion which in turns leads to a diminishing efficiency of the rainfall. The key recommended areas of concern by the drought investigation commission according to Van Zyl and Vogel (2009) and Dodson (2003) are the practice of overstocking farms is very prevalent throughout the union, and that several causes are responsible therefore, among which are extreme seasonal variations and the optimism of the farmers, animals on overstocked farms go into drought handicapped by a low condition as well as little food in prospect which circumstances lessons their chance of coming through the drought.

In addition the reserving of fodder for use in times of scarcity is a very unusual practice, largely responsible for drought is the almost universal practice of overstocking the farm, and failure to make any sort of provision for the drought which the farmer knows will come on him sooner or later (Interim report of the drought commission of April 1922).

As stated by Van Zyl and Vogel (2009), the extract from the above listed report constituted the first official attempt at a systematic and co-ordinated analysis of the fundamental short comings on farming. The result focused public attention on problems of soil erosion and

drought and also emphasised the fact that these were a threat to South Africa's progress which was essential to adapt farming systems accordingly. It was also concluded that certain interacting factors heightens drought impacts in South Africa, which include soil erosion and animal diseases.

2.5.2.3 Early drought response in South Africa

As given by Van Zyl and Vogel (2009), measures taken in times of severe drought in early years in South Africa in areas described as being stricken includes stock transfers; livestock could be conveyed out and back to better pastures, fodder could be rallied to drought stricken areas at one quarter the original rate. These were usually done with co-operation between Railway co-operation and National Treasury in South Africa.

Van Zyl and Vogel (2009) described another drought interventions introduced by the government during such period as the fodder bank systems. Such banks were maintained in areas stricken by drought with contributions from farmers on an insurance basis, the government was expected to contribute the larger percentage of seventy five per cent of the total storage and administrative costs, this scheme was however not acceptable to the then minister. In response to these, another committee was established to draw up a permanent drought aid plan. This plan was premised on the understanding that farmers should be enabled as far as possible to make their own provision against normal droughts, only when a very long period of drought prevails would the state assistance be required.

During these periods, farmers were encouraged to save in good years and such savings are not taxable in the Land Bank, planning by farmers whose farms are situated in proclaimed soil conservation district was required, otherwise, such farms would not be able to make use of the state's drought assistance scheme if his farm has not been planned or if he has not applied for such planning within specific period or does not apply conservative farming practices.

2.5.2.4 Drought legislation in South Africa

The outcome of the committee brought about the passing of the soil Conservation Act of 1946, which includes not only soil conservation but also safeguarding of agricultural resources as a whole (Van Zyl and Vogel, 2009). Other things outlined are the adverse natural factors farmers have to contend with, the widespread destructive systems of farming, the frequency of 'backward farming' methods, low educational standards and of deficient working capital.

Summarily, according to Van Zyl and Vogel (2009), the first concerted efforts by the State to manage droughts focused extensively on stock farming. Measures such as determining stocking rates, stock feeds and assistance to farmers during drought were repeatedly examined. The summary of key drought issues and measures taken by the state as given by Van Zyl and Vogel (2009) is as shown on Table 2.5 below.

Table 2.5 Summary of key drought issues and state response from 1900 to 1950

Key elements of drought	Institutional and policy response
Drought is regular feature that should be managed by farmers as part of their risk portfolios.	Despite the acknowledgement that drought should be managed, few incentives for risk reduction measures were in place to assist farmers to become more risk averse.
Farming and natural veld and soil resources issues.	Drought policy response repeatedly focused On soil and veld conservation and stock feed.
The role of sub-division of land and economic farming units often rose as a key factor exacerbating drought impacts.	Policy response variable over time although most commissions call for farming that is mindful of carrying capacity issues.
Drought often focussed on as a land issue. The role of water acknowledged but often not integrated into policy response.	Policies largely driven by the Department of Agriculture, although transversal drought risk was made mention of more, separate policy responses including those for the Department of Agriculture and those for the Department of Irrigation and Natural Resource Planning.
Drought seen as complex issues involving a range of factors. Farms organizations and supports suggested for better management of such complex issues.	Despite the call for greater integration and support groups, farmers' organizations believed this critical theme is not as prominent as the soil and veld conservation themes.

Source: Van Zyl and Vogel (2009)

2.5.2.5 Drought during 1950 – 1980 in South Africa

Van Zyl and Vogel (2009) identified years of consecutive drought as those of 1981/82 – 1982/83; 1968/69 – 1960/70; 1967/68 – 1968/ 69. The drought spell of 1960s and 1980s emerged as key periods of persistent drought spells in the latter half of the 19th century.

During the period 1960s – 1980s, van Zyl and Vogel (2009) stated that the years of consecutive drought were identified in various years including the North-Western Cape, northern areas of the country, Transvaal and the Free State. In March 1961, the Department

of Agriculture's Technical Services appointed a committee to Enquire into the Feeding of Animals in times of drought, they were asked to submit a report with recommendations on the following issues.

Supplementary research and extension services which may be necessary for the guidance of farmers in regard to the efficient feeding of animals in times of drought, planning and management measures to prevent and/or alienate the adverse effect of drought, methods of providing fodder for use during periods of drought; on farms, from other sources, with attention to the possibility of efficient utilization of feeds, such as maize, Lucerne hay, as well as the conservation, storage and the distribution of supplies of fodder.

During these periods, van Zyl and Vogel (2009) state that it was mandated that if a farmer has followed a correct farming practices as stipulated by the government and never the less fallen a victim to drought, the new Department of Agricultural Finance should be ready at all times with a drought relief fund out of which assistance can be given. This will enable the farmer to move his stock to suitable grazing and back or to convey fodder to the animals.

In the 1960s, a number of surveys on drought situation were carried out in several parts of the country. As a result of such surveys; a comprehensive memorandum was prepared and submitted to the Agricultural Advisory Council and the Minister of Agriculture. The result of the investigations confirmed some problems of farm units that were also a symptom of what was occurring in the rest of the country, which paved way for the legislation on the subdivision on Agricultural Land in 1970.

On 7th May 1966, the state President appointed the Commission of Enquiry into Agriculture (Marais Commission) to lay down the basic principles for healthy farming systems in the republic both economic and biological, to determine in what respects, branches and regions the present farming systems fall short and why, as well as to specifically investigate and make recommendations in respect of the reconstruction of agriculture in regions particularly subjected to drought conditions and to report thereon interim.

This commission gave an interim report in 1968 with recommendations on a wide range of matters including many pertaining to drought. They considered just like former commissions, that droughts of shorter or longer term duration are characteristic and inevitable phenomenon, which may be expected to occur with certainty over large parts of the republic at least once in five years (van Zyl and Vogel, 2009).

2.5.2.6 Drought in the 1980s and 1990s in South Africa

According to van Zyl and Vogel (2009) in the 1980s and 1990s there was an increase in drought occurrences and experiences which became more regional when it comes to reporting on drought impacts. In the early 1980s, the declaration of drought was based on the criteria such as rainfall over three seasons, veld condition, availability of water for stock, stock condition/deaths and availability of fodder to be purchased with a disaster drought being declared if rainfall over two consecutive seasons is 70 percent or less the average main precipitation of the area concerned (Bruwer 1990 cited in Van Zyl and Vogel, 2009).

The 1982-83 and 1991-92 droughts were the most severe meteorological drought of the 20th century in Southern Africa. In 1991-92 droughts, 70 percent of the crops failed. It was estimated that half of the population in the affected area was at risk of malnutrition, and other related health problems (Monnik, 2000).

As a result of drought in the 1980s, agricultural sector suffered a great deal, during these periods, an estimated R3 billion debts escalated from an emergency assistance to agricultural scheme (van Zyl and Vogel, 2009). Pre 1990 drought policy was directed primarily at stock farmers according to Monnik, (2000) because stock farming was considered to be best adapted to the highly variable rainfall conditions in South Africa. However, relief aids were tended to favour the poor and climatically marginal areas.

Van Zyl and Vogel (2009) stated that drought of late 1980s and early 1990s resulted in government bailing out farmers with a large sum of money through the Agricultural Department. This leads to the beginning of a change in policy direction, at this time, government decided that no future financial aid would be made to Agricultural Producers.

There was a shift in paradigm in 1994 (Walters, 1993; Monnik, 2000; O'Meagher *et al.*, 1998; Van Zyl and Vogel, 2009), this resulted from a change in the political dispensation, the disaster aid, especially drought assistance was to be revised and to make way to develop a more proactive response to the drought phenomenon; this was reflected in the 1995 White Paper on Agriculture which has the following contents:

That Agricultural production and practices would be organised in such a manner to improve national as well as household food security. Drought will be recognised as a normal phenomenon in the agricultural sectors and it will be accommodated as such in farming and Agricultural Financing Systems. The Government should not support measures that softens the negative impacts on farm incomes caused by poor risk management, as this will cause farmers to use high-risk methods which could endanger resource conservation, farming systems, which make provision for drought as normal phenomenon in South Africa should be developed.

In addition, the Government should therefore support the full spectrum of production systems and practices, from urban food garden and small-scale production for household income and food security, to large-scale production systems, which can add considerably to national food security. And lastly in the case of natural disasters, the government will be responsible for giving assistance to counter unacceptable consequences as far as possible. Natural disasters such as floods, runaway veld fires, severe droughts and untimely frosts can totally disrupt communities and can force farmers, over the whole spectrum of farm sizes out of business.

Such disasters do not include natural phenomenon, which occur on a regular basis, such as intermittent droughts in stock-production areas and hailstorms in hail-prone areas. In the

case of natural disasters, it is in the interests of the country as a whole that the Government should take steps to counter unacceptable consequences for the rural economy. Such steps could include financial assistance to the Agricultural sector.

2.5.2.7 Present-day disaster management in South Africa

Although various committees presented various recommendations finding proactive solutions to drought in South Africa, but in the real sense of it, recent drought in South Africa suggested that the actual practice on ground remains one of drought relief and response with few notable cases of drought-risk response being implemented Van Zyl and Vogel (2009).

According to Van Zyl and Vogel (2009), various consultations with a range of stakeholders to bring about a new drought risk reduction policy that would reflect the international thinking of the time was carried out. These include risk-reduction framework and development of a strategy to reduce the vulnerability of all South Africans at all levels most especially the poor and disadvantaged communities to periods of disasters.

This led to recommendations of the White Paper on Disaster Management of 1999, and in turn was contained in the Disaster Management Acts of 2002 which was promulgated by the parliament. Resulting from the National Disaster Risk Management Framework (NDRMT) of 2005, the Department of Agriculture accepted the primary responsibility of drought management by sharing responsibilities with other tiers of the government, organized Agriculture and the farming community. As a result, Agricultural Drought Management Plan (ADMP) was brought into place by the Agricultural Department with the following roles: to integrate institutional capacity/arrangements, for disaster risk assessment, for disaster risk reduction, for response and recovery.

According to van Zyl and Vogel (2009), the Department of Agriculture were also expected to facilitate drought risk management; information management and communication, education, training, public awareness as well as funding of other programs prescribed by the NDRMT. The long term aim of the ADMP was to ensure that the Agricultural sector has an effective and integrated drought management system for plant, animal husbandry and income, where negative impacts of drought have been minimized for sustainable use of natural resources.

This new policy exhibits a departure from the existing approach to disaster management. It brings about a rational national framework for disaster management aimed at integrating risk reduction measures into all development initiatives in order to avoid human, economic, environmental and property losses.

Although there was a paradigm shift in policy from reactionary to a more proactive measures, the focus in drought management across various governance scales has remained focussed on reactionary measures which includes large financial bail outs and subsidies rather than institutional capacity development and training in ensuring that drought efforts are more risk reduction in focus and where possible ensuring drought efforts are linked to various development initiatives (van Zyl and Vogel, 2009).

For instance as reported in the annual reports of National Department of Agriculture (1993/94), drought assistance to livestock farmers was about R143.7 million, free-of-charge transportation of donated stock feed/licks by rail was also offered by the government. Interests on loans by sugar-cane farmers hit by drought were downwardly reviewed by the government subsidising the interest up to 8percent per year.

Assistance in 1994/95 was mainly loans and subsidies and the expenditure was less than in previous year (1993/94). In 2001/02, Early Warning System (EWS) was established in collaboration with the South African Weather Service. Training of extension officers in the interpretation of weather climate forecast began, by 2002/03, a pilot project was launched

regarding an awareness program on weather/climate interpretation and five of the country's nine provinces were visited. Till date, only a few extension officers have been trained compared to the large farming community in South Africa.

In 2003/04 season, maize planting was the lowest in more than sixty years (NDA, 2003). A total of R500 million was approved by the South African Government as emergency drought relief fund in 2003/04 season, another R500 million was also approved for the preceding year. The funds were used for emergency relief to vulnerable rural communities, provision of fodder for livestock to both established and emerging farmers, as well as provision of water for both human and animal consumption. The trend above shows drought mitigation always taking the form of emergency relief program, there is the need for the government to take a more proactive measure as stipulated by the policies on natural disasters and most especially the drought.

2.5.3 Drought in the Free State Province

A review of Annual reports of the South African National Department of Agriculture of the 1990s and early 2000s reflects various facts about the effects of droughts and effort made in alleviating the associated problems brought to the farmers. According to the annual report of the National Department of Agriculture (1993), El Nino phenomenon in the Pacific Ocean influences South Africa's climate majorly in the summer rainfall areas which includes the Free State Province, this phenomenon brings about dryness of weather, or lack of rainfall (drought), thus leading to loss of vegetation and economic damages.

Percentage of Average Seasonal Greenness is one of the criteria used in determining the degree of rainfall over a particular period of time. This is reflected on how green the vegetation is. As shown in **Fig. 2.3** below, more area of the Free State Province experienced above average rainfall which is evident in the level of greenness of vegetation as shown on the map, although some areas experienced potential drought conditions while others actually suffered a drought condition.

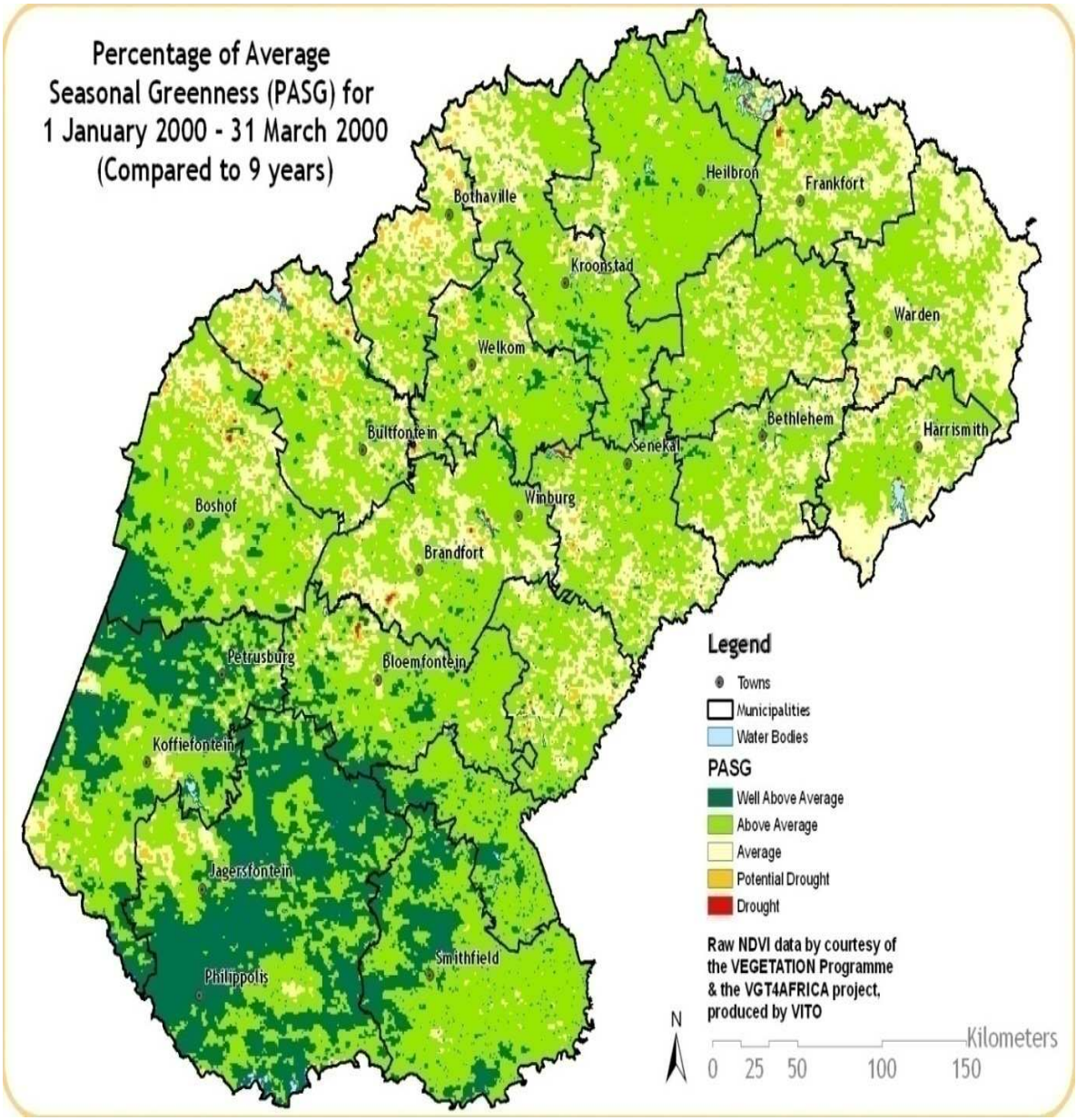

Figure 2.3 Percentage of Average Seasonal Greenness (PASG) for 1 January 2000 – 31 March 2000
Source: Agric Research Council (2007).

Unlike the previous year, drought conditions was experienced in most areas of the Free State Province, only a handful area of the province had an average to above average

green vegetation **(**see **Fig. 2.4)**. There was loss of vegetation and crop failure in the Free State Province during this period.

