THESIS

RESPONSES TO CLIMATE VARIABILITY OF THE LIVESTOCK SECTOR IN THE NORTH-WEST PROVINCE, SOUTH AFRICA

Submitted by

Jerry Wayne Hudson

Department of Anthropology

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WE HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER OUR SUPERVISION BY JERRY W. HUDSON ENTITLED RESPONSES TO CLIMATE VARIABILITY OF THE LIVESTOCK SECTOR IN THE NORTH-WEST PROVINCE, SOUTH AFRICA, BE ACCEPTED AS FULFILLING IN PART REQUIREMENTS FOR THE DEGREE OF MASTER OF ARTS.

Committee on Graduate Work

[redacted]

[redacted]

[redacted]

Adviser

[redacted]

Department Head/Director

ABSTRACT OF THESIS

RESPONSES TO CLIMATE VARIABILITY
IN THE LIVESTOCK SECTOR IN THE
NORTH-WEST PROVINCE, SOUTH AFRICA

The goal of this study is to compare management drought strategies, including the use of climate forecasts, of livestock farmers in commercial areas with livestock farmers in adjacent communal areas within the western region of the North-West Province of the Republic of South Africa. In this rural semi-arid to arid region of the southern Kalahari, the majority of people make their living from animal production. It is shown that commercial farmers have a greater number of strategic options and greater accessibility to natural and human resources including pasture lands, water, and information. This research demonstrates that in this relatively homogeneous ecological setting, farmers' animal management responses to drought and use of climate forecasts are highly variable due to human factors such as culture, production goals, history, government policy, and market constraints. A human ecological framework is used to explain research findings and examine results within existing ecological, economic, ethnic, and historical constraints faced by local populations.

Jerry Wayne Hudson
Anthropology Department
Colorado State University
Fort Collins, CO 80523
Summer 2002

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Chapter 1

INTRODUCTION

Statement of the Problem

The western region of the North-West Province in the Republic of South Africa is primarily inhabited by two groups of people who earn their livelihood from livestock production: commercial farmers of Dutch and British descent, and communal farmers of Tswana descent. The objective of this research is to determine variations between commercial and communal livestock farmers' livestock management strategies and responses to drought, including the use of climate forecasts.

The study area, part of the arid to semi-arid Kalahari, is historically prone to drought conditions and any year has a high probability of being a drought year (Tyson 1986). Farmers living there generally count on two to four years with ample rainfall, followed by one or sometimes two years of drought conditions (Klopper 1999). Since drought is considered to be a natural event which farmers expect to occur periodically, drought preparedness is a normal part of their management strategy. However, information about the specifics of drought management strategies used by farmers in the area is scarce. Likewise, differences in drought management responses between commercial and communal farmers is generally unknown (Freeman 1988, Adams 1983).

In addition to having drought coping strategies for livestock production, farmers must have access to adequate natural resources, such as grazing land and water. They also need access to timely climate forecast information to maximize utilization of these resources. The use of long term climate forecasts has been shown to be of value in drought preparedness (Glantz et al. 1991, IDS 1992, Riebsame 1989) and in particular for El Niño-related events (Glantz 1994). Furthermore, timely and accurate climate forecasts are deemed necessary components of farming management to provide effective strategies for maximizing food production and to minimize livestock loss due to drought (IRI 1999, Glantz 1994, Cashdan 1990). However, the availability, accessability, and utilization of information resources about climate events, including El Niño, is generally unknown for either group of farmers in the study area (Landman 1999).

The study area is a savanna environment located on the southern edge of the Kalahari (Figure 1.1). The majority of people living there use livestock (mainly cattle, sheep, and goats) as their primary livelihood and economic base. Environmental conditions are harsh, and relatively homogeneous across the study area. Since the environment is fairly homogeneous, environment is not considered a significant contributor to differences of drought responses, livestock management strategies, or use of climate forecasts between commercial and communal farmers. Furthermore, because variations in environmental conditions are insignificant, human factors must account for differences between commercial and communal farming management decisions, including farming methods and production.

Figure 1.1 Location of the study area.

The South African national policy of racial segregation, called apartheid, has affected the country's economic, social, and political development for over half a century. Although apartheid was officially abolished in 1994 and native Africans now have representation in their government as well as full civil rights, the two ethnic groups within this study area (for all practical purposes) remain spatially, culturally, and economically segregated.

Factors of culture, history, government policy, and market conditions are considered to be among what I term as the more significant *human resources* which contribute to and perpetuate the spatial, cultural, and economic segregation of present day South Africa. Furthermore, these factors lead to variations between commercial and communal farm management practices. Thus, their identification and evaluation can help determine the different resources available to farmers during normal rainfall years and the reserves farmers have to draw upon in times of drought.

These human resources are also important for determining scale of operation which is seen as a primary determinant of livestock management decisions. Scale of operation is shown to be different between commercial and communal farmers within the study area. Another determinant which modifies a farmer's decisions about livestock management is the occurrence of drought; how farmers perceive drought, what resources are available during drought conditions, and what responses and strategies have been developed to cope with recurring drought. The third determinant which modifies farmers' livestock management decisions is the availability and use of climate forecast information. These three determinants influence farming decisions and therefore the farmer's food security and economic well-being. The purpose of this thesis is to analyze and explain differences between commercial and communal farmers' livestock management decisions by using these three determinants of livestock management decisions: scale of operation, responses and adaptations to drought, and use of climate forecasts.

Definitions and Conventions

South Africa has occupational definitions and categorizations of people that are unique to the country. Conventional South African usages, as defined here, are used throughout this thesis for the sake of clarity, and to provide a common basis of understanding.

People in South Africa and the South African government generally classify people into four categories: *white*, *black, colored*, and *Asian*. White people are Caucasians, generally of European descent. Black people are dark-skinned, mostly indigenous Africans (sometimes called native Africans). The colored and Asian categories of people are generally inclusive of all people not included in the former two categories, including people from India, Malaysia, the Middle East, and others, as well as people of mixed ancestry. These terms are currently used throughout the country by people of all races, ethnicity, and socioeconomic status. Since this categorization of people is considered appropriate, and is widely used within South Africa, these terms are used in this thesis.

In South Africa, the term *rancher* is not used, instead, the term *farmer* is used to denote people who make their livelihood from crops, livestock, or both. The South African Department of Agriculture (SADA) identifies three categories of farmers: commercial, communal and emerging (SADS 2000). The SADA defines *commercial farmer*s as farmers who own their own land and try to maximize livestock production for the market economy. All commercial farmers in this study are white. *Communal farmers* are black farmers who live in tribal villages on former homeland areas. They typically own their own livestock, and use communal pastures for grazing. *Emerging farmers* are black farmers who have resources beyond that of most communal farmers. Since emerging farmers are considered to have greater resources than most communal farmers by the SADA, they are considered to have a higher chance of economic success than communal farmers. Therefore, they are especially targeted by the Department of Agriculture for development aid. Emerging farmers include those on the Bophuthatswana 4-40 Plan and those on the South African Development Test Farms (SADT), as discussed below. Less than 10% of the communal farmers in the study area are considered to be emerging farmers by the SADA, and emerging farmers make up approximately 12% of the communal farmers interviewed for this research. Production goals of emerging farmers are thought to lie somewhere between those of communal and commercial farmers. Since emerging farmers live in communal areas, and share the same cultural traditions, history, and language as communal farmers (SADA 1999d), they are grouped with communal farmers for the purpose of this thesis.

Purpose of Research

The purpose of this research is to understand farmers' management responses to climate variability and their use of climate forecasts. Little is known about how farmers in these districts change their management practices or what options are available in times of drought (Freeman 1988, Vogel 1994). For people living withing semi-arid climates, two factors, environmental conditions (such as climate, rainfall, and plant species) and human resources (such as culture, history, government policy, and market constraints) determine methods of livestock production, species of animals used, and quantity of animals produced. To illustrate, the environment sets certain limits on numbers and types of animals that can be supported within an area. However, people with different cultural backgrounds might vary in their preference for animal species and keep livestock herds for different reasons. Therefore, as in this study, different types of farmers will maintain their herds using different management practices. The SADA (1999f), when stating that poor pastureland management can create pseudo-drought effects, while on the other hand, good pastureland management can buffer the effects of drought, illustrates the relative significance of human and environmental factors. This means that human actions are known to be important contributors leading to the occurrence or absence of drought effects. Vogel (1994:152), notes that "... the severity of drought impacts [in South Africa] has been more a consequence of the mishandling of drought situations, farm management, and agricultural systems in the country than a consequence of a reduction in rainfall." Thus, Vogel sees human actions as paramount over natural events in regards to impacting human livelihood and food security.

Human factors have significant effects on livestock production in drought conditions, and since the study area is in a relatively homogeneous ecological environment, observed variations between commercial and communal farmers' management responses to drought must be attributed more to human resources such as culture, history, government policy, and market constraints than to environmental factors. The overall purpose of this study is to analyze scale of operation, use of climate forecasts, and management responses to drought, in order to determine how livestock management decisions are made by communal and commercial farmers.

First, results of this study will help to identify and understand variations in human resources, how resources are utilized, and why such a disparity in livestock production and economic well-being between exists commercial and communal farmers in the study area. Identifying and isolating problem areas of climate forecast availability and utilization faced by farmers is pertinent to farmers' economic well-being. Secondly, these research results can potentially aid the future development of more effective strategies for implementing and disseminating culturally appropriate climate forecast information.

Study Objectives

First, the study was designed to assess management options that farmers have for livestock production in times of drought and to isolate and analyze important factors leading to current management practices. This was accomplished by interviewing farmers and then evaluating their responses in the context of pertinent human resources (such as cultural, historical, governmental policy, and market constraints). This research compares findings from communal and commercial farming districts in order to gain understanding of the importance of human factors on drought management strategies in a relatively homogeneous environment.

Second, the study assesses the availability and utility of forecast information by commercial and communal farmers, and their perceptions of the value and accuracy of seasonal forecasts. This study also sought to understand how the accuracy of forecast predictions may modify a farmer's perception of the utility and value of climate forecast information.

Hypotheses

The following hypotheses were based on these study objectives, and were tested from data gathered during this research. The first two hypotheses are important in explaining differences in scale of operation between commercial and communal farmers, which in turn influences the ability to cope with drought. The third hypothesis is important in explaining cultural differences in management practices, and the fourth hypothesis is important in explaining the disparity between commercial and communal farmer's use of climate forecasts as a drought mitigation strategy.

1) Commercial farmers have larger farms which support larger numbers of people, larger numbers of livestock, and have a greater number of boreholes. Together, scale (size of the farm, number of people supported, numbers of livestock) and scope (farm support, infrastructure) of operation are greater for commercial farmers.
2) Commercial farmers can cope more readily with drought as indicated by scale of operation, different production goals, strategies to minimize effects of drought, and the number of years farmers perceive they can cope with drought.
3) Commercial and communal farmers have different production goals as determined by species of animals kept and reasons for selling livestock.
4) Commercial farmers consider climate forecast information as being more important than by communal farmers as determined by forecast availability and use, the perceived accuracy of forecasts, the perceived value of climate forecasts, and decisions based on forecasts.

Theoretical Framework

Human ecology is an appropriate perspective for this thesis because it has been shown to have high utilitarian and theoretical value in the two major elements encountered in this research: cross cultural studies, and studies of human adaptation in harsh environments (Little and Leslie 1999, Fossett and Cready 1998, Weiner 1980). It also provides a broad multi-disciplinary framework capable of incorporating a myriad of factors, including historical and ecological elements which are necessary to explain the research findings.

Interactions between humans and their natural environment generate complex problems which occur at various spatial and temporal scales. Due to the complex nature of these problems, a holistic approach is needed to achieve an understanding of social and environmental issues. Human ecology, with its interdisciplinary approach, provides a versatile framework which is used for the analysis of data gathered for this thesis. With its origins in human biology, ecology, and evolutionary theory (Little et al. 1990, Little 1995 and 1982), human ecology has been used to describe many aspects of the interaction between humans and their environment (Fratkin et al. 1994, Bidwell and Kasarda 1988, Richerson et al. 1996, Thomas et al. 1979). For example, the human ecology perspective sees adaptation as an interactive process between the environment, humans in the environment, and social organization. Thomas (2001) and Weiner (1980) consider two aspects of the environment which greatly influence human adaptation, the ecological environment and the social-political environment.

Consistent with these ideas, culture can be seen as a unique human adaptation to environmental conditions (Bidwell and Kasarda 1998, Weiner 1980, Little 1980). According to these theorists, cultures evolving in harsh environmental conditions will have characteristics that are different from those evolving in less harsh conditions. Cultural characteristics are also modified over time as both the social and natural environments change. Thus, cultural adaptations seen from the human ecology perspective are part of a complex interaction between humans and their environment. In short, humans modify their environment and the environment modifies human behavior. Human modification by the environment may occur as relatively short or long-term culturally adaptive responses (Thomas 2001, Goodman et al. 1988, Thomas et al. 1979). This is not to imply that there are universal deterministic characteristics of culture either intrinsically or from environmental influences, but simply that humans and their cultures are modified by a combination of dynamic evolutionary and environmental forces.

Consistent with theories of human ecology, and pertinent to this thesis, the interaction of two or more cultures fosters changes and adaptation within each culture, given the constraints of natural resources present within a particular environment. Furthermore, Weiner (1980) considers the human ecological approach as germane to both historical and current circumstances which they deem necessary to enable researchers to anticipate changes in structures and processes of interaction between humans and their environment (Weiner 1980). In other words, it is necessary to integrate a historical perspective as well as current political and economic processes to gain understanding of the interaction of two or more cultures (Crumley 1994, Balie 1998).

In the research analysis of this thesis, the framework provided by human ecology is used to examine environmental limitations, cultural differences, and changing government policies, which are currently thought to be responsible for variations in livestock production and responses to drought between commercial and communal farmers.

Conceptual Framework

The diagram of the conceptual framework used in this thesis illustrates factors influencing livestock management decisions made by commercial and communal farmers in the study area (Figure 1.2). These factors are divided into two main categories of resources: human and natural. If human resources, such as culture, history, government policy and markets, were not a factor in livestock production, then in the relatively homogeneous physical environment of the southern Kalahari, there would be little or no difference in livestock production between commercial and communal farmers.

Without human factors, and if biological processes of reproduction and growth are not considered, livestock production would be dependent upon limitations of natural resources as set by the physical environment. However, not only is the physical environment continually modified by variations in annual and perennial rainfall, temperature, and solar insolation, it is also modified by human intervention (Weiner 1980). These and other processes not only change biomass production and species composition of vegetation, but contribute to longer-term climate change. Drought is one of the natural products of short-term variation in these physical processes which occurs in the study area on a fairly regular basis.

Human resources, however, play an important role in livestock production. Human culture, history, government policy, and market conditions are factors identified in this thesis which contribute to scale of operation, drought coping strategies, and utilization of forecast information. Variations between commercial and communal farmers affect livestock management decisions and consequently food security and economic well-being.