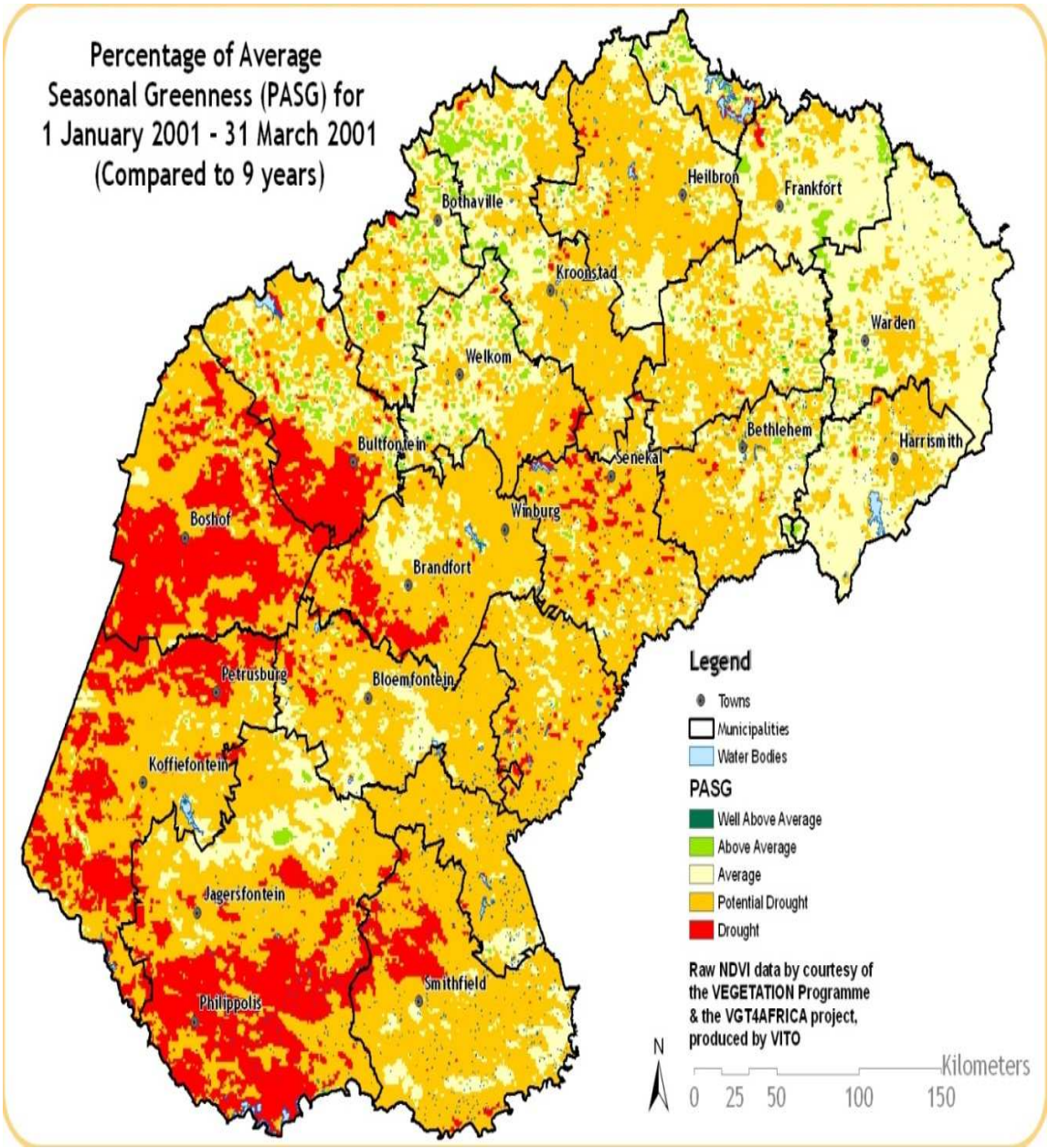

Figure 2.4 Percentage of Average Seasonal Greenness (PASG) for 1 January 2001 – 31 March 2001.
Source: Agric Research Council (2007).

Compared to 2001**(Fig. 2.4)**, the year 2002 could be said to be a successful one in terms of level of greenness of the vegetation, because most areas as shown in **Fig. 2.5** had average to above average level of greenness while only some few spot showed potential drought to drought incidences.

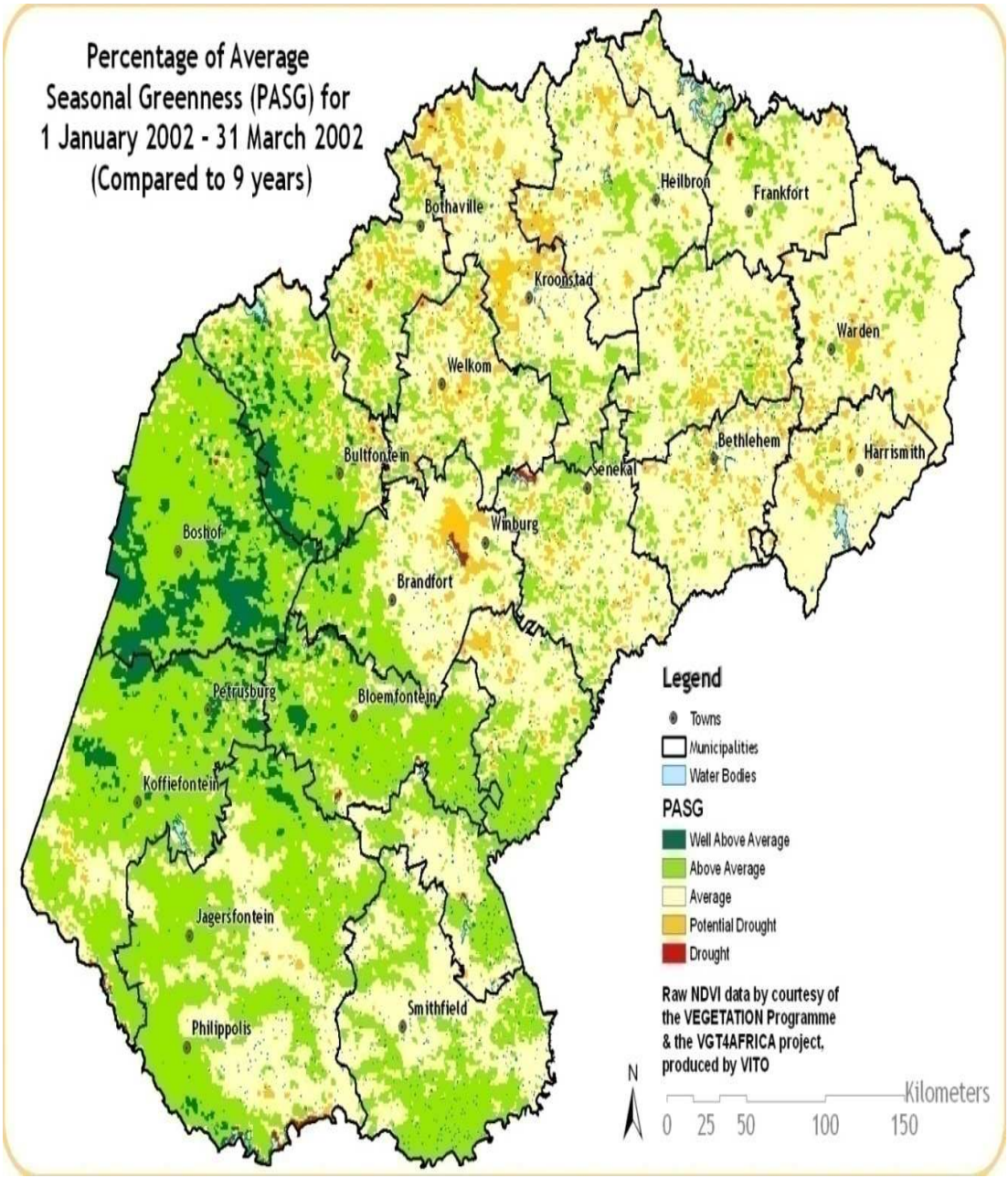

Figure 2.5 Percentage of Average Seasonal Greenness (PASG) for 1 January 2002 – 31 March 2002.
Source: Agric Research Council (2007).

Figure 2.6 below shows more areas with potential drought incidence. Only a few spot are with drought while average to above average level of greenness is also not well pronounced over the period in review.

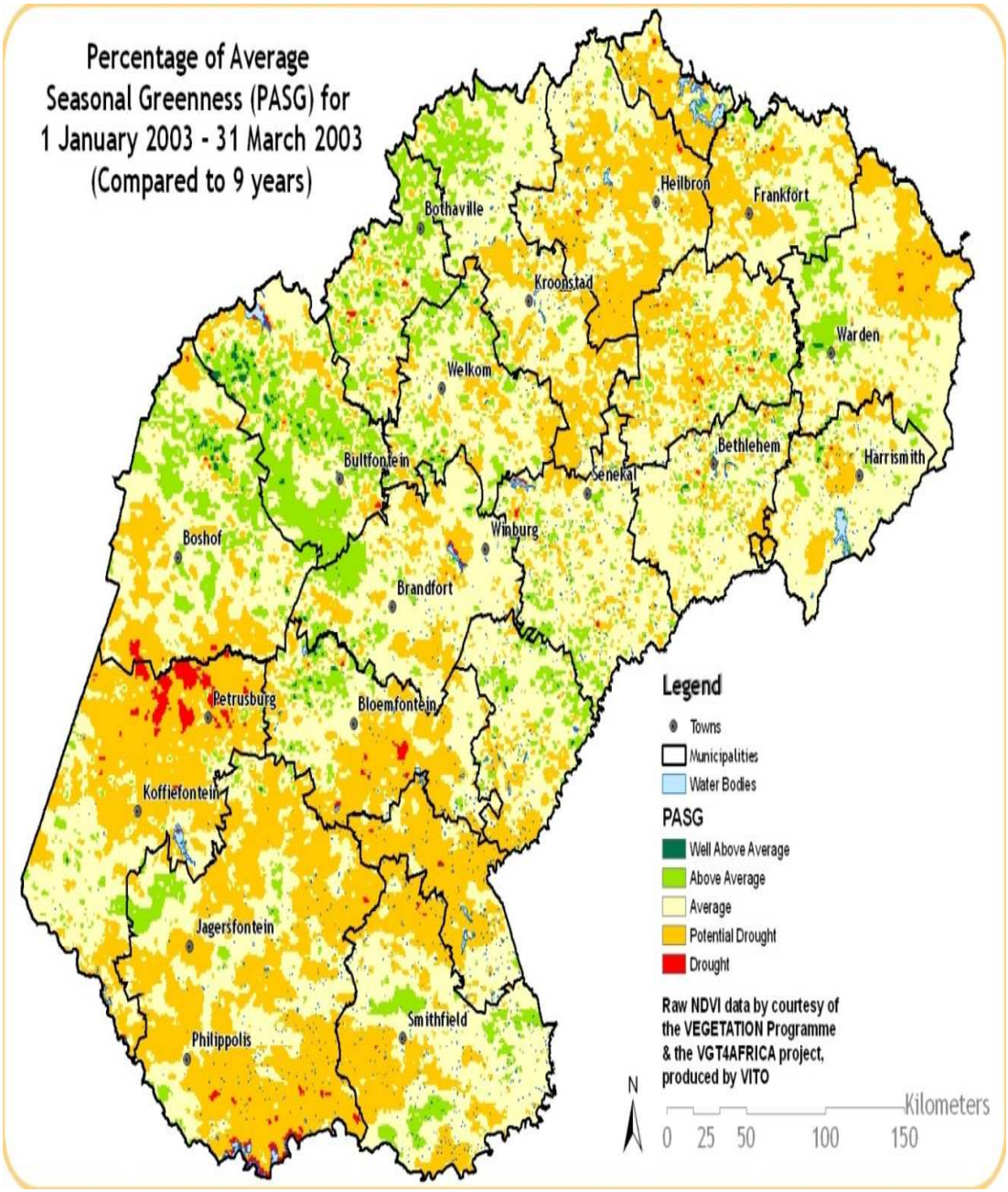

Figure 2.6 Percentage of Average Seasonal Greenness (PASG) for 1 January 2003 – 31 March 2003.
Source: Agric Research Council (2007).

2004 was the year most provinces were declared disaster areas because of the effect of a drought, as indicated in **Fig. 2.7** below, more area showed a potential drought condition while others suffered drought, only a few experienced above average greenness of vegetation while none was characterised with well above average vegetation greenness in the Free State Province during the year 2004.

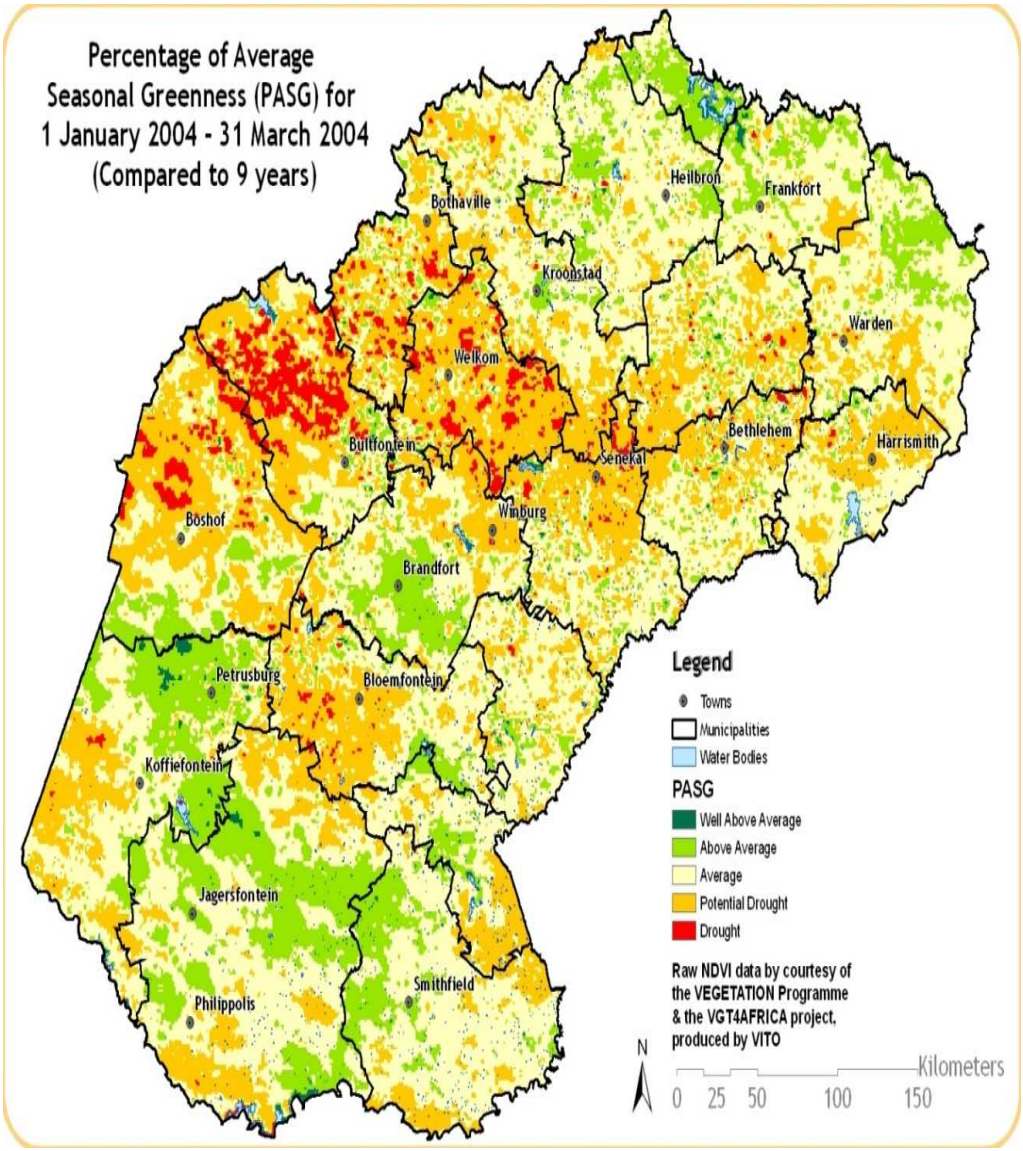

Figure 2.7 Percentage of Average Seasonal Greenness (PASG) for 1 January 2004 – 31 March 2004.
Source: Agric Research Council (2007).

The problem of drought persisted just as in the previous year, the southern part of the Free State Province was more affected, only a few areas within the province experienced well above average vegetation greenness which made it a little better than 2004 as shown in **Fig. 2.8**.