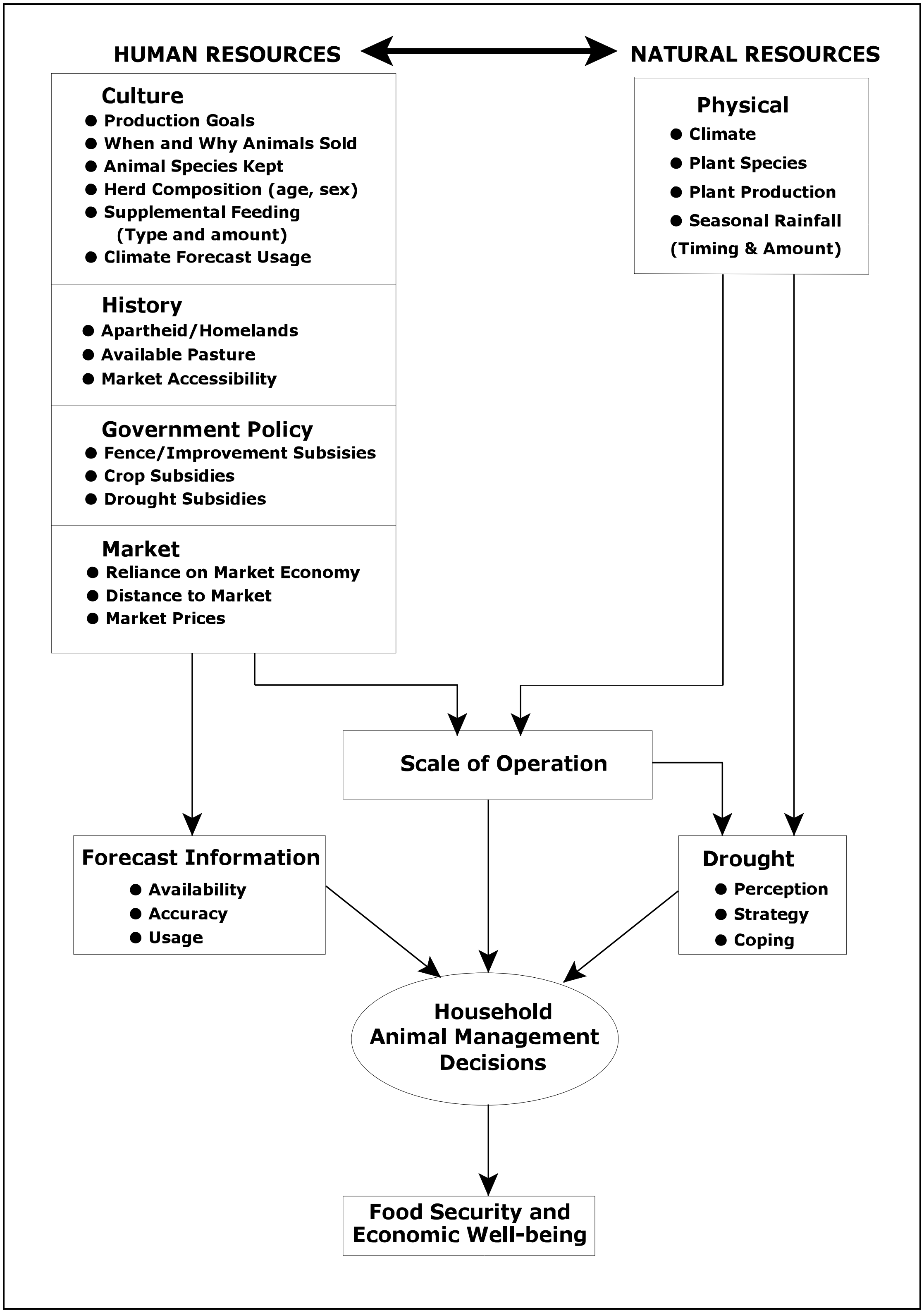

Figure 1.2 Block diagram of the conceptual framework.

Chapter 2

BACKGROUND INFORMATION

Study Site

The Republic of South Africa is, for administrative and legislative purposes, divided into nine provinces, which are further subdivided into districts. Similar to counties in the United States, districts define boundaries of the government's local-level organizational units. In some parts of South Africa, groups of districts having common political, ethnic, or physical similarities are known as regions.

The North-West Province, located in the north-central part of the country, is divided into 28 districts, in which five western districts make up almost half of the province's total area (Figure 2.1). These five districts (Vryburg 1, Vryburg 2, Ganyesa, Kudumane, and Taung) are collectively known as the western region of the North-West province. This region defines the boundary and locus of the study area.

The western region is a savanna environment which is generally deemed unsuitable for dryland crop production because of limitations in climate, soils, or terrain (Cowling et al. 1997, Vogel 1994, Tyson 1986, Leppan and Bosman 1923). Consequently, the majority of people living there use livestock (mainly cattle, sheep, and goats) as their primary economic base, and a substantial portion of the nation's livestock

Figure 2.1 Commercial and communal districts of the North-West Province's western region.

production is located within this region (SADA 1999d). The town of Vryburg, located near the center of the Vryburg2 farming district, has a population of about 8,000. It is the largest town in the study area and claims to have the largest cattle market in the southern hemisphere (Vryburg Development Center 1999). Up to 250,000 cattle are sold annually in Vryburg, mainly by commercial farmers (Stellaland Tourist Board 1999).

Two districts, Vryburg 1 and Vryburg 2 are populated by commercial farmers, the other three districts, Taung, Ganyesa, and Kudumane, are communal farming districts. Sizes of commercial and communal districts of the western region are well known (Table

2.1). Vryburg 1, is the largest (19,056 km^2), Vryburg 2 is 11,054 km^2, and together they are 1.6 times larger than the three communal areas together (Ganyesa 7,357 km^2, Kudumane 8,992 km^2, and Taung 2,773 km^2). The population density averages around 1 person per 4 ha and is fairly similar throughout the 5 districts.

Table 2.1 Commercial and communal district sizes

	District Sizes Five Western Districts N-W Province		
	District	**Area (sq km)**	**Total**
Commercial	Vryburg 1	19,056	30,110
	Vryburg 2	11,054	
Communal	Ganyesa	7,357	19,122
	Kudumane	8,992	
	Taung	2,773	

Commercial Farming Districts

Farmers in the two Vryburg districts generally own their livestock and pastureland and make their living by producing livestock for the market economy. About 70% of the farmers in these two districts are Afrikaners who are descendants of Dutch settlers. The other 30% are of British descent. No black landowners are known to live in these two districts (SADA 1999d). Some black and colored people live in and around towns in the Vryburg districts, but they make their livelihood in the service and labor sectors of the economy and do not own or keep livestock within the two commercial districts.

Commercial farmers own large western-style farms that are typically greater than 2,500 ha and are mainly used for market-oriented cattle production (SADA 1999c). The farms in these two districts have been surveyed, are well-delineated with fences, and have houses for permanent workers in addition to the owner's farm house. The majority of commercial farmers use the camp system, in which animals are rotated among numerous pastures. This system of livestock production prevents overgrazing and allows an increase in forage production. Commercial farmers typically have several boreholes in each camp that provide their animals with an ample supply of water. Within the commercial districts, farms have typically been in the family for three or four generations. Recently, harder economic times, decreasing farm profits, and the increasing age of farmers have resulted in some families selling their farms and often leaving the district. Some farmers absorb neighboring farms in order to increase pasture lands and herd sizes, and consequently, increase their profit margin. Other farmers diversify by providing products for specific markets such as specialized cattle breeds, produce game animals, operate hunting lodges, or engage in selective breeding of foreign animals. One example of this diversification is a commercial farmer who breeds American Quarter horses to improve endurance of the breed. In general, commercial farms are run for profit, support a small nuclear family, and support a large number of permanent workers along with the worker's families.

People in the Vryburg districts have traditions and lifestyles similar to their ancestors in rural Europe, but experience harsh environmental conditions as well as increasing political and economic pressures on their lifestyles. These pressures include recurrent drought (Laing 1992), changes in government policies for land use (SADA 1999d), a steadily decreasing market economy (Simbi 1998), and changes in resource management legislation, including new and presently changing water and land tenure laws (Simbi 1998, Bromley 1995, Levin and Weiner 1994).

Communal Farming Districts

Three districts in the western part of the North-West Province, Ganyesa, Kudumane, and Taung, are communal farming districts. These districts were originally formed as part of the Bophuthatswana Homeland for Tswana peoples during the country's apartheid era. No white farmers or landowners are known to live in these districts, which are only inhabited by people of the Tswana tribes. Farmers in these districts live on tribal or village land, and own individual adobe homes, and their own livestock. Most villagers get water from one or more community wind-driven or diesel-powered boreholes (wells) which fill cisterns or stock-tanks. Household water is carried from a borehole to the home, and in a few villages, animals and humans share water from the same borehole.