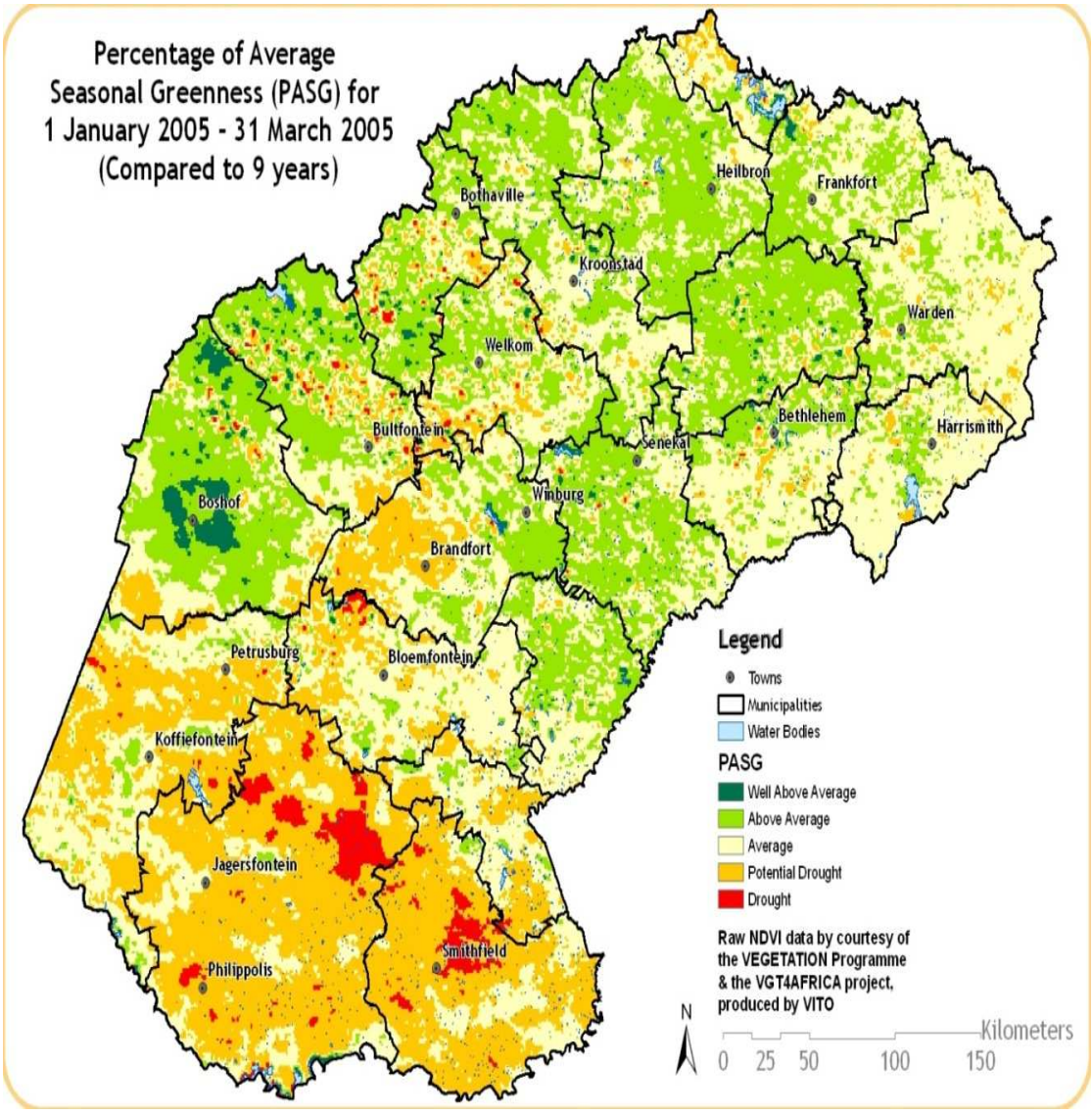

Figure 2.8 Percentage of Average Seasonal Greenness (PASG) for 1 January 2005 – 31 March 2005.
Source: Agric Research Council (2007).

From figure **2.9**, it was by far a better year compared to the past four to five seasons. Greenness of vegetation is well pronounced in most areas of the Free State Province as indicated in **Fig. 2.9**, but also not without some drought and potential drought areas as shown in **Fig. 2.9** below.

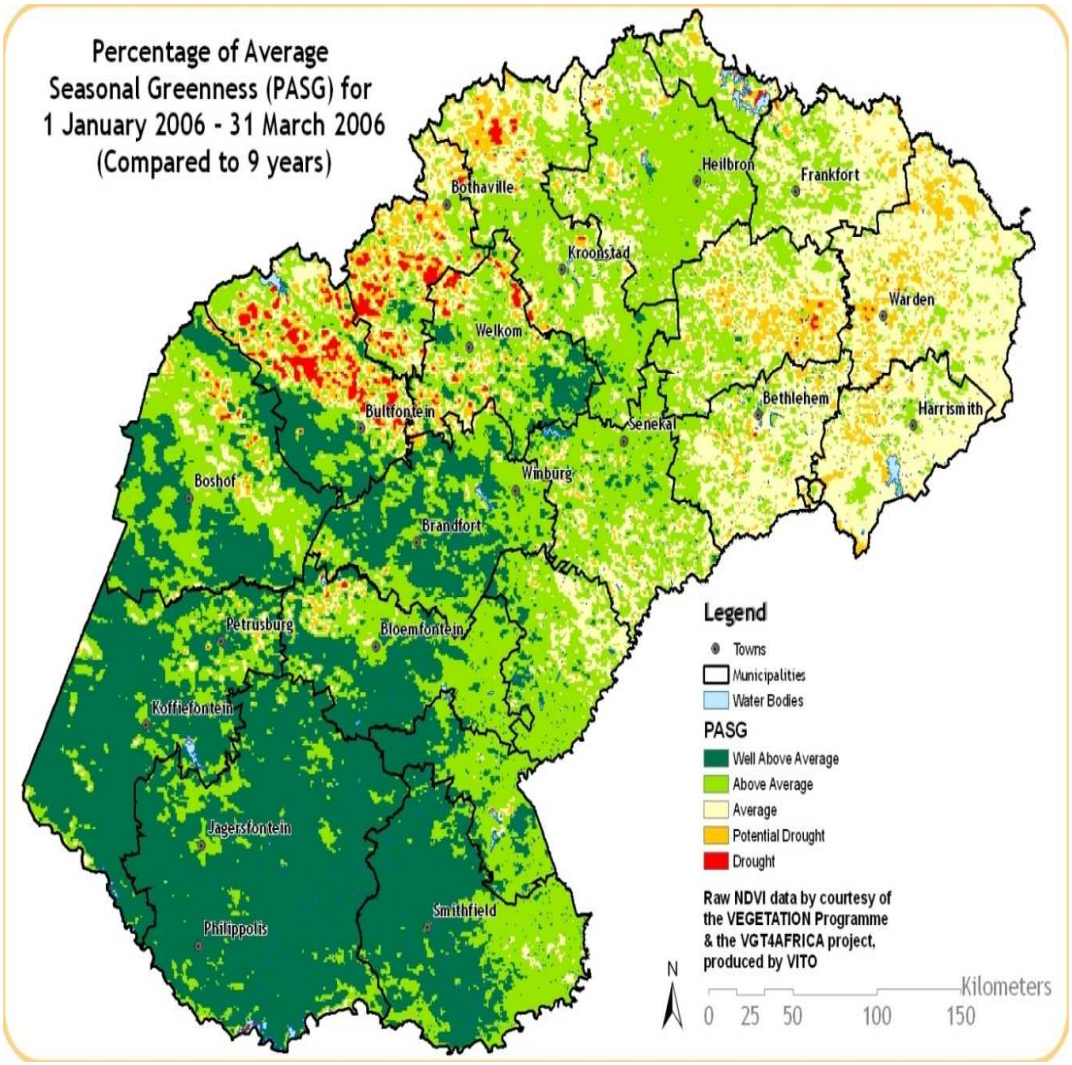

Figure 2.9 Percentage of Average Seasonal Greenness (PASG) for
1 January 2006 – 31 March 2006.
Source: Agric Research Council (2007).

This was another bad year, because the degree of greenness of vegetation has greatly reduced compared to the previous year. The best news this year was that some areas had average rainfall, while above average to well above average rainfall could not be seen in most areas as reflected by the percentage of average seasonal greenness as shown in **Fig. 2.10.**

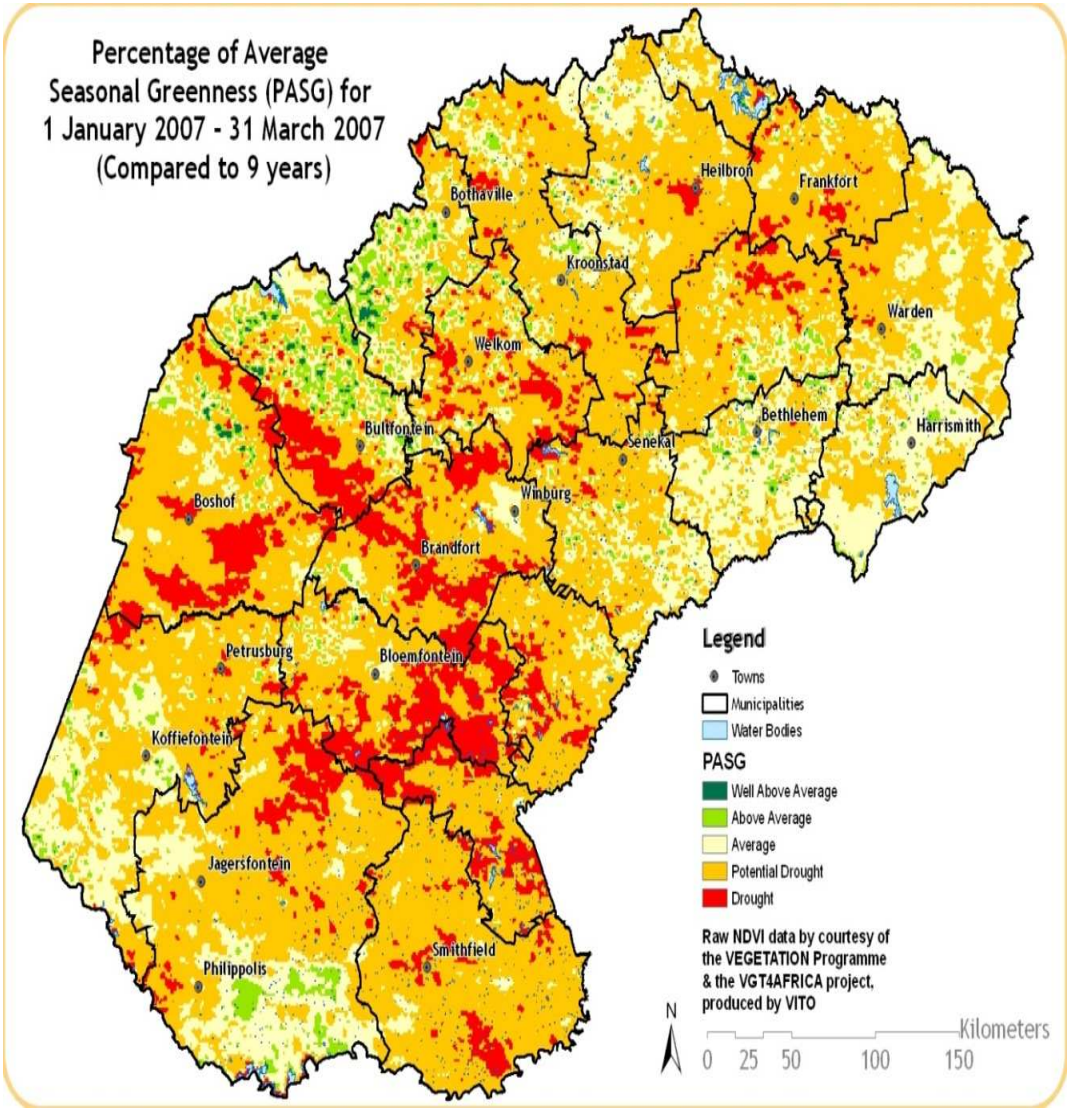

Figure 2.10 Percentage of Average Seasonal Greenness (PASG) for 1 January 2007 – 31 March 2007.
Source: Agric Research Council (2007).

Figure 2.2-2.10 show various level of greenness of vegetation resulting from shortfall in annual rainfall leading to drought or potential drought situations especially in the Free State Province, the effect of which reflected in reduction or loss in agricultural products.

For instance, in 1992, maize crop production suffered a reduction to only about 2.9 million tons compared to 7.8 million tons harvested in 1991. As a result, 3.9 million tons of maize had to be imported to supplement the 6.5 million tons required for local consumption. In 1993, cattle and sheep slaughtering also decreased, which meant the substantial quantity of beef and mutton, had to be imported, wool production dropped by 11 percent in the same year. There were also general increases in the producer prices.

With the El Nino conditions returning and prevailing during the entire 1994/95 season, the wheat crop in the Free state, which is largely dependent on good spring rains, was once again unsatisfactory. When these adverse of weather occurs, apart from a significant drop in crop production, there are also some associated problems such as death of animals, increase in debt of farmers as well as severe veld and bush fires that are usually experienced.

2.6 PLANNING FOR DROUGHT

Sivakumar and Wilhite (2002) indicated that the effects of drought accumulate slowly but the impacts spread over a larger geographical area than the damages that result from other form of natural hazards. When theses occurs, most of the policy responses to drought tend to address the immediate needs, providing what are usually more costly remedies and attempt to balance a competing interest in a balanced atmosphere.

Like many other hazards, drought impacts span through economic, environmental and social sectors and this can be reduced through mitigation and preparedness. For virtually all regions, droughts are a normal part of climate changeability. As a result, it is important to build up plans to deal with these extended periods of water shortage in a timely and orderly approach as they evolve. This planning process according to Wilhite *et al* (2000) needs to occur at various levels of government and be integrated between these governments' levels.

Wilhite (1991) develops a ten-step planning process which was based largely on interaction with many states in the US and sought to incorporate their experiences and lessons learned. These ten-step process was conceptualised based on response to discussions originating from an international drought symposium and workshop held at the University of Nebraska.

Wilhite (1991) states further that this planning process has gone through several interactions in recent years in order to mould it to specific countries or subset of countries. Steps 1-4 of this planning process focuses on making sure that the right people are brought together, that they have a clear understanding of the planning process, know what the drought plan must accomplish and are supplied with adequate data to make fair and equitable decision when formulating and writing the actual drought plan.

Step 5 describes the process of developing an organisational formation for completion of the tasks necessary to organise the plan. Step 6 and 7 delineates the need for ongoing research and coordination between scientists and policy makers, steps 8 and 9 stress the importance of promoting and testing the plan before drought occurs while step 10 highlights modification of the plan to keep it current and making assessment of the plan's effectiveness in the post drought period.

Although these steps are sequential, most of the tasks are addressed simultaneously under the leadership of a drought task force and its complements of committees and working groups. The ten-step planning process which are given below according to Wilhite (1991), Sivakumar and Wilhite (2002) and Wilhite *et al.* (2000) should be considered as part of an integrated planning process rather than as a series of discrete tasks.

Step 1: Appoint a drought task force

In order to initiate a drought planning process, there is need to appoint a drought task force. This task force has two purposes. First is to supervise and coordinate drought plan development. The second purpose is to coordinate actions, implement mitigation and recommendations to the required authority during times of drought when plan is activated. This task force comprises of representation from all stakeholders involved in drought response and mitigation process, a two way communication system must be maintained with the public.

Step 2: State purpose and objectives of the drought plan

According to Wilhite *et al.* (2000) in order to determine the way forward, the drought task force need to state the general purpose of drought plan, various question should be considered to determine the purpose of the plan, such as the: purpose and role of the state/provincial government in drought mitigation and response effort, scope of the plan, most drought prone area of the state/province, historical impacts of drought, most vulnerable economic and social sectors, role of the plan in resolving conflict between water users and other vulnerable groups during the period of drought, current trend (e.g., land and water use, population growth) that may increase/decrease vulnerability and conflicts in the future, legal and social implications of the plan and principal environmental concerns caused by drought.

A generic statement of purpose for a plan is to reduce drought impacts by identifying principal activities, groups or regions most at risk and develop mitigation actions and programs that alter their vulnerability. The plan also provides a systematic way of accessing drought conditions, developing mitigation actions and programs to reduce risk in advance of drought as well as developing response option that minimizes economic stress, environmental losses and social hardships during drought.

After all the above might have been done, there is now the need for the task force to identify specific objectives that support the purpose of the plan. These objectives will vary between regions; reflect unique physical, environmental, socioeconomic and political characteristics

of each region. At the national government level, less emphasis should be placed on financial assistance measures; technical assistance on the other hand is a common element of the state or provincial government mission.

As stated by Wilhite (1991), Sivakumar and Wilhite (2002) and Wilhite *et al.* (2000) the objectives to be considered by states or provinces should include: the collection and analysis of drought related information in a timely and systematic manner, establish criteria for declaring drought emergencies and triggering various mitigation and response activities, provision of an organisational structure and a delivery system that assures information flow between and within different levels of government.

Also the State or Provinces should define the duration and responsibilities of all agencies with respect to drought, maintain a current inventory of state/provincial and federal programs used in accessing and responding to drought emergencies, identify drought prone areas of the State/Province and vulnerable sectors, individuals, or environments.

Other objectives include identifying mitigation actions that can be taken to address vulnerabilities and reduce drought impacts, provide a mechanism to ensure timely and accurate assessment of drought impacts on agriculture, industry, municipalities, wildlife, tourism and recreation, health and other area, keep the public informed of current condition and response actions by providing accurate and timely information to the media in electronic and print form.

More importantly the objective should include the provision of timely information to the media in print and electronic form, establish and pursue a strategy to remove obstacles to the equitable allocation of water during shortages and establish requirements or provide incentives to encourage water conservation and lastly establish a set of procedure to continually evaluate and exercise the plan and periodically revise the plan so that it will stay responsive to the needs of the region.

Step 3: Seek stakeholder participation and resolve conflicts

During drought periods, there is usually an intensified competition for scarce water resources which brings about conflicts among soil, economic and environmental values. In the light of this, there is need for task force members to identify stakeholders and their interests (Sivakumar and Wilhite, 2002).

After identifying such stakeholders, there is need to incorporate them early and continuously. In order for a fair representation and effective drought management and planning, which brings about understanding of one another's various viewpoints and leads to generation of collaborative solutions in times of problems.

One of the main important reasons to involve various stakeholders in planning, decision and policy formulation is to prevent a situation whereby stakeholders feel left out and as a result impeding progress in the development of plans by the government and its advisory boards at all levels.

Step 4: Inventory resources and identify groups at risk

The tasks force needs to take an inventory of natural, biological and human resources as well as identification of various constraints that may impede the planning process. It is important to determine the vulnerability of these resources to periods of water shortage that results from drought.

Water is the most obvious natural resource of importance; where is it located, how accessible is it, and of what quality is it? Biological resources refer to the quantity and quality of grasslands/rangelands, forests, wildlife etc. Human resources includes labour needed to develop water resources, lay pipeline, haul water and livestock feed, process citizens complaints, provide technical assistance and direct citizens to available services.

At this stage, it is also important to identify constraints to the planning process and to activate plans in response to a developing drought. These constraints may be physical,

financial, legal or political. Associated cost with plan development must be weighed against the losses that will likely result if no plan is in place. Some areas are likely to be more at risk than others; as a result, areas of high risks should be identified, as should actions that can be taken before drought occurs to reduce these risks.

Step 5: Establish and write drought plan

This step describes the process of establishing relevant committees to develop and write the drought plan (Wilhite, 1991, Sivakumar and Wilhite, 2002 and Wilhite *et al.*, 2000). The drought plan should have three primary components: monitoring, risk and impact assessment, as well as mitigation and response. The first two could be focused on by established committees while the mitigation and response aspects could be taken care by the drought task force. These committees will have their own tasks and goals, but there must be a well established communication flow between all organs of the committees.

2.6.1 Monitoring committee

A reliable assessment of water availability and its outlook for the near and long term is considered valuable information in both dry and wet periods. During drought, the value of this information increases markedly. The monitoring committee should include representatives from agencies with responsibilities for monitoring climate and water supply.

According to Wilhite (1991), Sivakumar and Wilhite (2002) and Wilhite *et al.* (2000) while evaluating water situation and outlook for a region, information and data on each of the applicable indicators of drought should be considered (e.g., precipitation, temperature, evapotranspiration, soil moisture, stream flow, groundwater level, reservoir, lake levels and snow packs).

The agencies responsible for collecting, analysing and disseminating data and information will vary according to state organised structure and by geographic region. The monitoring committee are expected to meet regularly, especially in advance of the peak demand season. After each meeting, reports should be prepared and disseminated to the state drought task force, relevant state and federal agencies and the media.

The chairperson of the monitoring committee should be a permanent member of the drought task force. The public should receive a balanced interpretation of changing conditions; monitoring committee should work closely with public information specialists to keep the public well informed.

The primary objectives of Monitoring Committee according to Wilhite (1991), Sivakumar and Wilhite (2002) and Wilhite *et al.* (2000) are to: adopt a workable definition of drought that could be used to phase in and phase out levels of State/Province actions in response to drought, establish drought management areas i.e., divide the state or region into more conveniently sized districts by political boundaries, shared hydrological characteristics, climatologically characteristics, or other means such as drought probability or risk.

Other objectives are to develop a drought monitoring system, to obtain inventory data quantity and quality from current observation networks and lastly to develop and/or modify current data and information delivery systems.

2.6.2 Risk assessment committee

Risk is the result of exposure to the drought hazard (i.e., probability of occurrence) and social vulnerability which is represented by a combination of economic, environmental and social factors. In order to reduce drought vulnerability, it is essential to identify the most significant impacts and assess their underlying causes (Wilhite, 1991, Sivakumar and Wilhite, 2002 and Wilhite *et al.*, 2000).

For reducing risk before drought occurs and for appropriate responses during drought, information on drought impacts and their causes is crucial. The membership of the risk Assessment Committee should represent economic sector, social group and eco-system most at risk from drought. It is also advised that the committee chairperson should be a member of the drought task force.

The most effective approach to follow in determining vulnerability to and impact of drought is to create a series of working groups under the aegis of the Risk Assessment Committee. The responsibilities of the committee and working groups is to access sectors, population groups and eco-systems most at risk and identify appropriate and reasonable mitigation measures to address this risk. Wilhite *et al.* (2000) state that these working groups would be composed of technical specialists representing those areas identified as eco-systems most at risk from drought.

Methodology for assessing and reducing the risks associated with drought involves identifying and prioritizing drought impacts, determining their underlying causes and choosing actions to address the underlying causes. This methodology can be employed by each working groups. This effort requires an inter-disciplinary analysis of impacts and management options and is divided into six tasks according to Wilhite, (1991); Sivakumar and Wilhite, (2002) and Wilhite *et al.* (2000) which are to assemble the team, evaluate the effects of past droughts, rank impacts, identify underlying causes of risks for various regions, identify ways to reduce risks and also write a 'to do' list i.e. action most likely to be most feasible, cost-effective and socially equitable.

2.6.2.1 Mitigation and response committee

Wilhite (1991), Sivakumar and Wilhite (2002) and Wilhite *et al.* (2000) state that the actions of this committee could be under the responsibility of the drought task force or could be assigned to a separate committee. It is recommended that the task force, working in cooperation with the Monitoring and Risk Assessment Committees, have the knowledge and experience to understand drought mitigation techniques, risk analysis (economic, environmental and social aspects) and drought related decision making processes at all levels of government.

Due to the fact that the task force is composed of senior policy makers from various state and federal agencies, they are in excellent position to recommend and/or implement mitigation action, request assistance through various federal programs or make policy recommendation to the legislatures and government in general.

Mitigation and response by this committee should be determined for each of the principal impact sectors identified by the Risk Assessment Committee. Before drought outset, task force should inventory all forms of assistance available from local, state or federal government during severe drought. They should be able to give assistance both on a short and long term basis, so as to reduce risk to drought. Assistance should also be defined in a very broad way to include all forms of technical, migration and relief programs available.

2.6.3 Writing the plan

After all the committees in place, with the inputs from all the committees and assistance of a professional writing specialist, the drought task force will undertake the assignment of drafting the drought plan. After the drafting, it is recommended that a public hearing takes place to explain the purpose, scope and operational characteristics of the plan. The plan should not be considered as a static (but dynamic) document. And it should be communicated at all times to end users (Wilhite, 1991; Sivakumar and Wilhite, 2002 and Wilhite *et al.*, 2000).

Step 6: Identify research needs and fill institutional gaps

As research needs and gaps in institutional responsibility become apparent during drought planning, the drought task force should compile a list of these deficiencies and make recommendations on how to remedy them to the relevant government agencies. Step 6 should be carried out concurrently with steps 4 and 5.

Step 7: Integrate science and policy

An important aspect of planning process is integrating the science and policy of drought management. The policy makers understanding of scientific issues and technical constraints involved in addressing problems associated with drought is often limited. Likewise,

scientists generally have a poor understanding of existing policy constraints for responding to impacts of drought. If the planning process is to be successful, communication and understanding between the science and policy communities must be enhanced.

Good communication is required between science and policy makers in order to distinguish what is feasible from what is not achievable for a broad range of science and policy issues. The drought task force must consider various alternatives in bringing these groups together and maintain a strong working relationship.

Step 8: Publicise the drought plan, build public awareness

If there has been a good communication during the process of establishing a drought plan, there may already have been a better-than-normal awareness of drought and drought planning by the time the plan is actually written.

Themes to be considered in writing news stories during and after the drought planning process could include; how drought plan is expected to reduce the impact of drought and what changes people might be asked to make in response to different degrees of drought, such as restricted lawn watering and car washing, or not irrigating certain crops at certain times.

Step 9: Develop education programs

A concise education program to raise the level of awareness of short and long term water supply issues will help ensure that people know how to respond to drought when it occur and that drought planning does not lose ground during non-drought years.

Step 10: Evaluate and revise drought plan

The final step in the planning program is to create a detailed set of procedure to ensure adequate plan evaluation. Periodic testing, evaluation and updating of the drought plan are essential to keep the plan responsive to different needs. To maximise the effectiveness of the system, two modes of evaluation must be put in place:

Ongoing evaluation

This keeps tracks of how societal changes such as technology, new research, new laws and changes in political leadership may affect drought risk and operational aspects of drought plan. Drought risk may be evaluated quite frequently while the overall drought plan may be evaluated less often. An evaluation under simulated drought conditions (i.e., drought exercise) is recommended before the drought plan is implemented and periodically thereafter.

Post-drought evaluation

Post-drought evaluation or audit documents involve analysis and assessment of response actions of government, non governmental organisations and others, it provides for a mechanism to implement recommendations for improving the system.

It would be difficult to learn from past successes and mistakes or failures without pos-drought evaluation as institutional memory fades.

Post-drought evaluation should include the following among others: the climatic and environmental aspects of the drought, the economic and social consequences of drought, the extent to which pre-drought planning was useful in mitigating drought impacts, in facilitating relief or assistance to stricken areas, post recoveries and other weaknesses or problems caused by or not covered by the plan

In order to avoid a biased appraisal, the government may wish to place the responsibility for evaluating drought and societal response to it in the hands of non governmental organisations such as the universities and/or specialized research institutes (Wilhite, 1991; Sivakumar and Wilhite, 2002 and Wilhite *et al.*, 2000).

2.7 ROLE OF EARLY WARNING SYSTEMS IN SOUTH AFRICA

Monnik (2000) defined early warning system as a system of data collection that brings about the detection and monitoring of disasters so as to put in place necessary measures to reduce the effect of the disaster in some way. The real importance of an early warning system is to provide adequate information to required agencies in order to be able to put up a timely measure to counter or manage the effects of the impending disaster.

According to Monnik (2000), the following are parameters that should be included in an ideal early warning system: meteorological information, agricultural information, production estimates, price trends of food and feed, availability of water and household vulnerability. Also a dependable early warning system should incorporate some physical aspects such as: spatial extent of drought, duration of drought, time of occurrence of drought in relation to the crop calendar and severity of drought.

The primary user of early warning system in South Africa includes the government departments, the agricultural industrial organisations as well as commercial farmers.
Over the years there has been a loss of faith in these forecasts. For instance in 1997, it was forecasted that a large El Nino event would take place which led to a noticeable response from the private sectors, during these period, reduction in tractor sales was experienced up to about 20 percent, but the impact of this ENSO event on South Africa rainfall did not materialized as predicted (Monnik, 2000).

As a result of changing government policies on disaster management, more responsibilities are being placed on the farmers to manage themselves and cope in these periods of disasters such as drought. As such, a more reliable system would be required to enable them to be able to anticipate such disasters so that they can effectively respond.

A good early warning system brings farmers representatives and government together to decide on the appropriate combination of crops to sow in order to maximise the overall yield. It will also help in the management of water resources, agricultural planning and adequate management of reserves of grains and fuel oil.

2.8 DROUGHT INDICES

According to Hayes (2006) drought indices assimilates thousands of bits of data on rainfall, snow pack, stream flow and other water supply indicators into a comprehensive big picture. A drought index value is typically a singular number, far more than raw data for decision making. Hayes (2006) pointed out that there are several indices that measures how much precipitation for a given period of time has deviated from historically established norms, but, none of the major indices is inherently superior to the rest in all circumstances, it is just that some indices are better suited than others for certain uses. For example, the Palmer Drought Severity Index has been widely used in the U.S. Department of Agriculture to determine when to grant emergency assistance, but the Palmer is better when working with large areas of uniform topography.

Western States, with mountainous terrain and the resulting complex regional microclimates, find it useful to supplement Palmer values with other indices such as Surface Water Supply Index, which takes snow pack and other unique conditions into account. Newer indexes such as the Standardized Precipitation Index are used by others to monitor moisture supply conditions. Distinguishing traits of this index are that it identifies emerging droughts months sooner than the Palmer Index and it is computed on various time scales. Some examples of drought indices given by Hayes (2006) are as follows.

2.8.1 Percent of normal

The percent of normal is a simple calculation which is well suited to the needs of TV weather casters and general audiences. Its pros and cons are that it is quite effective for comparing single region or season, but it is easily misunderstood, as normal is a mathematical construction that does not necessarily correspond with what we expect the weather to be.

The percent of normal precipitation is one of the simplest measurements of rainfall for a location. Analysis using the percent of normal is very effective when used for a single region or a single season. Percent of normal is also easily misunderstood and gives different indications of conditions, depending on the location and season. It is calculated by dividing actual precipitation by normal precipitation-typically considered to be a 30-year mean- and multiplying by 100 percent. This can be calculated for a variety of time of time scales. Usually these time scales range from a single month to a group of months representing a particular season, to an annual or water year. Normal precipitation for a specific location is considered to be 100 percent.

One disadvantage of using the percent of normal precipitation is that the mean or average precipitation is often not the same as the median precipitation, which is the value exceeded by 50 percent of the precipitation occurrences in a long-term climate record. The reason for this is that precipitation on a monthly or seasonal scale does not have a normal distribution. Use of the percent of normal comparison implies a normal distribution where the mean and median are considered being the same.

2.8.2 Standardized precipitation index

The SPI is an index based on the probability of precipitation for any time scale, SPI is being used by any drought planners. It can be computed for different time scales and it can also provide early warning of drought and help assess drought severity (see Table 2.5). It is less complex than the Palmer; the only disadvantage is the fact that values based on preliminary data may change. The SPI was developed by McKee *et el*. (1993).

Table 2.6 Standardized precipitation index values (Based on probability of precipitation)

SPI Values	Drought Category
2.0 +	Extremely wet
1.5 to 1.99	Very wet
1.0 to 1.49	Moderately wet
-.99 to .99	Near normal
-1.0 to 1.49	Moderately dry
-1.5 to -1.99	Severely dry
-2 and less	Extremely dry

Source: Hayes (2006)

2.8.3 Palmer drought severity index (The Palmer, PDSI)

The Palmer is a soil moisture algorithm calibrated for relatively homogeneous region (see Table 2.6), many U.S. government agencies and states rely on the Palmer to trigger drought relief programs, it was the first comprehensive drought index developed in the U.S., Palmer value may lag emerging droughts by several months, it is less well suited for mountainous land or area of frequent climatic extremes, it is complex because it has an unspecified, built in time scale that can be misleading and it was developed in 1965 by W.C. Palmer.

Table 2.7 Palmer drought precipitation index (Based on soil moisture)

Palmer Classification (Soil moisture algorithm)	**Drought Category**
4.0 or more	Extremely wet
3.0 to 3.99	Very wet
2.0 to 2.99	Moderately wet
1.0 to 1.99	Slightly wet
0.5 to 0.59	Incipient dry spell
0.49 to -0.49	Near normal
-0.5 to -0.99	Incipient dry spell
-1.0 to -1.99	Mild drought
-2.0 to -2.99	Moderate drought
-3.0 to -3.99	Severe drought
-4.0 or less	Extreme drought

Source: Hayes (2006)

2.8.4 Crop moisture index (CMI)

It is a palmer derivative; the CMI reflects moisture supply in the short term across major crop-producing regions and is not intended to assess long-term droughts. CMI identifies potential agricultural droughts and it was also developed by Palmer in 1968.

2.8.5 Surface water supply index (SWSI)

The SWSI is designed to complement the one of Palmer in the state of Colorado, where mountain snowpack is the key element of water supply, calculated by river basin based on snow pack, stream flow, precipitation and reservoir storage, it represents water supply conditions that is unique to each basin. Using SWSI, inter basin comparisons are limited because changing a data collection station or water management requires that new algorithms be calculated and the index is unique to each basin. It was developed by Shafer and Dezman in1982.

2.8.6 Reclamation drought index (RDI)

Like SWSI, the RDI is calculated at the river basin level, incorporating temperature as well as precipitation, snow pack, stream flow and reservoir levels as input. It accounts for evaporation by including a temperature component, but because the index is unique to each river basin, inter basin comparison are limited. It was developed as a tool for defining drought severity and duration and for predicting the onset and end of periods of drought as shown in Table 2.7.

Table 2.8 Reclamation drought index classification

RDI Classification	Drought Category
4.0 or more	Extremely wet
1.5 to 4.0	Moderately wet
1 to 1.5	Normal to mild wetness
0 to -1.5	Normal to mild drought
-1.5 to -4.0	Moderate drought
-4.0 or less	Extreme drought

Source: Hayes (2006)

2.8.7 Deciles

It groups monthly precipitation occurrences into deciles (see Table 2.8) so that, by definition, “much lower than normal” weather cannot occur more often than 20 percent of the time. This is being used in Australia and it provides an accurate statistical measurement of precipitation but accurate calculations require a long climatic data record. It was developed by Gibbs and Maher (1967).

Table 2.9 Deciles drought classification

Deciles Classification	Drought Category
Deciles 1-2: lowest 20percent	Much below normal
Deciles 3-4: next lowest 20percent	Below normal
Deciles 5-6: middle 20percent	Near normal
Deciles 7-8: next highest 20percent	Above normal
Deciles 9-10: highest 20percent	Much above normal

Source: Hayes (2006)

2.9 DROUGHT INDICES USED IN SOUTH AFRICA

After the percent of normal, the rainfall deciles is the second drought indices that are been used in the monthly climate summary publication issued by the South African Weather Services (2008). This index requires rainfall data for long period of time. The monthly rainfall distribution over a long period of time (usually more than 30 years) is divided into tenths of the distribution. Each of these 10 categories is called a “decile”.

The decile index is a more useful index in assisting decision makers to determine where financial assistance has to be provided in times of drought. The disadvantage of the index is that it compares the rainfall deficit in the current month with rainfall for the same month in the history of the station and does not consider cumulative effect of rainfall deficit.

The South African Weather Service moved to the Standardized Precipitation Index (SPI) because neither Percent of Normal nor the decile drought indices employed are able to assist decision-makers with the assessment of the cumulative effect of reduced rainfall over various time periods.

Neither of these indices can describe the magnitude of the drought compared with other drought effect. The SPI can alleviate both of these principal short comings of the other indices, while at the same time being less complex to calculate than some other drought indices not in use at the South African Weather Service.

2.10 CONCLUSION

This chapter reviewed various literatures that dealt with different characteristics of drought and its impact, drought concept, definition, impact, drought vulnerability, coping mechanisms exhibited by drought victims in various parts of the world, history of drought in South Africa, drought in the Free State province, measures taken by government to mitigate drought, drought indices used around the world as well as in South Africa.

The review of relevant literature on drought reveals that drought transcends water shortage problem for farmers on agriculture, and includes other aspects such as socio-economic, political in terms of policy and other aspects. It was also highlighted that coping mechanisms adopted by farmers in various countries of the world are inter-related, but only differs in terms of available resources; it also includes farmers' financial background and level of diversification. Most importantly, it was evident in the review that farmers in underdeveloped and developing countries are unable to cope with drought without external influence in terms of drought relief packages.