Reliance on the market economy has replaced many egalitarian traditions, although village life is still built on close-knit social customs where extended families, kinship, and clan relationships play a large part in the activities of daily life, and in governing the village. Trading and selling livestock is the Tswana's primary means of earning a livelihood, but approximately half of the adults are engaged in wage labor, service industries, or have other supplementary sources of income. Migrant work in gold mines and diamond fields was once a major source of income for many Tswana people, but mineral production in South Africa is now approximately 20% of production levels during the 1970s and 1980s (SADA 1999d). Currently, selling livestock is the only method of earning income for approximately half of the communal households. In general, the more animals a communal farmer possesses, the greater number of nuclear and extended family members the farmer supports. Access to pastureland varies highly between villages, and may be controlled by the village chief, the village council, or other complex social norms. In some cases, the chief or other tribal authority may allocate individual grazing rights to select pastures, but in general, grazing land is usually shared by all village farmers. Because the boundaries of village pastureland are poorly defined and fences are virtually nonexistent, animals from two or more villages often graze in the same pasture. Pasture may be shared between villages by simple custom or by formal agreement (SADA 1999d).

Although the Tswana people live in a semi-traditional tribal system, they are also experiencing increasing pressures on their lifestyles. These pressures include recurrent drought (Laing 1992), population increases (SADA 1999d), changes in land use policies (SADA 1999d), market economy influences (Simbi 1998), land reform and land tenure changes (Levin and Weiner 1994, Bromley 1995), and a growing popular desire for full democratic representation in village affairs in lieu of their traditional chiefdom system (SADA 1999d). The outbreak of HIV has reached endemic proportions in South Africa with over 20% of the population (4.1 million people) diagnosed with HIV. The HIV epidemic is spreading at a much slower rate in the white population, which has a 1% infection rate compared to the black infection rate of up to 60% in some regions. If this trend continues, the white population will outnumber the black population in just over a decade (SADS 2000).

In summary, although living under the authority of the tribal government, Tswana people are becoming almost totally dependent on the market economy for their livelihoods. Most traditional cultural norms and values have been integrated with western ideals and practices, and they are under substantial pressures and influences from outside sources (ETF 1985, RSA 1975 and 1972).

Physical Environment

The western region of the North-West Province lies within longitudes 22:45 E and 25:10 E and latitudes 25:15 S and 28:00 S and is located in the southern part of the Kalahari savanna (Partridge 1997, Rutherford and Westfall 1994). The region is bounded on the north by the Molopo River, whose dry riverbed forms the international boundary between Botswana and South Africa. On the west and south and southeast, the region is bounded by brushlands of the Northern Cape and Free State Provinces. Savannas in the western region merge into more mesic grasslands in the eastern region of the North-West Province. Surface water in the western region of the North-West Province is limited to a few perennial rivers, seasonal pans, and ephemeral streams (Schulze 1997).

Geologically, the Kalahari Basin was formed during a period of global aridification about 2.8 M years ago. Since then it has been subject to recurrent episodes of aeolian redistribution, occasionally interrupted during the Pleistocene period by cycles of glaciation (Partridge 1997). At present, with the exception of a few dune crests in the most arid areas, soils are stabilized by vegetation.

The region is classified by the South African Department of Agriculture (SADA) as Kalahari Thornveld and Shrub Bushveld. However, the region has previously been characterized by over 21 different classification schemes (Rutherford and Westfall 1994, Harris 1980), including “Fynbos” by Acocks (1975 and 1953), Wooded Steppe with abundant *Acacia* and *Commiphora* by Keay (1959), Semi-Arid Woodland - Shrubland by Sheepers (1982), Werger (1986), and dry steppe (Evenari et al. 1986). Although classified under many different systems, a general category of semi-arid or arid savanna is most commonly used in the literature describing the climate and ecology in the vicinity of the study area. The key feature common to savannas is a hot climate having a wet season lasting between four and eight months in duration, and a warm dry season for the rest of the year (Schultze 1997).

As is typical of savannas, winters in the study area are dry and warm, but sometimes punctuated with cold fronts and lower temperatures that typically last less than a week. Early morning frost is not uncommon in the winter, however, daytime temperatures rise well above freezing. Generally, rains do not occur from late autumn, through winter, or into early spring. Since almost all rainfall occurs in the summer months, cloud cover and rains usually keep summer temperatures pleasant for humans and their livestock. However, during clear dry spells of summer, temperatures often rise to and above 45^{O}C (Landman 1999, Schultze 1997).

The national average rainfall for the Republic of South Africa is 497 mm (Harris 1980). Roughly 65% of the country receives less rainfall than the 500 mm level, which is regarded as the minimum precipitation for successful dry-land farming of crops (Smith 1992, Tyson 1986). About one fifth of the country receives less than 200mm of rain per year (Schulze 1997). On the national level, rainfall is generally most plentiful in the eastern part of the country and decreases in a westerly direction. A smaller rainfall gradient exists with increasing rainfall from north to south. The north-south gradient is substantially weaker than the east-west gradient, and for the purposes of this thesis is not considered significant (SADA 1999a, Rutherford and Westfall 1994).

Annual precipitation records for the study area tend to follow the national pattern,

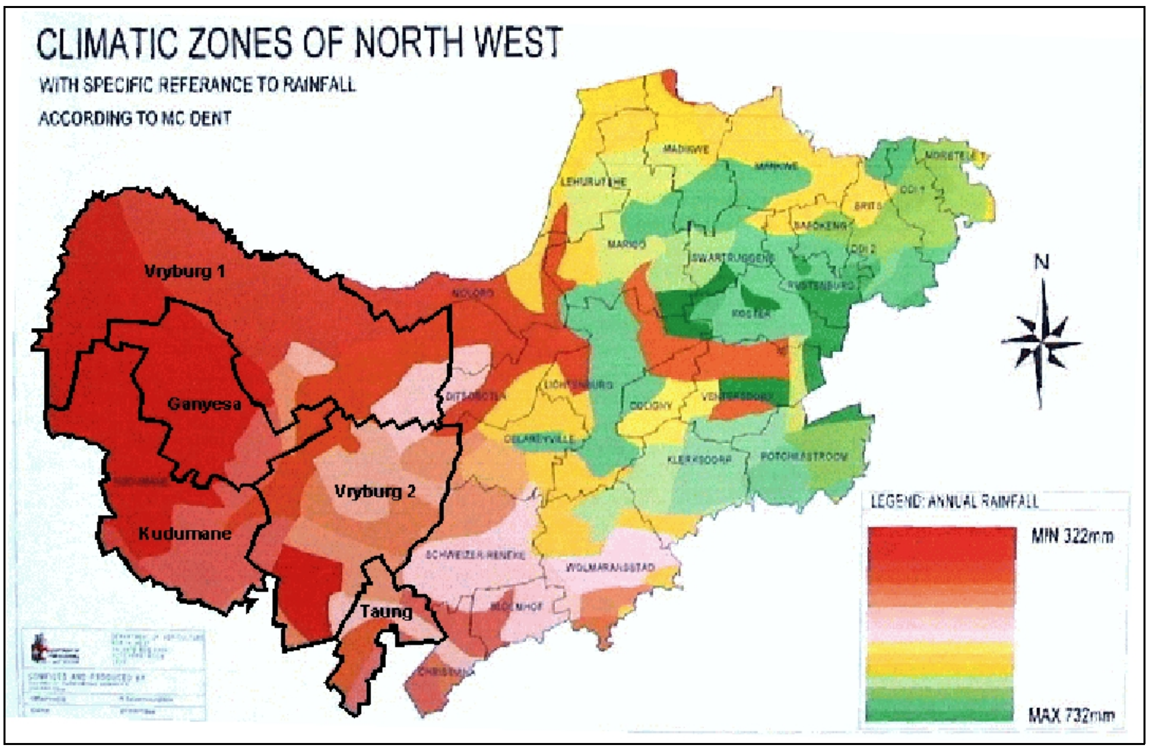

Figure 2.2 Rainfall gradient in the North-West Province.
(Source: RSA Department of Agriculture)

and show a decreasing precipitation gradient from east to west with the lesser gradient of decreasing precipitation levels from the south to north (Figure 2.2). The westernmost part of the province has an average of approximately 322 mm of annual rain. Schulze (1997) reports that rainfall within the study area (outlined in black) are of an unreliable nature, averaging 200 to 400 mm annually, and occur mainly in the summer months between November and May. Some rainfall measuring stations in the study area have been in operation for 60 years and have recorded average yearly rainfalls ranging from 318 to 495 mm (SADA 1999a), slightly more than amounts reported by Schulze (1997). However, rainfall reports from Schulze (1997) and observational stations are consistently below the minimum rainfall required for successful dry-land crop production as reported by Leppan and Bosman (1923).