CHAPTER 3
DEMARCATION

Chapter three consist of brief discussion about the study area which is the Free State Province. Areas such as geography, districts, people, industrial sector, mining sector and agriculture sector were touched.

3.1 THE FREE STATE PROVINCE

3.1.1 Geography

In terms of geographical distribution, the Free State Province which is one of nine provinces in South Africa (see **Fig. 3.1**) is centrally located; it represents 10.6 percent of the total land area of the country. The Province covers an area 129,464 square kilometres and according to the national estimated population of 2007, it has a population of 2.77 million (Statistic South Africa, 2007).

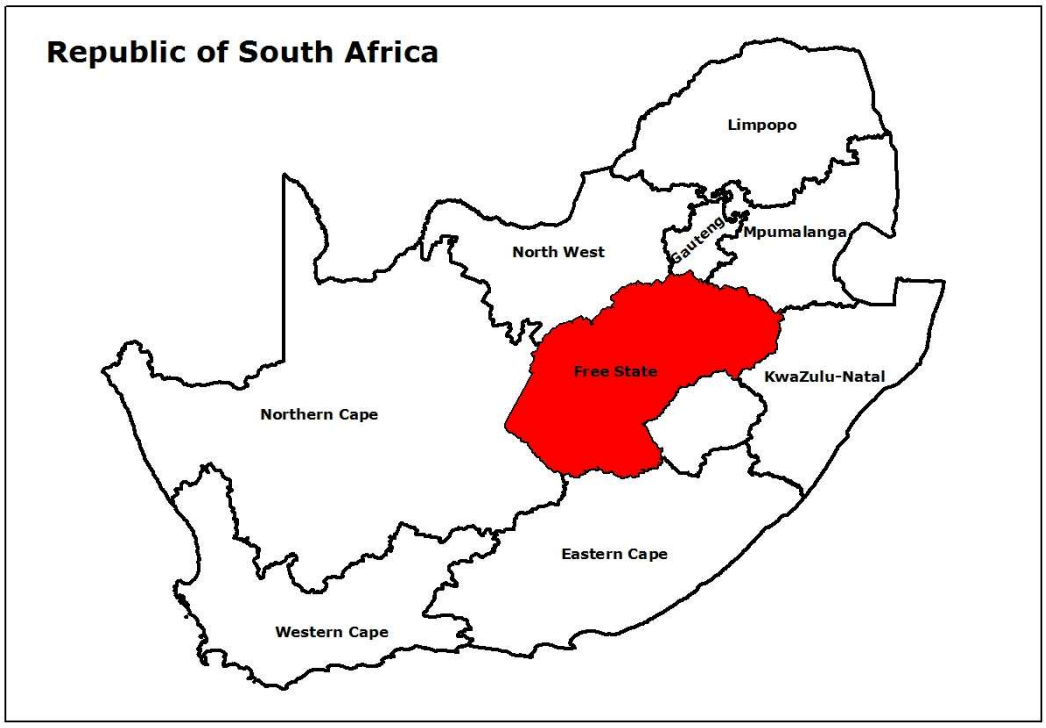

Figure 3.1 South African Provinces

Source: Municipality and Demarcation Board of South Africa (2009)

The Free State is situated on the flat vast plains in the centre of South Africa; Free State Province borders six other provinces with the exception of the Northern Province and Western Cape. Internationally it shares boundary with Lesotho on the east, it is bordered by the Orange Vaal River on the south, while the north-eastern boundary is formed by the Klip River.

3.2 DISTRICTS OF THE FREE-STATE PROVINCE

The Free State Province consists of five main areas which can be distinguished as shown in Figure 3.2.

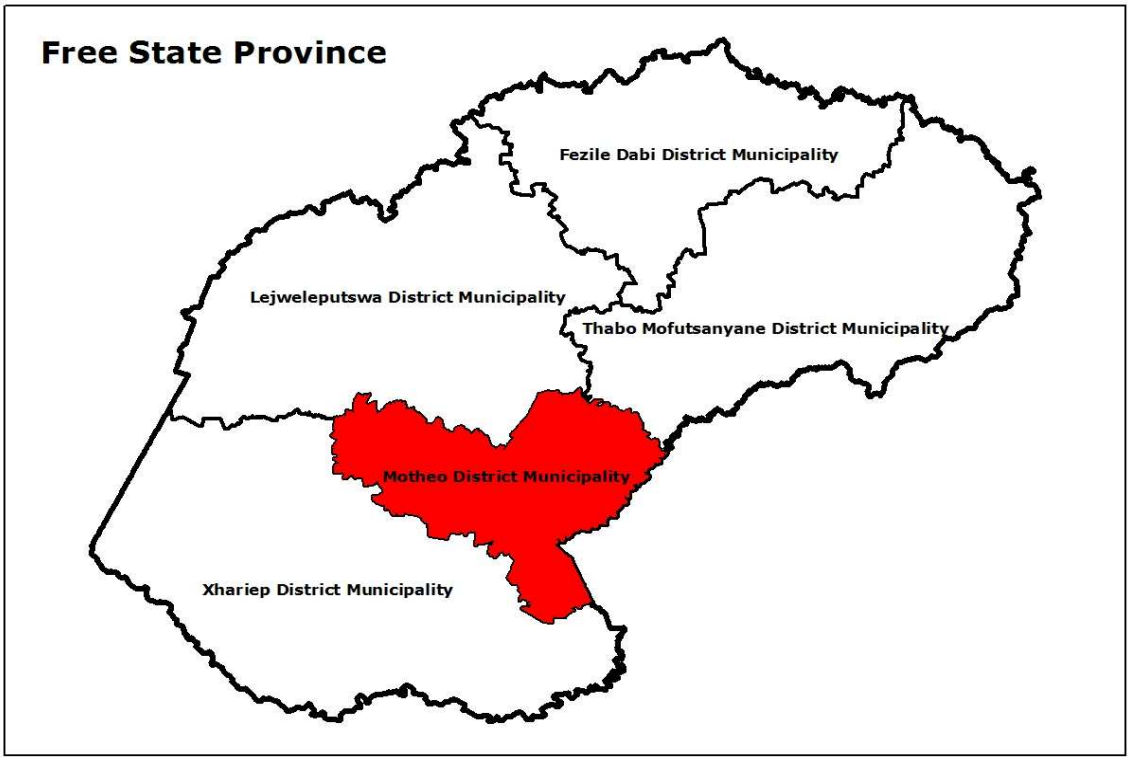

Figure 3.2 The Free State Province

Source: Municipality and Demarcation Board of South Africa (2009)

3.2.1 The Xariep District

The Xariep District is a dry region of the Free State Province with extensive farming which consist mainly sheep and small towns. The district comprises open grasslands;

the southern bordered by the Orange River called Gariep by the indigenous Khoikhoi people. This dam is one of major tourist attractions which offer variety of accommodation and leisure facilities which is centred on water.

3.2.2 The Motheo District

Motheo in Sesotho word means ‘foundation of string base of building’. The largest population in this district is found in the Bloemfontein which is the economical and industrial heart of the

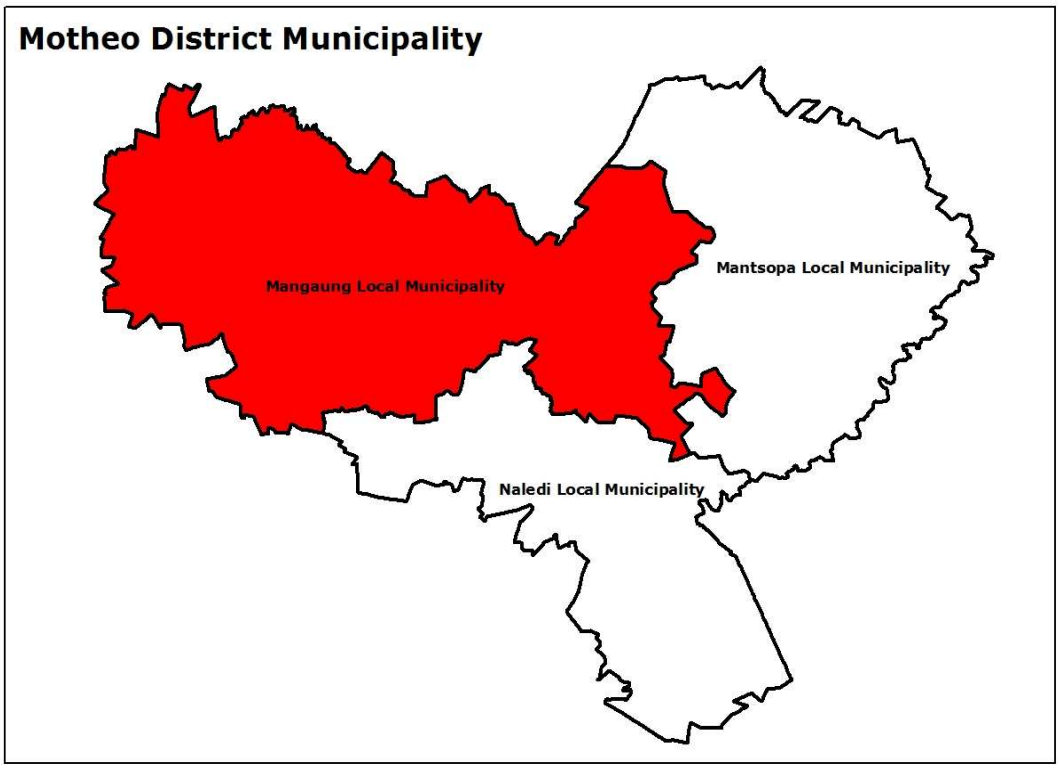

Figure 3.3 Motheo District of the Free State Province

Source: Municipal and Demarcation Board of South Africa (2009)

Province; it is also the most urban centre. The district mainly comprises of an open grass field with mountains in the eastern most part. The Motheo District Municipality (see Figure 3.3) consists of three local municipalities which are:

- Mangaung Local Municipality
- Mantsopa Local Municipality
- Naledi Local Municipality

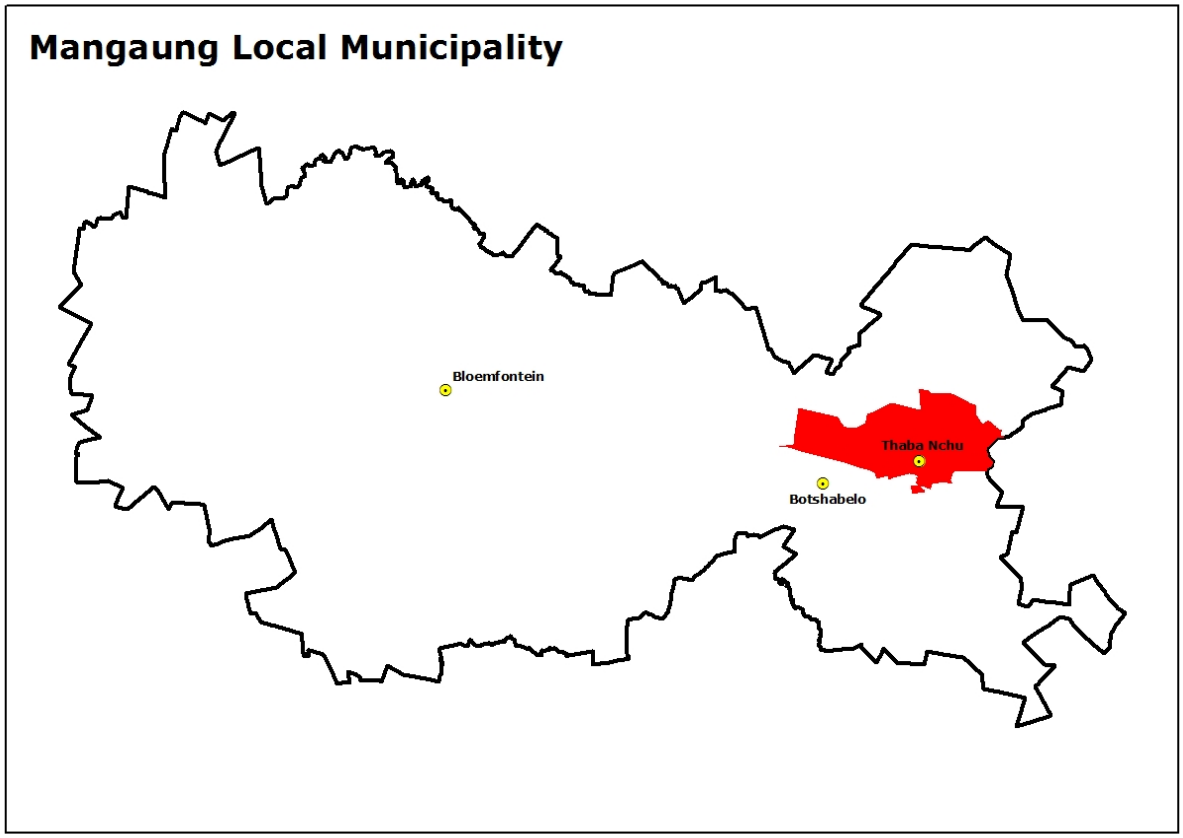

Figure 3.4 Mangaung Local Municipality

Source: Municipal and Demarcation Board of South Africa (2009)

3.2.2.1 Mangaung local municipality

The Mangaung Local Municipality consists of Bloemfontein which is known as the "city of Roses". It is the sixth largest city in South Africa and capital of the Free State Province, while forming inter alia the cultural, tertiary educational and shopping hub of the province.

Also from a historical point of view, Bloemfontein/Mangaung ranks very highly, while it houses the seat of the Appeal Court which makes it the judicial capital of South Africa, Bloemfontein's central location makes it ideal for the holding of conferences, as the city disposes a wide range of entertainment, recreational and sporting facilities.

Botshabelo which is also found in the Mangaung local district is located 55 kilometres from Bloemfontein, with a population of approximately 5000,000 people; it is the largest township development in The Free State and one of the largest in South Africa. Botshabelo consists of an industrial park with factories and infrastructure worth 500 million Rands.

Thaba 'Nchu within which the study was carried out (highlighted in red in Figure 3.4); is another area which is highly dominated by black emerging farmers, it is situated 12 kilometres from Botshabelo. This town has vibrant retail shopping facilities, a luxury hotel and casino and other cultural amenities. At Thaba 'Nchu, industrial development is coming on stream.

3.2.2.2 Mantsopa local municipality

It comprises of towns of Ladybrand, Hobhouse, Excelsior, Tweespruit and Thaba Phatswa. The area is traversed by the Maluti Route on R26 from Kwazulu Natal via the Eastern Free State, up to the Eastern Cape highlands and the Lesotho Kingdom. Ladybrand is an economically busy town with high property prices and sometimes being popularly referred to as the "capital" of Lesotho.

3.2.2.3 Naledi local municipality

It encompasses towns such as Dewesdorp, Wepener and Vanstadensrus and stretches along the Highlands of the Maluti Route. The R26 Route links the Naledi areas/towns together.

3.2.3 The Thabo Mofutsanyane District

This district has beautiful hills and fruit farms; it forms the eastern part of the province and borders the Kingdom of Lesotho and Kwa-Zulu Natal. The district is one of the most

important tourist destinations in the Free State mainly because of the spectacular beauty of the Drakensberg and Maluti mountain ranges.

3.2.4 The Northern Free State District/ Fezile Dabi

This is an important agricultural production area, particularly for maize. It is known as “the grain basket” of South Africa. It consists of the Vaal Dam which is the main source of water for Gauteng; it also offers a wide range of sport and leisure facilities. The district also consists of the Vredefort Dome which is the third largest meteorite site in the world (20km in diameter).

3.2.5 The Lejweleputswa District

This district is the major contributor to the Free State Gross Domestic Product (GDP), and also an important agricultural area. The district is predominantly known for Free State Goldfields, which forms part of the larger Witwatersrand basin.

The economy of the area is built around gold mining industry, followed by maize production. Bothaville is considered one of the most important maize centres in South Africa and also forms part of the Free State Maize Route. The annual NAMPO Harvest Farm and Festival attracts more than 20000 visitors and is the second largest private agricultural show centre in the world.

3.3 AGRICULTURAL SECTOR

The western part of the province consists of plains, the eastern part is mountainous. The Free State is almost treeless, consisting mainly of grasslands with some Karoo vegetation in the south. The soil is rich and climate good, allowing a thriving agricultural industry. The Free State is a summer-rainfall region and is extremely cold during winter months, especially towards the eastern mountainous regions where temperatures could be as low as -9 degree Celsius. The western and southern areas of the Province are semi-desert. The mean annual rainfall is 532mm.

Cultivated land in the Free State covers 3.2 million ha, on the other hand natural veld and grazing land covers about 8.7 million ha. Two third of gross agricultural income in the Free

State comes from field crops. Animal products contribute about 30 per cent while horticulture makes up for the balance.

Soya, sorghum, sunflowers and wheat are cultivated in the Eastern Free State; largest percentage of cherry crop is produced in Ficksburg district while about 40 per cent of the country's potato production comes from the high-lying areas of the Free State. The main vegetable crop is both white and green varieties of asparagus, the Province also export about 1.2 million tons of cut flowers a year (South Africa.info reporter, 2007).

3.4 INDUSTRIAL SECTOR

The Free State economy has moved from dependence on primary sectors such as mining and agriculture to an economy increasingly oriented to manufacturing (South AfricaInforeporter, 2007). About 14 per cent of the province's manufacturing is classified as being in high-technology industries, northern Free State chemical sector is one of the most important in the southern hemisphere, while Sasol which is a world leader in production of fuels, waxes, chemicals and low-cost feedstock from coal is based in Sasolburg area of the Free State Province.

3.5 MINING SECTOR

The Free State contributes about 16.5 per cent of South Africa's total mineral output. The major employer in the Free State Province is the mining industry and is responsible for some 22.3 per cent of GDP of the Province. A gold reef over 400 kilometres long, known as the goldfield region stretches across Gauteng and the Free State. The largest gold-mining complex is Free State Consolidated Goldfields, with an area of 330 square kilometres.

There are 12 goldmines in the province which produces about 30 per cent of South Africa's output and making it the fifth largest producer in the world. Gold mines in the Free State also supply a substantial portion of the total silver produced in the country, also uranium, diamond, bentonite and bituminous coal which is converted to petrochemicals at Sasolburg is mined in the Province.

3.6 CONCLUSION

This chapter reviewed the study area which was Thaba 'Nchu found under Mangaung Local Municipality of Motheo District of the Free State Province. Most of the information in this chapter was found on South Africa info reporter (www.southafrica.info), the official website of the Motheo District Municipality (www.motheo.com) as well as the Provincial government's website (www.fs.gov.za/index.htm).

CHAPTER 4

METHODOLOGY

In this chapter, the methods and tools used for data collections were discussed.

4.1 AIMS AND OBJECTIVES

4.1.1 Aims

The primary aim of the research was to study drought coping mechanisms exhibited by farmers by investigating their actions and inactions before and during a drought.

4.1.2 Objectives

The aims of this research were addressed through investigating the following objectives which are to:

1. Investigate farmers' the strategies in response to disturbances and changes during drought
2. Determine the differences between all the coping strategies adopted by different farming families
3. Identify the effect of drought and coping mechanisms adopted by farmers on their family during the process.

4.2 METHODS

To achieve these set aims and objectives of the study, eight (8) villages were selected from Thaba'Nchu of Mangaung local municipality and its environs (see Figure 4.1), and the selection were based on the fact that they suffer from drought and other associated effects from time to time, it should also be noted that these areas represents other communities with similar characteristics which makes the findings of the present study applicable to such areas. According to the field extension workers in Motheo District, Thaba'Nchu consists of basically small scale farmers.

Different perspectives of farming families about drought were obtained with the use of questionnaire, aspects such as human demography, farmers understanding about drought,

effect and response of drought on the livestock heard and crops, drought effects on farmers and their households, as well as their strategies in response to disturbances and changes during drought were all considered.

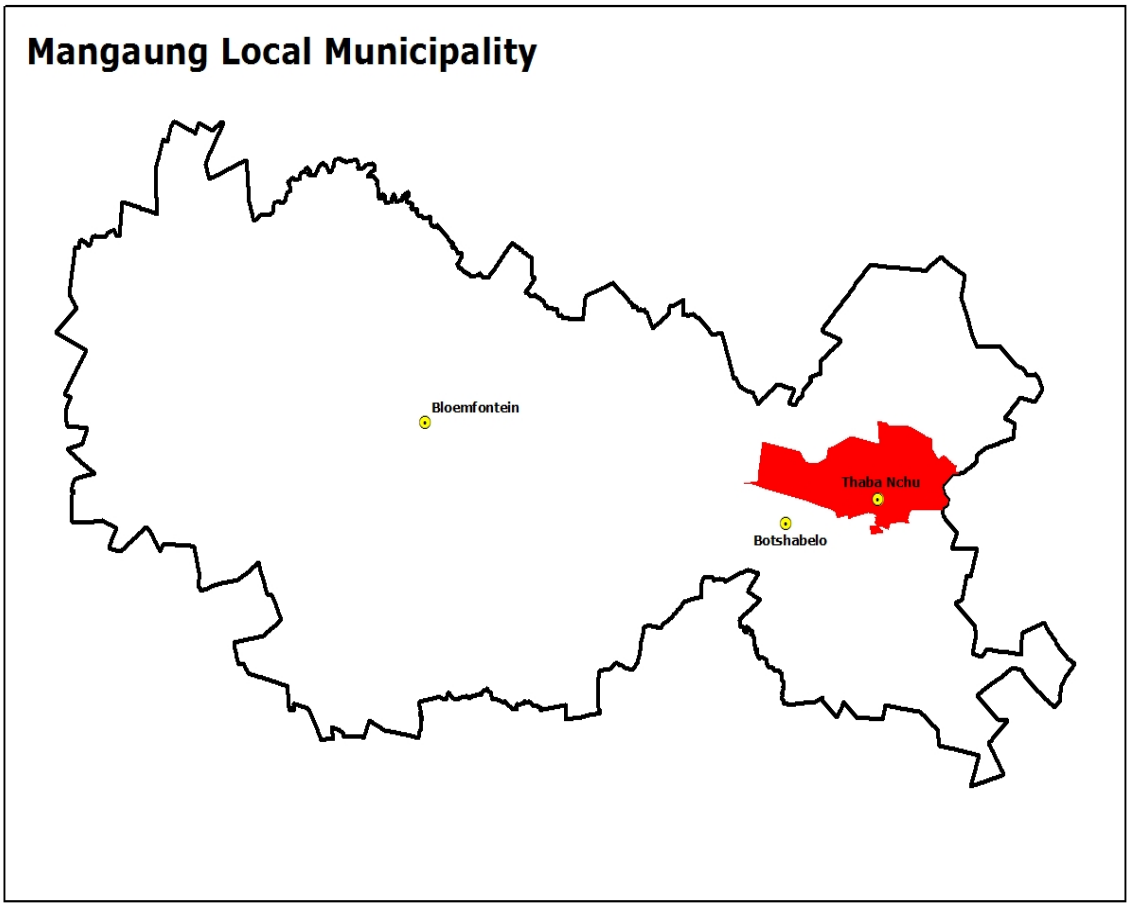

Figure 4.1 Mangaung Local Municipality
Source: Municipal and Demarcation Board of South Africa (2009)

4.2.1 Population and Sample size

Small-scale farmers were basically targeted for this survey, and they are regarded as farmers operating on a farm land less than ten hectares irrespective of their gender. These farmers were either crop famers, livestock farmers or mixed farmers. The primary sampling unit was the individual household. This consists of 200 randomly selected farming households. For the purpose of this study, a household is a group of people in a housing unit living together as a family and sharing the same kitchen. The household head represented his or her household members as the respondent for this survey. The head of the household

is defined as the person making major economic, social and household decisions irrespective of age and gender.

4.2.2 Sampling tool

The questionnaire which is an often used observational piece of equipment to gather personal data and opinion according to Hopkins *et al*. (1990) was use for this study. It offers a way to collect personal information from subjects that may not readily be obtainable using other methods. According to Krathwohl, (1993), questionnaires provide structured responses and as a result must be carefully developed and revised to obtain valid data.

4.2.2.1 The role of questionnaire

Bryman and Bell (2007) and Hague (1993) described questionnaire as a vehicle by which people are interviewed, it provides the interviewer a form or medium upon which to record answers, without a questionnaire there is no structure for an interview. Hague (1993) gave four purposes of questionnaire which were taken into consideration while selecting the medium for data collection; to draw accurate information from the respondents and this is obtained by asking the right question to the right person, it provides a structure to the interviewer so that it flows smoothly and orderly, it provides a standard format on which facts, comments and attitudes can be recorded and lastly it facilitates data processing.

4.2.2.2 Types of questionnaire

There are three recognised different types of interview situations by researchers, which in turn require three different types of questionnaires (Hague 1993):

a. Structured questionnaire

In structured questionnaires, the researcher set out precisely the wording of the questions and order in which they will be asked. Most of the questions have pre-defined answers and there will be little latitude for a respondent to stray beyond them. Structured questionnaires

are the bedrock of large quantitative surveys; it could be telephonic, face-to-face or self completion.

b. Semi-structured questionnaire

This type of interview uses questionnaires with a mixture of questions with predefined answers as well as those where the respondent is free to say whatever is liked. In each interview the question are asked in the same way and there may be hundreds of interviewees in the whole survey. The semi-structured questionnaire is a more flexible tool than its highly structured counterpart and there is likely to be more probing to find out reasons for certain actions. This type of questionnaire was used for the data collection for this study.

c. Unstructured questionnaire

In this type of informal or in-depth interview, the researcher uses a checklist of questions rather than a formal questionnaire on which answers are written down. There is considerable latitude allowed on the part of the interviewer and different channels of questioning are selected during the interview itself. The interview is often recorded on tape.

Whether the researcher uses a structured, semi-structured or unstructured questionnaire depends on the number of people to be interviewed, what type of people they are, the type of information to be collected and the type of interviewers who will be administering the questions. The method of data analysis also has an influence, though in itself this is influenced by the size of the survey and the type of information collected.

4.2.2.3 Questionnaire as a research instrument

Questionnaires are used by researchers as instrument to convert the information directly given to a person who is the subject into data. It provides access to what the subject knows, i.e. it makes it possible to measure what a person thinks or knows, likes or dislikes about a particular issue. The use of questionnaire is a way of getting data or information about persons by asking them rather than watching them behave or by sampling a bit of behaviour; as a result, self report poses certain problems such as; cooperation from

respondents while completing the questionnaire, also there is need for respondents to tell what is, rather than what they think should be, or what the researcher want to hear, lastly respondents must know what they feel or think in order to report it(Hague 1993).

According to Maraj (2000) the questionnaire has certain advantages which were taken into consideration when it was selected as research instrument, the advantages include cost consideration i.e. the questionnaires could be hand delivered to respondents and collected instead of postage, it produces quick results, when it is not difficult to contact respondents, it is a convenient method of data collection, there is a good assurance for anonymity, also the questionnaire is ideal for a stable, consistent and uniform measure without variation as well as the fact that it covers a wider range of issues.

During the compilation of the questionnaire, certain guidelines listed by Cox, (1996) were also considered, these include; use of simple sentence structure, avoiding the use of uncommon terms or languages, word or phrase with unclear or uncertain meaning, avoid asking respondents' opinion on a subject they cannot be expected to know anything about, as well as to avoid writing compound question or phrases.

4.2.3 Pilot sampling

The questionnaire was developed and tested with a small group of farmers before it was used on a larger scale. During the pilot sampling, it was discovered that some farmers were not comfortable answering certain questions, such questions were either reframed or totally removed from the list. There were also some open ended questions which was later converted to a closed ended ones because farmers opinion about such questions were not easily obtainable and as such made the completion of the questionnaire more lengthy and time wasting.

4.2.4. Data collection

As stated previously, questionnaires were used to collect information from the selected villagers that have at one time or the other experienced drought disaster. The questionnaire was developed and tested on a smaller sample before it was used for the larger sample. Data were collected through administration of questionnaire to the farmers in their households by the researcher with the help of trained personnel from University of the Free State. These personnel are South Africans who understood properly the local language indigenous to the study area. A descriptive survey methodology was used in this study for the analysis and interpretation of data collected from drought affected farmers.

4.2.5 Data capturing

Data were initially captured using Microsoft office excel 2007 and later converted to SPSS. This was done using codes, for instance, questions requiring yes or no answers (closed ended questions) were coded as follows:

1 = Yes

2 = No

3 = Not available/applicable

The open ended questions were also grouped and coded based on the response of the farmers using numbers accordingly.

4.2.6 Data analysis

The data collected were analysed using SPSS. The variables which were grouped under six sections (section A-F) were linked to the research questions and initial aims and objectives of the study. These variables are associated basically with coping mechanisms adopted or exhibited by farmers during the drought period.

4.3 Conclusion

In this chapter, research methods, data collection tools, data capturing and how the data will be analysed were elucidated. The design of questionnaire was explained and motivation was

given why the study area was chosen. The next chapter will present research results and findings.

CHAPTER 5
DATA ANALYSIS AND INTERPRETATION

In this chapter, data collected using tools and techniques described in the preceding chapter were collated and analysed, the method of analysis, findings and interpretation of such findings were discussed.

5.1 Introduction

Two hundred households were randomly selected for the purpose of data collection. All the 200 questionnaires were completed and returned, although some questions were not answered. This was because some questions were not applicable to certain farmers, for instance questions on livestock management were only applicable to livestock farmers and those practising mixed farming while crop management questions in the same vein were applicable to only crop farmers and mixed farmers alone.

5.2 Data analysis and interpretation

The data were captured and analysed using SPSS to obtain the frequency, cross tab, univariate ANOVA (mean values) as well as the logistic regression analysis. The results were summarised based on the original objectives of the study which sought to identify farmer's perceptions, coping mechanisms, differences between coping mechanisms adopted by different households as well as the effects of drought and coping mechanisms adopted by farmers on their household.

5.2.1 Definition of variable labels

The questionnaires consisted of six sections with sub-sections which include human demography, farmers' perception about drought, drought effects and response on livestock herds, drought effects and response on crops, drought effects on farmers and their households, as well as farmers' strategies in response to disturbances and changes during the drought. The six sections consist of questions (variables) ranging from six to nineteen

which were considered too long to be included in the tables during data analysis but they were labelled and defined as shown in Table 5.1 below.

Table 5.1 Definition of variable labels

FP	Did you fence to protect the water source?	Yes=1; No=2
PSBD	Did you provide supplementary feeds for your animals before the drought period?	Yes=1; No=2
PSDD	Did you provide supplementary feeds for your animals during the drought period?	Yes=1; No=2
SGLBD	Did you share your grazing lands with anyone before the drought?	Yes=1; No=2
SGLDD	you share your grazing lands with anyone during the drought?	Yes=1; No=2
CCS	Did you have to change your cropping system during the drought period?	Yes=1; No=2
ASW	Did you have alternative source of water for your crops?	Yes=1; No=2
MFH	Did you move from your household village because of drought?	Yes=1; No=2
MFM	Did any member of your family migrate during the drought period?	Yes=1; No=2
ACW	Did you have access to clean water for domestic purposes during these periods?	Yes=1; No=2
AGF	Did you have access to good food during drought?	Yes=1; No=2
AQH	Did you have access to quality health care?	Yes=1; No=2
MCS	Did any member of your family (who are schooling) change school during these periods?	Yes=1; No=2
PDBO	Were you prepared for drought before onset?	Yes=1; No=2
STDF	Did you draw upon stored food during drought?	Yes=1; No=2
SPA	Did you sell or pledge assets?	Yes=1; No=2
AAS	Were you able to achieve the aim of sale?	Yes=1; No=2
SNSF	Did you seek new source of food?	Yes=1; No=2
DFM	Did you have to disperse family members during any phase of the drought?	Yes=1; No=2
RSA	Did you render services or assistance in exchange for food during drought?	Yes=1; No=2
FSE	Were you forced to seek employment elsewhere during the drought period?	Yes=1; No=2
EWM	Did you get the employment within your locality or you migrated?	Yes=1; No=2
DHF	Did you receive help or assistance during normal time and drought period?	Yes=1; No=2
HAT	Was the help or aid timely?	Yes=1; No=2
DAMN	Aid or assistance from agencies?	Yes=1; No=2
CCM	Did the coping mechanisms you adopted help to ease the effect of drought on your household?	Yes=1; No=2

5.2.2 Human demography

Findings regarding demographics in the study area are shown on Table 5.2 below. These include information about farmer's marital status, educational background and types of farming activities practiced. Results of the survey on Table 5.2 show that over 55.5 percent of the farmers were married, 29.0 percent were single, 4.5 percent were divorced and 11.0 percent were either widows or widowers while only 0.5 percent was separated. Some of the married farmers whose spouses were not engaged in agricultural sector claimed income from spouses who were engaged in non-agricultural sector helped to ease drought effects at the household level in meeting household needs.

Table 5.2 Demography

Characteristic	Frequency	Percentage
Marital status of respondents		
Married	110	55.0
Single	58	29.0
Divorced	9	4.5
Widow/er	22	11.0
Separated	1	0.5
Total	**200**	**100**
Highest level of education		
Not started primary school/No education	52	23.5
Pre-school	9	4.5
Completed primary	32	16.0
Did not complete high school	28	14.0
Secondary/High school	28	14.0
Matric	32	16.0
Diploma	5	2.5
Degree	2	1.0
Others	17	8.5
Total	**200**	**100**
Type of farming activity		
Livestock farming	75	37.5
Crop farming	83	41.5
Mixed farming	42	21
Total	**200**	**100**

n =200

Data on education from Table 5.2 indicate that 23.5 percent of the farmers surveyed had no formal education, while a larger percentage of 76.5 had a formal education which varied from primary to university education. Judging by the percentage of interviewed farmers with no formal education, this implies that many farmers might not be able to read or write, which tends to limit their access to required information during drought, such situation requires an exhaustive preparation from designated government and non-governmental organisations to bring about awareness about any impending disaster. Out of the 200 respondents, 37.5 percent were livestock farmers, 41.5 percent were crop farmers while 21 percent of them practiced mixed farming (see Table 5.2).

5.2.3 Farmers' perception about drought

It is important to understand farmers' perception about drought, this gives an insight into their previous drought experiences, level of understanding and awareness about drought, medium of awareness as well as whether or not they believed when informed that there would be a drought incidence.

Majority of the respondent (92 percent) had at one time or the other experienced a drought event (Table 5.3). Only 8percent of the farmers claimed they have never experienced drought in farming, this was attributed to the fact that they were new farmers. During data collection period (late November-early December 2008), interviewed farmers claimed lateness in rainfall which led to shortage of grazing for livestock.

Prior to any form of disaster, it is important to have a fore knowledge of the situation, such as the likely duration and intensity of a looming disaster in order to plan ahead and reduce the level of vulnerability to such disasters. As indicated in Table 5.3, most of the farmers interviewed (92.0 percent) have experienced drought incidence at one time or the other, yet their level of awareness about drought hazard before the actual occurrence of the hazard was not significant. Table 5.3 shows only 29 percent of the farmers were aware of drought before its onset, a larger percentage of 71.0 were not aware. Considering the higher

percentage of people that were not aware about an impending drought condition, it signifies that coping and mitigation in such circumstances would be difficult because logically, awareness brings about preparation.

Table 5.3 Farmer's perception about drought

Characteristic	Frequency	Percentage
Previous drought experience		
Yes	184	92.0
No	16	8.0
Total	**200**	**100**
Awareness before drought incidence		
Yes	58	29.0
No	142	71.0
Total	**200**	**100**
Awareness through different medium		
TV	28	14.0
Radio	19	9.5
Friends and Neighbours	5	2.5
Extension workers	1	0.5
Others	5	2.5
Not applicable	142	71.0
Total	**200**	**100**
Believed when told there would be drought		
Yes	42	21.0
No	16	8.0
Not applicable	142	71.0
Total	**200**	**100**

N = 200

Out of the 29 percent of the respondents that claimed to be aware of a drought incidence before hand, only 28 percent knew through the television media, 9.5 percent knew through the radio, 2.5 percent knew through friends and neighbours, 0.5 percent knew through extension workers while 2.5 percent knew through medium that were not listed.