The combination of low annual rainfall, relatively flat topography, and high evaporation rates result in a shortage of surface water (Cowling et al. 1997). This combination of factors also severely restricts the number of potential dam sites and further limits surface water potential for crop production. Where rivers are dammed, average evaporation rates of up to 2,000 mm a year have been measured (Schultze 1997). This evaporation rate is substantially more than the average yearly rainfall. The high evaporation rate and relatively slow flow of rivers result in scarce supplies of surface water. Therefore, large-scale crop or pasture production is not economically efficient (SADA 1999b). Earthen dams are relatively few and when built, are mainly used for gathering rain to supplement borehole water for livestock. A few springs found in the study area such as those in Kudumane and Taung, are used by animals or for limited irrigation (Cowling et al. 1997). Overall, the study area is an arid to semi-arid savanna, which lacks adequate surface water for crop or livestock production but has ample underground water which is accessible by borehole.

Drought

While a universal definition of drought does not exist, one generally accepted definition is the occurrence of 75% or less of normal rainfall (Laing 1992). Using this criteria, the Republic of South Africa has a history of frequent drought conditions (Cowling et al. 1997, Vogel 1994, Smith 1992). Tyson (1980), in a seminal work on weather variability, reported a quasi 20-year drought oscillation in South Africa exemplified by a higher number of droughts occurring in the years from 1944 to 1953 and from 1963 to1972, with wetter than normal conditions during the intervening years

The occurrence, length, and intensity of drought in South Africa is often unpredictable, as exemplified by a three-year drought starting in 1956 and lasting until 1958 (Glantz et al. 1987), and the El Niño-driven drought of 1991-1992 which was reported by Harsch (1992) as being the worst since the beginning of the century. However, Laing (1992) classified the 1991-1992 drought as having roughly the same intensity as the last three recorded droughts in southern Africa.

Droughts of the 1980s and 1990s resulted in reduced livestock production and maize yields (Harsch 1992, Laing 1992), including a 50% crop failure in one region of South Africa (Vogel 1995). The impact of the drought in the Vryburg districts during the 1960s included mean decreases between 80 and 82% in aboveground biomass production of major grass species. While drought effects are often only measured in terms of economic losses such as crop failure and livestock losses, drought conditions are also usually associated with decreased levels of employment, income, nutrition, and health (Chagnon 2000, Glantz 1994, Vogel 1995).

El Niño and Global Weather

Fishermen and mariners from Ecuador and Peru have used the Spanish term *El Niño* for centuries (Carrillo1892) to describe the occasional occurrence of a warm, southerly flowing Pacific Ocean current in their coastal fishing waters. Because this warm current was usually observed in December and January, it was associated with the coming birth of the Christ Child, and named *El Niño* (the male child). Although the earliest ocean-current anomalies associated with El Niño were described as occurring in the years 1791 and 1804, decreased fishing harvests associated with warm El Niño waters have been documented from texts dating from the early 1500s (Allen et al. 1996). A modern definition provided by Glantz et al. (1991) defines El Niño as "the occurrence of warm water from the western equatorial Pacific into the central and/or eastern equatorial Pacific Ocean, in conjunction with a cessation of cold up-welling waters."

The impact of this phenomena on weather patterns was not known until 1966 when it was first realized that the warm El Niño waters were correlated with irregular temperature and moisture variations at the global scale (Allen et al. 1996). Prior to this time, meteorologists knew temperature and moisture variations were associated with pressure differences in large maritime air masses, but the discovery of this correlation helped later researchers discover that a difference in sea-level pressure between Darwin, Australia, and Tahiti not only precedes El Niño events, but could also be correlated with the intensity of these events (Allen et al. 1996, Tyson 1986). The difference in atmospheric pressure at these two locations is known as the Southern Oscillation (SO) because they tend to be out of phase with each other. Calibrated as the Southern Oscillation Index (SOI), this pressure differential is now used to predict the development and intensity of an El Niño event. A prolonged negative SOI value indicates that the western equatorial waters will warm, resulting in a developing El Niño condition, and a positive SOI indicates these waters are cooling (Wright 1977). Effects of unseasonable water cooling is known as *La Niña*. However, La Niña is presently thought to have a much smaller effect on global weather than El Niño (Allen et al. 1996).

Large scale ocean-atmospheric interactions, now known as the El Niño-Southern Oscillation (ENSO), have received considerable worldwide attention since the mid 1970s (Allen et al. 1996). ENSO (often called El Niño) events have been shown to be associated with many global climatic anomalies such as flooding and drought (Glynn 1990).

Globally, El Niño-related droughts, when coupled with high temperatures and abnormal rainfall distribution, produce lower than average yields of rice, maize, wheat and other agricultural products (Allen et al. 1996). Dryland farming and livestock production in semi-arid lands has been identified as being especially susceptible to El Niño events (Glynn 1990).

El Niño-Related Drought in South Africa

Droughts in many parts of the world are part of normally occurring inter-annual climate variations, and although El Niño events may cause or intensify drought conditions, many droughts are independent of the El Niño phenomena. This variable cause of drought is exemplified by southern Africa, where there is a strong correlation between the ENSO and rainfall patterns (Wright 1977), but not all droughts are correlated to ENSO events and conversely not all ENSO events result in drought conditions. In general, southern Africa receives less rain than normal during El Niño years (Tyson 1986), and there is a high degree of correlation between El Niño events and drought (Lindesay 1986).

Drought disasters in South Africa tend to occur in the year following the onset of El Niño and are less frequent at other times (Dilley and Heyman 1995). Indeed, many of the more severe droughts in South Africa have been associated with El Niño (Donaldson 1967), including the drought of 1982-83, which caused drought not only in South Africa, but also in Australia, and southeastern Asia (Glantz et al.1987). In 1992, a major drought associated with the ENSO occurred in South Africa. At this time, many farmers sold their animals at extremely low prices and almost all farmers lost livestock due to drought and starvation (Rwelamira 1997).

While the 1997-98 El Niño had devastating effects in areas such as Australia and East Africa (Chagnon 2000), the study area in South Africa was generally unaffected (SADA 1999d). However, during the 1991-92 El Niño drought in South Africa, livestock prices decreased drastically due to the poor conditions of animals and market saturation

(Rwelamira 1997). Most rural farmers in South Africa were economically devastated during this drought since livestock is their major asset. During the 1991-1992 drought, it is estimated that about 243,000 head of cattle and 101,000 head of small stock died in the former homelands due to lack of forage (Ministry of Agriculture 1997) or from eating poisonous plant material that they normally avoid (Kellerman et al. 1988).

Effects of Drought in South Africa

While drought effects are often measured in terms of economic losses, related issues are that drought generally translates into decreased levels of employment, income, nutrition, and health (Johnson and Holt 1997, Vogel 1995). Drought conditions also change plant ecology by changing species composition and species abundance (Meyers 1999, Kellerman et al. 1988), and since livestock grazing behavior is associated with water consumption, drought usually changes livestock production efficiency (Lloyd et al. 1978).