The question was not applicable to 71.0 percent of the respondents. The agricultural extension workers are the agency responsible for weather interpretation (National Department of Agriculture, 2003), and as a result it would be expected that this agency should create awareness to farmers about any form of disaster associated with agriculture. But on the contrary, only a few farmers got to know about drought through the extension workers.

Survey data outlined on Table 5.3 indicates that 21 percent of the farmers that were aware of drought before it started claimed that they believed when they were told there would be a drought while only 8.0 percent did not believe, 71.0 percent did not respond because they were not aware of drought incidence. This demonstrates that the early warning system is well suited to drought, if necessary weather information gets to the end users such as farmers, it would help increase their level of preparedness and as such reduce their vulnerability to drought.

5.2.4 Drought effects and response on livestock herd

In this section, attempts made by farmers to reduce the drought effects on their livestock were considered. It reflects coping mechanisms exhibited by livestock farmers to ensure sustainability of animals during periods of water and grass shortages. As shown in Table 5.4 below, only 8.5 percent of the respondents fenced to protect their water sources during the drought period, such water sources include harvested water stored in tanks at farmers' homes as well as tap water sources. Ninety one percent (91 percent) percent of the respondent did not fence their water sources, which indicates that farmers in the study area did not have control over water sources which may hinder their coping ability, such water sources are rivers and dams available to the entire community.

Out of the livestock or mixed farmers interviewed, 33.0 percent provided supplementary feeds for their livestock during normal times; 67 percent did not supply their animals with supplements. Although Table 5.4 also indicates that more farmers provided supplements for their livestock during the drought period; 42.5 percent provides supplements while 57.5

percent did not provide supplements for their animals during the same period. It would have been expected that all the farmers would provide supplement for their animals for lack of adequate grazing, but this was not the case because many farmers claimed lack of adequate finances.

Table 5.4 Drought effects and response on livestock herd

Variables	Affected (%)	Not affected (%)	χ^2	df	sig.
FP	8.5	91.5	0.422	1	0.445
PSBD	33.0	67.0	2.066	1	0.114
PSDD	42.5	57.5	0.001	1	0.575
SGLBD	100.0	-	-	-	-
SGLDD	99.0	1.0	3.354	1	0.199

n = 200

The study area consists of farmers operating mainly on communal lands, such lands does not belong to any individual farmer, as a result, it is not surprising that all the respondents with the exception of only 1.0 percent shared grazing lands with others both before and during the drought period as shown in Table 5.4 above, these few farmers claimed they did not share grass grown within their homestead with others. This implies that farmers does not have control over grazing lands just like the case of water sources and as such may not be able to plan effective utilisation of these vital resources.

5.2.5 Drought effect and response on crops

Effects of drought on crops and subsequent measures taken by farmers were looked into in this section. During the drought, changing cropping systems or crop types helps to deal with effect of water shortages for crop growth and development. Table 5.5 shows that only 35.5 percent of the respondents who are crop farmers changed their cropping systems during the drought period in other to maximise production. Such cropping systems includes intercropping, wide spacing of crops so as to avoid over-crowding which could encourage severe competition for available water among plants, shifting to early maturing crops and cultivation of a vast area in different directions.

Table 5.5 Drought effects and response on crops

Variables	Affected (%)	Not affected (%t)	χ^2	df	sig.
CCS	35.5	65.5	0.492	1	0.329
ASW	50.5	49.5	2.453	1	0.090
WAS	50.5	49.5	2.181	2	0.336
Mini-irrigation	16.5	-	-	-	-
Hand irrigation	34.0	-	-	-	-

n = 200

Without adequate rainfall for crop growth and development, there is bound to be a partial or total crops failure during periods of severe drought. As a result, there is the need for farmers to seek alternative sources of water for their crops in other to minimize drought effects on crops, out of the crop producing farmers, 50.5 percent had alternative sources of water for their crops (see Table 5.5); 16.5 percent used mini-irrigation system while a larger percentage (34.0 percent) employed hand irrigation as indicated on Table 5.5 above.

The effect of water shortage on crop farmers varies from one family to the other, although some farmers claimed the water shortage did not have a great effect on their crops because they cultivated a small area of land and were able to provide adequate water through hand and mini-irrigation systems, while other farmers suffered greatly as a result of water shortage.

5.2.6 Effects of drought on farmers and their household

When drought strikes, it does not only affect the farming activities, it also affect farmers' livelihood, including their household. As a result of such effects, farmers are left with no choice other than to respond to disturbances which change the status quo at the household economic level. This section deals with effect of drought on the farmers and their household as well as effect of coping mechanisms adopted by farmers on their household.

During periods of natural disaster like drought, migration is one of the measures usually taken by affected rural communities. Contrary to expectation, Table 5.6 shows only 2 percent of the respondents left their household village because of drought, while 98 percent

did not relocate. The few farmers that left claimed they could not cope with the hardship of drought effects and had to leave because they lost all their animals as a result of disease outbreak which led to loss of their livelihood. The larger percentage that did not relocate couldn't do so mostly because they couldn't leave their homes.

Table 5.6 Effects of drought on farmers and their households

Variables	Affected (%)	Not affected (%)	χ^2	df	sig.
MFH	2.0	98.0	0.479	1	0.639
MFM	2.5	97.5	0.602	1	0.571
ACW	82.5	17.5	4.074	1	0.50
AGF	57.5	42.5	0.252	1	0.391
MFFS	12.5	87.5	0.920	1	0.257
WSDD	5.0	95.0	4.259	1	0.074
AQH	49.5	50.5	2.453	1	0.090
MCS	0.5	99.5	0.118	1	0.895
DMDS	1.0	99.0	1.991	1	0.199

n = 200

As revealed by the study, only 2.5 percent of the respondents' family members migrated during the drought period while a larger percentage of 97.5 did not have any member of their family migrating from their household villages (Table 5.6). In this case, the fact that farmers in the study area did not consider mass migration out of their household villages as an option against drought effects could be as a result of either the level of severity of the drought or that they exhibit a strong bond with their roots.

Availability of clean and adequate water supply for domestic purposes could not be over emphasised during drought periods. This helps to prevent outbreak of water borne diseases such as cholera which could hamper farmers and their households in their various farming activities. The survey data in Table 5.6 indicates that 82.5 percent of the respondents have access to clean water during drought periods while only 17.5 percent of them did not have access to clean water for domestic purposes. This access to clean water was mostly subjected to irrational supply and could not be concluded to be adequate.

Table 5.6 shows 57.5 percent of the farmers said that they have access to good food during drought period while 42.5 percent said they did not. However, most of the farmers claimed that they have access to the same types of food they had during normal times which could not be said to be a balanced diet. The only thing that changed during drought period was the quantity of such foods (rationing) because they had to forgo buying foods for the family in other to be able to purchase feed supplements for their livestock.

During any period of drought depending on level of severity, farmers may suffer a great deal health-wisely which could result from various causes such as fatigue, malnutrition or outbreak of diseases and epidemic. When this occurs, there is a great need for health facilities to combat such health risks. Table 5.6 indicates that 12.5 percent of the respondents' family members fall sick during the drought period, 87.5 percent of the respondents claimed none of their family members fall sick during the same period. Out of the farmers that members of their household fell sick during the drought period, only 5.0 percent of them claimed that the sickness was due to malnutrition as a result of drought.

Table 5.6 also indicates that 49.5 percent of the surveyed households claimed to have access to quality health care while 50.5 percent of them claimed otherwise. In most of the areas where the study was conducted, most farmers had access to either a mobile clinic or had to travel far to seek medical assistance. Farmers found in areas attended by mobile clinics claimed such clinics are ineffective; this is because these clinics operate fortnightly and sometimes do not show up, others who travelled long distances in other to seek medical assistance complained that the long distances tells on their finances.

From the results obtained on Table 5.6 above, only 0.5 percent of the respondents' household members changed school during the drought period. Ninety nine point five percent (99.5 percent) of them said none of their household member changed school during the drought period. This signifies that many farmers did not leave their household villages

as stated earlier and as a result did not necessitate changing schools for their children. However, the children had to help their parents on the field after school hours.

5.2.7 Farmers strategies in response to disturbances and changes during drought

In order to cope with drought effects, various adjustments were practiced by farmers which were based on limited resources available at the household levels as well as help from external sources. This section deals with measures taken by farmers in trying to ease the effects of drought.

As shown in Table 5.7 below, only a few farmers prepared for drought before its onset (12.5 percent), a larger percentage (87.5 percent) did not prepare for drought. Although early warning system is well suited for drought prediction, it still shows that needed information about hazards such as drought is not adequately managed by the concerned authorities. Farmers and other stake holders in agricultural sector have to be kept abreast with information about drought early warning system so that adequate coping or management strategies could be formulated to reduce farmers' vulnerability to drought.

Many farmers were not aware of an impending drought incidence which did not help in terms of preparation such as storage of food crops for family and livestock. Farmers who claimed to be prepared for drought were among the few ones, who were aware of drought before onset. Some of the preparations made by farmers include; storage of water in tanks, digging of wells, storage of hays for livestock as well as food crops. In addition to this, some claimed adequate management of their limited resources.

Table 5.7 shows that 19.5 percent of the farmers drew upon stored food, 80.5 percent did not draw upon stored foods during the drought period. Drawing on stored foods was made possible for some farmers not because they were prepared for drought but because they've cultivated the habit of saving for the raining days, which could only be explained as a coincidence. Most of these farmers do not have storage facilities hence lack the habit of

food storing food crops. They mostly produce just enough crops to sustain them for certain periods, most of these small scale farmers in the rural areas are largely dependent on child grant and old age pension provided by the government for sustainability hence the habit of storing food crops.

Table 5.7 below shows that 23.5 percent of the respondents pledged or sold assets during the drought period. This was done mainly to reduce the effects being suffered as a result of drought. All the farmers in the study areas operated on communal lands which do not give them ownership to such lands, as a result, lands could not be sold or pledged, and most of the farmers also lacked adequate farming equipments such as tractors. The only form of assets available to them was livestock which they mostly sold at give away prices considering the situation at hand. In addition 76.5percent of them did not sell or pledge asset during the same period and these were mainly crop farmers who did not have animals to sell.

Table 5.7 Farmers' strategies in response to disturbances and changes during drought

Variables	Affected (%)	Not affected (%)	χ^2	df	sig.
PDBO	12.5	87.5	0.920	1	0.257
STDF	19.5	80.5	8.155	1	0.008
SPA	23.5	76.5	24.320	1	0.000
AAS	17.5	82.5	14.743	1	0.001
SNSF	21.5	78.5	0.074	1	0.486
DFM	8.5	91.5	7.071	1	0.021
RSA	16.5	83.5	4.826	1	0.037
FSE	31.0	69.0	7.497	1	0.008
EWM	9.0	91.0	0.800	1	0.371
DHF	32.0	68.0	0.813	3	0.846
HAT	29.0	71.0	0.002	1	0.593
DAMN	23.5	76.5	0.001	1	0.972
CCM	26.5	73.5	0.087	1	0.500

n = 200

Out of 23.5 percent of farmers that pledged or sold assets during the drought period, 17.5 percent of them claimed that they were able to achieve their aim for which the assets were

sold while others said the returns from such sales was not enough to reduce the effect of drought on their households (see Table 5.7)

In past studies of drought coping mechanism, farmers do sought wild fruits and animals to supplement available foods. The study area is not characterised by forest, as such farmers could not seek wild fruits. Also considering the governments' stance on gaming, it would not be expected of farmers to kill wild animals as they pleased. Although 21.5 percent of the farmers said they sought new source of food during the drought periods, this was done by managing their limited disposable income in purchasing cheaper brand of foods than what they normally buy as well as trying out cheaper combinations of new foods in stores. Seventy eight point five percent of the farmers did not seek new source of food (see Table 5.7).

Drought period could be a different experience for different families. Those with stored crops tend to take advantage of high market prices and cash in on their crops while others with inadequate food find other ways of coping with the effect of drought, these may include dispersing family members to live with relatives within and outside their household villages, some do that to seek help to feed their families while other just see it as a way of reducing the burden of feeding yet another mouth. Table 5.7 shows that only 8.5 percent of the farmers had members of their family dispersed during the drought period while 91.5 percent did not disperse their family members.

Some farmers adjusted to food shortages by rendering services in exchange for food during the drought period. Table 5.7 shows that 16.5 percent of the farmers rendered services in exchange for food during the drought period, 83.5 percent t did not. The farmers that rendered such services claimed it was the only option available for survival during the drought period in other to be able to support their family. Others claimed it was a low thing to do but it was better than getting involved in criminal activities to make the ends meet.

In past studies of drought, seeking alternative employment is one of the coping mechanisms available to drought affected farmers, most of the farmers interviewed said as much as they

would have loved to look for employment, they could not do so because they did not have the financial backing to live outside their household villages, other claimed they tried to, but it did not work out for them.

Table 5.7 indicates 31.0 percent of the farmers sought employment opportunity elsewhere, 69.0 percent did not. These percentages only reflects farmers that got employed elsewhere and those that did not, but did not reflect those that tried to get employed in non agricultural sector during the drought period but were rather unlucky. About 9.0 percent of these farmers got the employment within their household villages while others did it at nearby cities.

From the data on Table 5.7, 32.0 percent of the farmers affected by the drought received help during normal times and during the drought while 68.0 percent did not receive any help. Such help as claimed by the farmers were in form of food and groceries from friends and families, others considered the monthly child grant and old age pension as a form of help from the government in assisting them to cope with drought effects.

As shown in Table 5.7 above, only 6.0 percent of the farmers that got help said such helps were timely and they believed that the aid or assistance met the need they hope it would meet. Out of 200 farmers that responded to the questionnaire, only 26.5 percent believed that actions taken during drought helped them to cope with drought effects, although it was not exclusively satisfactory. Seventy three point five percent (73.5 percent) concluded that whatever they did to cope with drought effect did not help while others (26.5 percent) claimed that they did nothing to cope because they were caught unaware and as such did not prepare which rendered them vulnerable.

5.2.8 ANOVA for farmers affected and not affected by drought

In this ANOVA analysis, the independent variable is preparation for drought before onset, considering some of the variables in Table 5.8 below, statistically, there are significant relationships between the independent variable (i.e.; preparation for drought before onset) and variables such as sharing grazing lands before and during drought periods (SGLBD & SGLDD), access to clean water for domestic purposes (ACW), drawing upon stored foods during the drought period (STDF), sale or pledge of assets (SPA), sale or pledge of asset achieving aim of sales (AAS), dispersal of family members during drought to meet family needs (DFM), rendering service in exchange for food during drought (RSA), as well as being forced to seek employment elsewhere during the drought period (FSE).

Table 5.8 Analysis of variance for farmers affected and not affected by drought

Variables	Affected	Not affected	P-value
	Mean value	Mean value	
FP	1.952	1.911	0.516
PSBD	1.810	1.654	0.151
PSDD	1.571	1.575	0.972
SGLBD	1.000	1.000	0.067
SGLDD	1.048	1.006	0.000
CCS	1.714	1.637	0.483
ASW	1.333	1.514	0.117
MFH	2.000	1.978	0.489
MFM	2.000	1.978	0.438
ACW	1.333	1.156	0.044
AGF	1.476	1.419	0.616
AQH	1.667	1.486	0.117
MCS	2.000	1.994	0.713
STDF	1.571	1.832	0.004
SPA	1.333	1.816	0.000
AAS	1.524	1.860	0.000
SNSF	1.762	1.788	0.785
DFM	1.762	1.933	0.008
RSA	1.667	1.855	0.028
FSE	1.429	1.721	0.006
EWM	1.857	1.916	0.371
HAT	1.714	1.709	0.964
DAMN	1.762	1.765	0.972
CCM	1.762	1.732	0.768

n = 200, df = 1

5.2.9 Logistic regression for farmers affected and not affected by drought

Further analysis was carried out using the logistic regression (see Table 5.9) to determine the relationships between the selected variables. In this logistic regression analysis, just like in the ANOVA, preparation for drought before onset is also the independent variable. The findings are outlined below:

- **Fencing to protect water sources during drought (FP):** The odds ratio for fencing to protect water sources during the drought is 0.566; this means that farmers are 0.566 as likely to fence in order to protect their water sources as they are not to fence so as to protect water sources for livestock during the drought period.

- **Provision of supplementary feeds before the drought (PSBD):** Farmers are 0.401 as likely to provide supplementary feeds for livestock as they are not to provide supplementary feeds for livestock before the drought.
- **Provision of supplementary feeds during the drought (PSDD):** The odds ratio of providing supplementary feeds for livestock during the drought period is 2.622; farmers are two times more likely to provide supplementary feeds than not to provide for their livestock during the drought period.
- **Sharing of grazing land before and during the drought (SGLBD):** The odds ratio of sharing grazing lands during the drought is 4.689E10; this implies that farmers are more than four times likely to share grazing land than they would not before and during droughts. This means that farmers in the study area would readily share grazing lands before and during the drought. This is evident of the fact that they operate on communal lands.
- **Changing of cropping systems during the drought (CCS):** Data in Table 5.9 shows the odds ratio for farmers changing their cropping system is 0.630; this means that it is 0.630 as likely for farmers to change their cropping system during the drought period as they are not to change their cropping systems during the same period.
- **Use of alternative source of water for crops (ASW):** It is 13.402 more likely for farmers to use alternative source of water for their crops than not to use during the drought period.
- **Farmers moving from their villages or family members migrating because of drought (MFM & MFH):** The odds ratio for farmers moving from their household villages and their family members migrating is 0.000; it could be deducted that it is 0.000 less likely for farmers to migrate or have their family members leaving their household villages during the drought period as they would not. That farmers in t implies. Study area would not readily migrate during any phase of the drought.

Table 5.9 Logistic regression result for farmers affected and not affected by drought

Variables	B	S.E	Wald	df	Sig.	Exp(B)
FP	-.0568	1.935	0.086	1	0.769	0.566
PSBD	-0.914	1.362	0.450	1	0.503	0.401
PSDD	0.964	1.095	0.775	1	0.379	2.622
SGLBD	24.571	4019.326	0.000	1	1.000	4.689E10
SGLDD	24.571	4019.326	0.000	1	1.000	4.689E10
CCS	-0.462	1.667	0.077	1	0.782	0.630
ASW	2.595	1.295	4.016	1	0.045	13.402
MFH	-21.317	15515.473	0.000	1	0.999	0.000
MFM	-22.951	13265.708	0.000	1	0.999	0.000
ACW	-1.972	1.314	2.253	1	0.133	0.139
AGF	-1.128	0.961	1.379	1	0.240	0.324
AQH	-2.200	1.094	4.046	1	0.044	0.111
MCS	-66.436	69616.916	0.000	1	0.999	0.000
STDF	0.444	0.898	0.244	1	0.621	1.559
SPA	3.425	1.082	10.017	1	0.002	30.736
AAS	0.451	1.078	0.175	1	0.676	1.571
SNSF	-1.430	1.218	1.378	1	0.240	0.239
DFM	2.551	1.303	3.831	1	0.050	12.816
RSA	0.998	1.049	0.906	1	0.341	2.713
FSE	1.061	0.980	1.170	1	0.279	2.888
EWM	-1.835	1.833	1.002	1	0.317	0.160
HAT	0.194	1.096	0.031	1	0.860	1.214
DAMN	-0.579	1.196	0.235	1	0.628	0.560
CCM	-0.319	1.124	0.080	1	0.777	0.727

n = 200

- **Access to clean water for domestic purposes during the drought (ACW):** The odds ratio of clean water during the drought period is 0.139; it is 0.139 as likely for farmers to have access to clean water as they would not during the drought period.
- **Access to good food during the drought (AGF):** As shown in Table 5.9, it is 0.324 as likely for farmers to have access to good foods during drought period as they would not during the drought period.
- **Access to health care during drought (AQH):** The odd ratio for access to quality health care during the drought period is 0.111; it is 0.111 as likely for farmers to have access to health care as they would not during the drought period.

- **Family member changing schools during the drought (MCS):** It is 0.000 less likely for farmer's family members who are schooling to change school during the drought period.
- **Drawing on stored food during the drought (STDF):** The odds ratio for drawing on stored foods during the drought period is 1.559; it is about one time and half times more likely for farmers to draw upon stored foods than not to draw on stored foods during the drought period.
- **Sale or pledge of assets (SPA):** Data from Table 5.9 show the odds ratio for sale or pledge of asset during drought to be 30.736; it is over thirty times more likely for farmers to sell or pledge assets during drought than not to pledge or sell assets during the same period.
- **Achieved aim of assets sales (AAS):** It is about one and half times (odds ratio 1.571) more likely for farmers to achieve aim of sale or pledge of assets during the drought than they are not to achieve the aim.
- **Seeking new sources of food during the drought (SNSF):** It is 0.239 as likely for farmers to seek new source of food during the drought as they are not to seek new source of food.
- **Dispersal of family members during the drought (DFM):** From Table 5.9 above, the odds ratio for dispersal of family members in order to meet family needs during the drought is 12.816; it is over twelve times more likely for farmers to disperse their family members than they would not disperse their family members during drought.
- **Rendering services or assistance in exchange for food during the drought (RSA):** It is over two times more likely for farmers to render service or assistance in exchange for food during the drought than not to render service (odds ratio 2.713).
- **Forced to seek employment elsewhere during the drought (FSE):** It is over two times more likely for farmers to be forced to seek employment elsewhere than not to seek employment during the drought (odds ratio 2.888).

- **Did help or aid received meet needs (DAMN):** It is 0.560 as likely for help received during drought to meet the need of the farmers as it would not meet their needs.
- **Conclusion that coping mechanism adopted helped to ease drought effects on farmers (CCM):** It is 0.727 as likely for farmers to reach the conclusion that coping mechanisms adopted during drought helped to ease the effects of drought as it would not ease drought effects on farmers.

Unlike the statistical significance relationship between dependent and independent variables in the ANOVA shown in Table 5.7, only a few variables have a statistically significant relationship with the dependent variables in the logistic regression analysis result shown on Table 5.9.

CHAPTER 6
CONCLUSIONS AND RECOMMENDATIONS

This chapter summarises the findings of this research, conclusions and appropriate recommendations were also made.

6.1 FINDINGS AND CONCLUSIONS

The findings of this study have shown that farmers perceived drought as reduction in soil water table level for crop growth and development, inadequate grazing land as a result of delay in rainfall and/or inadequate precipitation. Various perceptions of farmers was also believed to have led to crop failure, malnutrition of farmers and livestock alike, forcing them to manage and cope with drought consequences with limited or inadequate resources.

Drought effects on farmers in the study area among others include:

- Lack of clean water for human and animal consumption
- Crop failure
- Animal mortality
- Partial or total loss of source of livelihood

In trying to cope with above listed effects of drought and others in the study area, the following coping mechanisms were identified:

- Sale of assets
- Use of mini or hand irrigation systems
- Purchase of supplementary feeds for livestock
- Change of crop cultivation patterns
- Travelling long distance in search of grazing
- Seeking alternative sources of income

Findings of the present study are generally consistent with results of past studies on drought coping mechanisms, but on the contrary, migration, seeking alternative sources of food such

as wild fruits and animals, sales of assets such as land, farming equipments and personal effects was not experienced in the study areas.

Although some of the farmers tried various ways to manage and cope with different changes and effects brought by drought as stated in chapter 5, most farmers were unable to cope effectively with the drought mainly because there was lack of information about drought occurrence and drought management as well as lack of resources, in view of these, the current research hypothesis has been accepted.

6.2 RECOMMENDATIONS

6.2.1 Recommendation in terms of Early Warning System

According to 2002/03 annual reports of National Department of Agriculture, only a handful of extension workers have been trained in terms of weather data interpretation to help with early warning system during drought as at that period, it was still evident that not so many extension workers were working in this regard, this was reflected in the percentage of farmers that were aware of drought incidence before its onset in the study area, there is need to intensify such projects.

Among other stake holders such as manufacturers of agricultural equipments, utilities and various inputs, farmers are one of the most important end users of early warning systems. As such, information about anticipated weather or climate changes should be communicated to them on time so as to be able to strategise ahead of such impending disasters in order to reduce their level of vulnerability to such disasters. In the light of this, all available medium of communication and awareness should be employed to convey information about any form of disaster.

6.2.2 Recommendation in terms of farmers' preparedness

Most farmers claimed that they were not prepared for drought because of lack of information about impending disasters, while others claimed that they did not know what to do to prepare even if they have access to such information. This research made it known that with farmers' financial status, level of education and lack of valuable information, it is

impossible for them to manage and cope with drought without external help or assistance from governments and agencies at all levels. Making available useful information about an impending drought may not be enough; there is also the need to go a step further by providing information about how to cope with such disaster.

Considering the fact that most rural farmers in South Africa does not have control over various production factors such as arable land, grazing land and their homes because most of them are cultivating on communal lands which does not belong to any individual as well as their homes which are mostly government owned houses (RDP) and as such could not pledge, sell or even use them as collateral in other to seek for financial assistance while trying to cope with drought. It would be recommended that farmers are advised and equally trained from time to time on how to cope and manage with drought and its associated effects or problems; these should include preparedness, public education and collaboration.

6.2.3 Recommendation on general issues

During the drought periods or other agricultural disasters, farmers tend to migrate to nearby towns and cities in search of alternative source of income. At such times, government could bring about developmental activities which include rural community building such as road construction, bridge construction, drilling of bore-holes, building community centres where there is none; this would in a way provide a temporary employment and income to farmers to ease the effect of disasters at that particular point in time.

Lastly, farmers should be encouraged to store hay at all times, protect vegetation cover, trained and educated on certain farming ethics with regards to drought as well as rational use of water. Also the use of various tested drought resistant plants and other agricultural inputs should be introduced to rural communities prone to drought so as to gain and improve their confidence level on such inputs over time.

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ANNEXURE A: TABLES NOT USED IN THE ANALYSIS

Characteristic	Number	Percentage
Ages of respondents (years)		
0 - 20	4	2.0
21 - 40	48	24.0
41 - 60	93	46.5
61 and above	48	24.0
Total	**193**	**96.5**
Years of formal education		
0 - 6	80	40 .0
7 and above	113	56.5
Total	**193**	**96.5**
Total number in household		
1 - 5	131	65.5
6 and above	63	31.5
Total	**194**	**97.0**
Years of farming		
0 - 10	98	49.0
11 - 20	51	25.5
21 and above	39	19.5
Total	**188**	**94.0**

Characteristic	Number	Percentage
Farmers' perception of drought		
Natural occurrence	13	6.5
Hardship	3	1.5
Lack of rainfall	71	35.5
Water shortage	34	17.0
Period of excessive heat	8	4.0
Overgrazing	2	1.0
Shortage of food	49	24.5
Hunger and famine	5	2.5
Soil erosion	5	2.5
Storm	2	1.0
Total	**192**	**96.0**
Most recent year of experiencing drought		
Year 2008	148	74.0
Before year 2008	31	15.5
Total	**179**	**89.5**
Numbers of water sources for livestock		
1	76	38
2	20	10
3	4	2
Total	**100**	**50.0**

Characteristic	Number	Percentage
Type of water source for livestock		
Stream	56	28
Bore-hole	9	4.5
Digging in stream-bed	1	0.5
Ponds	1	0.5
Concrete in ground	1	0.5
Reservoir/dam	13	6.5
Others	2	1.0
Total	**83**	**41.5**
Distance to water sources (km)		
0 - 3	74	37.0
4 and above	18	9.0
Total	**92**	**46.0**
Number of grazing sites		
1	72	36.0
2 and above	30	15.0
Total	**102**	**51.0**
Distance to primary grazing sites before (km)		
0 - 3	84	42.0
4 and above	12	6.0
Total	**96**	**48.0**
Distance to primary grazing sites during drought (km)		
0 - 3	71	35.5
4 and above	25	12.5
Total	**96**	**48.0**

Characteristic	Number	Percentage
Most significant livestock management changes made during drought		
None	32	16.0
Keeping animals together at all time	1	0.5
Purchase of feed supplements	50	25.0
Going far to graze	1	0.5
Use of vaccines	10	5.0
Fetching water	6	3.0
Total	**100**	**50.0**
Areas of land cultivated before drought (Ha)		
0 - 3	91	45.5
4 and above	30	15.0
Total	**121**	**60.5**
Areas of land cultivated during drought (Ha)		
0 - 3	92	46.0
4 and above	22	11.0
Total	**114**	**57.0**
If there was no access to quality health-care, why?		
Clinic to far from household village	37	18.5
Mobile clinic	65	32.5
Total	**102**	**51.0**
If any family member changed school during drought, why?		
Lack of resources	1	0.5
Total	**1**	**0.5**

Characteristic	Number	Percentage
What preparation did you make before drought?		
Tap water	1	0.5
Stored grain and grass	6	3.0
Stored water	3	1.5
Irrigation	2	1.0
Managed what we had	1	0.5
Workshop on how to cope	1	0.5
Total	**14**	**7.0**
Was sale or pledge of asset during the drought able to achieve aim, why or why not?		
Not enough	22	11.0
Helped to make other plans	1	0.5
Profitable	2	1.0
Total	**25**	**12.5**
Did you get employment within or outside your locality during drought?		
Within locality	20	10.0
Migrated	39	19.5
Total	**59**	**29.5**
Did you receive any help from patrons or agencies before or during drought period?		
During normal times	28	14.0
During drought	15	7.5
Both periods	2	1.0
Total	**45**	**22.5**

ANNEXURE B: RESEARCH QUESTIONNAIRE

DROUGHT COPING MECHANISMS SURVEY QUESTIONNAIRE

Location

Date of interview (DD/MM/YYYY)

(A) Human Demography

1. Ages of respondents: .....

2. Marital status

1 = Married
2 = Single
3 = Divorced
4 = Widow/er
5 = Separated

3. What is the highest grade/education level achieved?

0 = Not started school/no education
1 = Pre-school
2 = Completed primary
3 = Did not complete high school
4 = Secondary/High School
5 = Matric
6 = Diploma
7 = Degree
8 = Post-graduate
9 = Others……..

3b. Years of formal education…… **(Years)**

4. Total number in household ……

5. How long have you been farming? ……. **(Years)**

6. Type of farming activity

1 = Livestock farming
2 = Crop farming
3 = Mixed farming

(B) How do farmers Perceive drought?

1. What do you understand by drought?

……
……
……
…….

2. Have you ever-experienced drought incidence since you started farming?

1 = Yes
2 = No

3. When in the most recent time? …….

4. Were you aware of drought incidence before its onset?

1 = Yes
2 = No

5. If yes, through what medium?

1 = TV
2 = Radio
3 = Newspaper
4 = Farmers' union
5 = Friends and neighbours
6 = Extension workers
7 = Others

6. Did you believe when you were told there would be drought?

1 = Yes
2 = No

(C) Effects and responses on the livestock herds

1. **How many water sources did you have access to for your livestock before the onset of the drought?** ……..

2. **What type of water sources were they and what were the distances to these sources?**

Type of water source	Before drought	During drought	Distance (km)
Stream			
Bore hole			
Digging in stream bed			
Ponds			
Concrete in ground			
Concrete above ground			
Reservoir/dam			
Others			

3. **Did you fence to protect the water source?**
   1 = Yes
   2 = No

4. **How many grazing sites did you have access to before the drought?**
   .....

5. **What was the distance to the primary grazing sites before and during the drought period?**

Numbers of grazing sites	Distance before drought (km)	Distance after drought (km)

6. **Did you provide any supplementary feeds for your animals before the drought period?**
   1 = Yes
   2 = No

7. Did you provide any supplementary feeds for your animals during the drought period?

1 = Yes
2 = No

8 What was the most significant livestock management change you experienced during drought?

……
……
……
……

9. Did you share your grazing lands with anyone before and during the drought period?

Before drought	During drought

10. If yes, why?

……
……
……
……

(D) Effect and response on crop

1. What area of land do you cultivate during normal/drought period?

Periods	**Land area (Ha)**
Normal period	
Drought period	

2. Did you have to change your cropping system during the drought period?
1 = Yes
2 = No

3. What type of cropping system did you employ during the drought period?
1 = Intercropping
2 = Wide spacing
3 = Shifting to quick maturing crops
4 = Cultivation of vast area in different directions
5 = Others

4. How did the water shortage affect your crops?
1 = Little
2 = Very
3 = Very much
4 = Not at all

5. Did you have alternative source of water for your crops?
1 = Yes
2 = No

6. If yes, what are alternative sources of water?
1 = Mini irrigation systems.
2 = Hand irrigation

(E) Effects of drought on farmers and their household

1. Did you have to move from your household village because of drought?
1 = Yes
2 = No

2. Did any member of your family migrate during the drought period?
1 = Yes
2 = No

3. Did you have access to clean water for domestic purposes during these periods?
1 = Yes
2 = No

4. How would you rate your access to clean water?
1 = Good
2 = Very Good
3 = Fairly Good
4 = Bad
5 = Worse

5. Did you have access to good foods during drought?
1=Yes
2=No

6. Did any member of your family fall sick during the drought period?
1 = Yes
2 = No

7. Was the sickness due to malnutrition?
1 =Yes
2 = No

8. Did you have access to quality health care?
1 = Yes
2 = No

9. If no, why?
……
……
……
……

10. Did any member of your family (schooling) changed school during these periods?

1 = Yes
2 = No

11. If yes, why?

……
……
……
……

12. Did any member of your family dropped out of school as result of drought effect.

1 = Yes
2 = No

13. If yes, why?

……..…..……
……...……
……..…….....
.....

(F) Farmers' Strategies in Response to Disturbances and Changes During Drought

1. Where you prepared for drought incidence before its onset?

1 = Yes
2 = No

2. What kind of preparation did you put in place?

……
……
……
.....

3. Did you draw upon stored foods during drought?

1 = Yes
2 = No

4. Did you sell or pledge assets?

1 = Yes
2 = No

5. Was it able to achieve the aim of sale?

1 = Yes
2 = No

6. Why, or why not?

……
……
……
……

7 Did you seek new source of food, like wild fruits and animals during drought period?

1 = Yes
2 = No

8 Did you have to disperse family members during any phase of drought in other to meet family needs?

1 = Yes
2 = No

9 Did you render services or assistance in exchange for food during these period?

1 = Yes
2 = No

10 Were you forced to seek employment elsewhere during the drought period?

1 = Yes
2 = No

11 Did you get the employment within your locality or you had to migrate?

1 = Within
2 = Migrate

12 Did you and your family received help form patron, or any agencies during drought or normal periods?

1 = During drought
2 = Normal time

Assistance	Normal times	During drought
Relatives		
Patrons		
Community/neighbours		
Government agencies		
NGOs		
Private agencies		
Farmers' union		
Others		

13 How did you find out about the organisation you received help from?

1 = Friends and families
2 = Farmers' union
3 = Community associations
4 = News media
5 = Others

14 Was these help or aid timely?

1 = Yes
2 = No

15 Did the aid or assistance from agencies you mentioned met the need you hope it would meet?

1 = Yes
2 = No

16. Why, or why not?

……
……

……
……

17 Can you conclude that the coping mechanisms you adopted helped to ease the effect of drought on your household?

1 = Yes
2 = No

18. Why or why not?

……..…
…….....……..…….……..…...…
……..…….....…….....
.....

19. What other associated disaster did you encounter during drought in your area (E.g. fire outbreak, epidemics, etc)?

.....
.....
.....
.....