Drought Effects on Vegetation

Drought has a peculiar and devastating effect on grazing lands in southern Africa. The combination of drought and overstocking under certain conditions provides environments favorable to many poisonous plants within South Africa (Cowling et al. 1997, Kellerman et al. 1988). Under drought conditions, animals often eat poisonous plants which they would normally avoid, and devastating outbreaks of poisoning have been reported under such conditions (Kellerman et al. 1988). In addition, many poisonous plants are grazed by certain animal species but not by others. Kellerman lists several poisonous plants that are associated with drought conditions and overgrazing, including:

Tribulus terrestrix has a country-wide distribution but is only extensively grazed in the semi-arid areas where it is particularly common on over- grazed or run-down pastures. The plant is highly nutritious and usually grazed by sheep. However, under severe dry conditions the wilted plant produces an often fatal toxin.

Cestrum (aurantiacum, laevigatum, parqui) poisoning in South Africa has only been observed in cattle, but has also been reported in goats in Kenya. "Cattle graze less selectively than other animal species and will eat the plant readily, especially during droughts" (Kellerman et al. 1988:93)

Pteronia pallens (Scholtz bush) poisoning is usually only experienced during droughts, when animals are forced to eat whatever they can, or when sheep are newly introduced into areas where the plant occurs.

Senecio spp (latifolius and *retrorsus)*, a perennial herb with annual stems, mainly poisons horses, followed in decreasing numbers of incidence by cattle, sheep and goats. *Senecio* species are typically abundant where grassland has been denuded of grass as a result of bad farming practices and/or drought. Poisoning generally shows the same symptoms as Rift Valley Fever, a viral hemorrhagic fever.

Galenia africana is an active colonizer, thus, poisoning is becoming more widespread. It is often found in disturbed areas such as around corrals, next to roads, and in trampled or over-grazed pastures.

Kwebense spp. are poisonous bushes that replace the nutritious *Panicum maximum* that grow under *Acacia rubescens* trees during dry years and when pastures are over-grazed.

Lantana camera and *Lasiospermum bipinnatum* poisonings are found in cattle. Plants are more abundant in late winter or spring when forage is sparse.

Asaemia axillaris poisoning is found in sheep. Animals have been known to only eat these plants when driven by necessity due to drought conditions.

Dipcadi glaucum (wild onion) is a particularly common poisonous plant in the Vryburg and Kuruman districts. Within five or six days after the first rains of spring the plants reach a height of approximately 150 mm. Since these are usually the first green plants growing on pastures after winter and they are not particularly unpalatable, animals often seek them out. Animal poisonings from these plants are especially numerous if there was a drought in the previous growing season.

Kellerman et al. (1988) reported 6,000,000 sheep in South Africa died of plant poisonings in the drought of 1969. They report that during the same drought, a farmer in the Kuruman district supplemented the diet of about 40 cows with dune bush, a poisonous *Crotalaria* species *(spartioides, dura, globifera, juncea, and burkeana)* typically found in deep sand dunes and over-grazed areas. This resulted in death of 19 of his animals.

Problems of animal treatment in the case of poisoning and poisonous plant mitigation are compounded by the fact that many of the poisonous plants in Africa are unknown in other parts of the world. Thus much of the knowledge gained elsewhere is not applicable to South Africa (Cowling et al. 1997, Kellerman et al. 1988).

Drought Effects on Livestock

It is well known among animal scientists that a regular supply of water is the single most important factor deemed necessary to maintain healthy livestock (Hugo 1968, Roubicek 1969, Matsushita 1979). Table 2.2 gives estimates of water requirements by livestock in the semi-arid tropics.

Table 2.2 Estimates of water and fodder requirements of ruminant livestock.

Type	Ave Weight (kg)	Ave Water Needs (liter/day)	Dry Season Water Needs (liter/day)	Dry Season Days Between Drinks (days)
Cattle	350	25	30-40	1-3
Sheep	35	5	4-5	1-2
Goats	30	5	4-5	1-2

Sources: King 1983, Baudelaire 1972.

According to Maynard et al. (1979), an animal can lose almost all of its fat and half of its body protein and survive, but losing a little as one tenth of the body's water can result in the animal's death. In laboratory animals, a 50% restriction in water can reduce feed intake by 27%, reduce feed efficiency by 33%, and reduce weight gain by 50% (Lloyd et al. 1978). Animals lose most of their water by sweating or panting. European breeds of cattle have about 800 sweat glands per square cm of body surface, compared to the African Zebus cattle which have about 1500 (Roubick 1969). European and Zebus consume similar amounts of water per pound of dry matter consumed at 4-10^{o} C. At 29^{o} C water requirements of European cattle double, but those of Zebus cattle only increase 20-30%. It has also been shown that Zebus and Zebu crosses can go 48 hours without water before their appetite is suppressed (Matsushita 1979, Roubicek 1969). Cattle watered twice a day will drink 13% more than cattle watered once a day (Roubicek 1969).

Sheep, similar to cattle, have water requirements of about three pounds of water for every pound of dry matter consumed. However, sheep are less efficient water retainers in elevated temperatures and may need up to 12 times more water than normal. Some sheep species are known for their heat tolerance and have been shown to go six weeks without drinking water if green pasture is available (Matsushita 1979).

To insure maximum health, weight gain, and reproductive capacity, goats need water requirements similar to sheep (Table 2.2). However, goats are able to get most of their water needs from forage and are highly adaptable to living in arid and semi-arid conditions (Maynard et al. 1979).

Fluctuations in Herd Size

Within the study area, the SADA has observed that herd sizes of commercial cattle farmers tend to follow market prices, seasonal calving, and selling of weaned calves. Commercial farmers tend to closely observe market prices, and consequently, sell animals when they can get the best price for their livestock. They carefully manage herd size, sell non-producing cows and excess young male calves, and tend to sell when market conditions are most advantageous. By keeping the sex ratio of breeding animals from 2 to 4 bulls per 100 cows, commercial farmers maximize livestock reproductive success and avoid feeding an excess number of large bulls. Cows are typically sold after 2 non-reproductive years. Since commercial farmers tend to understock, their production tends to be fairly constant regardless of rainfall amounts and is more dependent upon the farming goal of maximizing profit.

Conversely, herd sizes of communal farmers tend to follow annual grass production. The SADA has also noted that herd sizes in communal districts are cyclic in nature and correlated to drought conditions. Communal farmers maintain a higher stocking rate than their commercial counterparts, and they are more susceptible to low forage availability because of lower grass production in times of reduced rainfall. Livestock numbers on communal lands typically decline sharply after a year or two of moderate to severe drought. After the drought years, livestock numbers tend to increase annually until they reach about 150% of the carrying capacity for the district (as defined by the SADA). Numbers of livestock remain fairly constant until the next moderate or severe drought then once again fall sharply. The communal farming goal of maintaining the maximum number of livestock means communal farmers are more susceptible to drought conditions and their herd sizes tend to follow annual rainfall patterns (SADA 1999d).

History Leading to the Present Socio-Economic Environment

In order to understand the human resources possessed by commercial and communal farmers in the study area, a brief background of culture, history, government policies, and market conditions is necessary.

European Settlement and Expansion

The first European settlers to southern Africa arrived in 1652 under the auspices of the Dutch East India Company who claimed control of the Cape (Wilson and Thompson 1969). Dutch settlers established a hospital and supply depot for ships on trade routes from Europe to Asia. The Netherlands sold their southern African interests to Britain in 1815, and with the arrival of British settlers, Dutch pioneer farmers (*Boers* in

Dutch) migrated northeastwards, establishing the Afrikaner/Boer strongholds of the Orange Free State and the South African Republic of Transvaal (Boonzaier 1996, Crais 1992). In these territories the Boers relied heavily on slave labor to work the land. However, only white people enjoyed the privileges of citizenship status, including the right to vote. Between 1834 and 1840 about 15,000 Afrikaner people (Dutch who were born or living in southern Africa) joined the Great Trek northwards into the interior to escape British rule and to form their own independent Boer colonies (Shillington 1995). Many Afrikaners of the great Trek settled in what is now the North-West Province. Afrikaner and British settlers colonized southern Africa and built towns, established farms, and employed (or enslaved) black people.

Tension between the Boer states and the British government, after the discovery of gold and diamonds, led to the Anglo-Boer War of 1899-1902 which the British won. Subsequently the two Boer Republics (the Orange Free State and the Transvaal) were annexed into the British Empire. After the Boer War the high unemployment rate of white people became an important political issue (Thompson 1995). Small-scale white farmers and landless white squatters gradually moved to the towns because of a series of droughts, a national economic depression, and changes in farming techniques by more successful large scale farmers. (Rwelamira 1997). This produced a new and expansive class of urban "poor whites", most of whom were Afrikaners.

As thousands of poor whites moved to shanty towns around main cities, they unsuccessfully competed with blacks for jobs. Employers preferred to hire blacks rather than whites because blacks would work for lower wages and could be bossed into submission (Crais 1992). By 1931 over 300,000 whites (almost 25% of the Afrikaner population) were classified as 'very poor' out of a white population of 1.8 million (Thompson 1995). The employed white classes also faced the threat of losing their jobs to blacks because black labor was cheap. High unemployment and poverty among whites are seen as major factors in acceptance by the white population for white job protection and discriminatory legislation against blacks (Rwelamira 1997).

In 1931 the four colonies (Cape Colony, Natal, Transvaal, and the Orange Free State) of the Union of South Africa became a self-governing territory within the British Commonwealth. In 1961, in response to international pressure against the official state policy of racial discrimination (apartheid), the Union of South Africa adopted a new Constitution and withdrew from the Commonwealth (Shillington 1995, Wilson and Thompson 1969).

Apartheid and Homelands

By 1900, settlers had expropriated most of the land by force or through "legal means." In order to ensure employment for whites, the Land Acts of 1913 and 1936 made it illegal for any white farmer to retain black tenant farmers and hundreds of thousands of blacks were driven off the land (Levin and Weiner 1994). Although these and other discriminatory laws were in force before the 1940s, racial discrimination was not officially institutionalized until 1948. During this era, race laws were enacted that affected many aspects of social life, including a prohibition of marriage between non-white and white people, and the sanctioning of "white only" jobs (Thompson 1995).

The Group Areas Act (also 1948) established separate geographical locations for white, black and colored people. Mass removals of black and colored people to areas outside of urban centers ensued and led to the creation of sprawling shanty towns, known as "townships." The Population Registration Act of 1950 divided the population on the basis of appearance, “general acceptance” and genealogical descent into three main categories: black, white, and colored. Colored people were defined as those of mixed racial descent as well as people from Indian and Asian origins (Shellington 1995). Indigenous black populations within South Africa were sub-divided into ten groups or "national units" and colored people were divided into seven groups. However, the white population retained a single (white) classification, and thus was numerically larger than any other population group (Festenstein and Pickard-Cambridge 1987).

The policy of apartheid extended beyond racial zoning. For example, the Black (Urban Areas) Consolidation Act of 1945, the Mixed Marriages Act of 1949, the Reservation of Separate Amenities Act of 1953, and the Immorality Act 1957, were designed to legislatively control social behavior and enforce segregation of races in many aspects of life such as in education, employment, marriage and family life, and the use of public facilities such as toilets, parks, buses, and restaurants (Shellington 1995, Crais 1992).

A series of legislative acts beginning in 1913 reserved approximately 13 to 14 percent of South Africa’s land for the black population. Only blacks, not colored people were given homelands. The two most important legislative acts leading to the formation of homelands were the legislative acts of the Promotion of Bantu Self Government Act of 1959, and the Bantu Homelands Citizenship Act 1970.

The 1959 Act divided land set aside for the black population into ten "homelands", one for each of the ten "national units" or groups into which the black population had been divided. The homelands, based on indigenous ethnicity and location, were as follows: Transkei and Ciskei (for the Xhosa-speaking people), KwaZulu (for the Zulu), Lebowa (for the North Sotho), Venda (for the Vhacenda), Gazankulu (for the Machangana - Tsonga), QwaQwa (for the South Sotho), KaNgwane (for the Swazi), KwaNdebele (for the Ndebele), and Bophuthatswana (for the Tswana).

Under the Bantu Homelands Citizenship Act of 1970 (now commonly called the National States Citizenship Act) every black South African was accorded citizenship of an ethnic homeland. After a few years, all homelands were granted independence: Transkei in 1976, Bophuthatswana in 1977, Venda in 1979 and Ciskei in 1981 (Bromley 1995). During this era, eight million people lived in these homelands. However, homelands were not recognized as independent countries by any nation except South Africa. The United Nations denounced independence of the homelands as unacceptable in international law and homelands were subject to the same economic sanctions against apartheid as the rest of South Africa (Delius 1996, Festenstein and Pickard-Cambridge 1987).

Two independent nations, Lesotho (located within the borders of South Africa) and Swaziland (almost completely surrounded by South Africa) were generally recognized as independent states by the international community as well as the Republic of South Africa. These two countries still maintain their status as independent countries. Today, approximately 55% of the South African black population live in former homeland areas. The rest reside within what is commonly called "white South Africa."

The homeland of Bophuthatswana consisted of 17,000 sq mi (44,000 sq km) in seven separate areas within the borders of South Africa. Three of these areas, Ganyesa, Kudumane, and Taung are located in the study area. Today there are 76 Bantu tribes in Bophuthatswana, including a few of non-Tswana origin in the eastern sections (Breutz 1968, Comaroff 1974). However, only Tswana people inhabit the three Bophuthatswana districts within the study area.

The Indigenous Tswana People

Nothing definite is known about the origins of the Tswana peoples, the only indigenous people currently inhabiting the study area. However, the conventional view, largely derived from oral tradition, is that the Tswana broke away from the main body of Bantu-speaking peoples who migrated from the vicinity of the east African Great Lakes (Magubane 1998). After a series of southward migrations lasting many centuries, the Tswana entered South Africa in two series of migrations between 1300 and 1400 (Wilson and Thompson 1969). At the beginning of the 19^{th} century, Zulu empire expansion exerted pressure on neighboring tribes, some of which were driven westward into Tswana-occupied areas (Magubane 1998). Invaders into Tswana lands during the Shaka-Zulu Wars, and dispossession of lands resulting from white settlements were major threats to local chiefs' sovereignty and led to changes in Tswana society (Isichei 1997).

During this time, small villages comprised of nuclear and extended nuclear families were reorganized to form larger more populous villages which were more easily defendable against invaders (Millin 1953, Breutz 1968).

Since a Tswana nation has never existed, the history of the people collectively known as Tswana consists of individual tribal histories. The tribal system is the widest socio-political context traditionally and currently known to the Tswana. Within the study area, the tribe is still recognized as the dominant cultural system. However, Christian influence and national political rule have generated a large degree of acculturation to western society and inter-tribal cultural standardization. These homogenization influences include inter-tribal migrations and marriages, involvement in the South African economic system, missionary work, migrant labor, urbanization, and exposure to modern mass media. Although these new cultural norms, patterns, and customs, have been grafted onto their existing culture, the Tswana people remain tribally oriented (Breutz 1958).

Today, the Tswana people have a semi-autonomous local-level community and inhabit a specific territory. Although they obey tribal law and customs, they must also obey laws of the republic of South Africa (RSA) government. The Tswana people are ethnically relatively homogeneous, and are bound by a common loyalty to a tribal chief whose status and authority are sanctioned by tradition. Although the tribal chief's power and authority has eroded significantly in most villages, the chief is generally responsible for settling minor disputes within his village and between villages. The land of the tribe is owned communally with the tribal chief acting as trustee.

Prior to Dutch and English influences, the Tswana lived on a subsistence economy in which traditional methods of livelihoods such as hunting, agriculture, and animal husbandry were considered the most important activities. The family is the basic social unit, followed by the extended family, the lineage, the ward and the tribe. Tswana people have an extensive kinship system and an individual is always the senior or junior of another, depending on his relationship with the most senior person of the lineage. A number of lineages constitute a ward, which is under the authority of a hereditary headman who represents the ward on the tribal council. The tribal council consists of the tribal chief, the headmen of the various wards, and a few close relatives of the chief. This body acts as the legislative, executive, and judicial authority of the tribe. When the tribal council considers it necessary to consult the tribal population on more serious or controversial matters, each headman calls a ward or tribal meeting, in which all members of the tribe can participate. Most disputes and crimes are handled within the village or between villages, but inter-village disputes and more serious offences are under the jurisdiction of provincial authorities. However, most matters are settled by tribe members just talking over problems among themselves (Breutz 1959 and 1963).

The money economy has changed traditional village life and migration to urban labor markets is commonplace. Long-term employment for males in mining or industry often results in women remaining as head of their household. Contemporary Tswana men have become more actively engaged in farming than in the past, and land is often considered an asset for production rather than merely a source of security (Breutz 1968). The influence of the national authority on the jurisdiction of tribal courts has seriously affected the position of the tribal chief. Modern schooling and the broad process of social mobilization are leading to demands for the democratization of traditional tribal government. Although there has been a shift in emphasis from tribal loyalty to national participation, especially since 1994, the tribe is still recognized as the cornerstone of Tswana socialization (Magubane 1998).

From a White to Black Ruled National Government

This thesis examines the use and management of natural resources by livestock owners at a time of continuing profound political and social change. In the mid 1980s, South Africa, crippled by international economic sanctions against apartheid, was experiencing increasing social unrest, rioting, and violence. The most significant changes began before F.W. De Klerk replaced President P.W. Botha as leader of the ruling National Party in 1989. Before his term as President, DeKlerk initiated a series of political reforms within the National Party, starting the progressive abandonment of apartheid as the official state policy. DeKlerk's changes in the National Party were instituted as state policy when he became President of South Africa. Due to international and domestic pressures, the South African government led by De Klerk began negotiations with black representatives to begin the transition toward equal citizenship status for all racial and ethnic groups of people (Mungazi 1998, Delius 1996).

The African National Congress (ANC), the primary black opposition group during the Apartheid era, was legalized in the early 1990s after decades of banishment. In early 1994, black and colored people were allowed to vote for the first time in a national election, and the ANC won the popular vote. The ANC leader, Nelson Mandela of Xhosa descent, was elected the first black president of the Republic of South Africa (Handelman 2000).

In April of 1994, all ten homeland areas were reincorporated into the Republic of South Africa, and their administrations absorbed into the South Africa provincial governments (Mungazi 1998). As part of the ANC's political platform of policy reform the country adopted a policy of establishing total equality for all people. World economic sanctions against the Republic of South Africa were lifted and the political environment in the country is considered relatively stable by the world community (Handelman 2000).

Land tenure for commercial white farmers is fairly straightforward: land is privately owned, deeded, transferred from one generation to the next, and bought and sold at fair market prices (Vryburg Development Center 1999). Conversely, present land tenure policies on communal lands varies widely, resulting from a mix of traditional village, trust village, and resettlement policies during the apartheid area.

In traditional villages, land ownership, farming rights, and patterns of pasture usage and livestock ownership are still strongly influenced by traditional custom. Also, tribal land is allocated by the chief to village men according to age and marital status (Drummond 1990).

Trust Villages were established in the 1930s. They are comprised of land bought from white farmers by the South African government to provide residential areas for black people who provided labor and services for white communities, mining, and industry (Roodt 1988).

Resettlement land was land given to large numbers of black people during the creation of homelands, including Bophuthatswana. The government owns approximately 57% of Bophuthatswana land and the rest is owned tribally or privately. Privately owned land in the homelands is reserved for black people. As part of a national agricultural development plan, the Bophuthatswana government leased 40 ha of pasture to groups of four farmers. Known as the Bophuthatswana 4-40 Plan, this plan allowed some communal farmers to have greater access to pasture land and thereby increase their potential for economic advancement (Valentine 1993).

In 1992, South African Development Test farms (SADT) were established. These farms tend to be about 2,500 ha in size and were established as another economic development program. If a communal farmer raised livestock, paid a modest fee for leasing the land, and provided a living for his family without having substantially degraded the land for seven years, the head of the household could apply for title to the land. At the time data were collected for this thesis, three of the SADT farmers had just finished meeting these requirements and had applied for title to their farmland, but none had yet received a response from the government. Several more were completing their last required year before applying for land ownership (SADA 1999d).

Government Policies for Farming

As a result of decades of dispossession and racist land laws, land distribution in South Africa is among the most highly skewed in the world (Simbi 1998), with large capital-intensive farms dominating much of the rural areas. Data from the South African

Department of Statistics (SADS) show white commercial farmers consist of only 28% of South Africa's rural population (a large proportion of whom are farm workers and their dependants), but own 88 % of the agricultural land (SADS 1997). Thus the remaining 12% of agricultural land supports 72% of the rural population, including black farmers in the former homelands (SADS 1997).

With the transition from white rule to black rule, the role of government in agriculture has dramatically changed as has the focus of agricultural programs. Of concern in this thesis are changes in government policies toward market controls, drought relief, land tenure, and emanation of climate forecast information.

Two major factors are seen as critical to the success of native African farmers during the mid 19th century: first was the unwillingness of the national government to intervene in markets, and second was the implicit support for black farming on the part of landowners who received rent from black tenant farmers (Rwelamira 1997). However, these factors changed after 1913 when the Natives Land Act segregated Africans and Europeans by designating about 8% of the country's farm land as reserves, which became the only areas that could legally be farmed by Africans (Simbi 1998).

In the latter part of the nineteenth century, African farmers successfully produced enough to meet increased demands for agricultural products from the new mining towns and the major towns of the English colony (Wilson and Thompson 1969). In 1860, over 80% of the nearly half million hectares of white-owned land was farmed by black tenants (Crais 1992). Black owner-operated or tenant farming proved to be at least as efficient as large-scale white settler farming based on hired labor, mainly because black farmers adopted new agricultural technologies, entered new industries, and competed successfully. In fact, white farmers argued that because of labor shortages, they could not compete with their black counterparts who had much lower costs (Shillington 1995, Crais 1992).

The Masters and Servants Acts of 1911 and 1932 were designed to further increase the supply of cheap labor. These legislative acts worsened the plight of black farm workers who were prohibited from breaking contracts or changing employers (Simbi 1998). Under the Marketing Act of 1931 there were tight controls over agricultural product marketing and homeland farmers could not access markets beyond the borders of these reserves (Simbi 1998). The goal of the Marketing Act was to create surplus labor for the mines and the white agricultural sector (Rwelamira 1997). As an additional benefit for white farmers, it also eliminated competition from black farmers (Simbi 1998).

During the 1930s and 1940s, white farmers also started receiving substantial support in the form of subsidies, grants, and other aid for building fences, dams, houses, and for veterinary and horticultural advice, as well as subsidized rail rates, special credit facilities, and tax relief (Rwelamira 1997).

Over the following half a century, the support system for white farmers was steadily strengthened. Over 80 Acts of Parliament were passed rendering assistance to the commercial farming sector, particularly in marketing (Simbi 1998). In the 1950s the Agricultural Credit Board (ACB) was established to give loans to farmers who were no longer found creditworthy by commercial institutions (Rwelamira 1997). Infrastructure was built, strong support services were established, and assistance was provided through the Land Bank for the acquisition of land for farming by whites (Rwelamira 1997).

The white commercial agricultural sector responded positively to this government support with substantial increases in output. Farmers were protected from foreign competition, subsidies continued, and producer prices, which were largely controlled by the government, were frequently above world-market levels (Simbi 1998).

Since the 1994 election, formerly controlled agricultural markets have been radically deregulated. At the end of 1996, the Marketing of Agricultural Products Act was passed, allowing the government to collect limited information about herd sizes and composition. It also allowed the SADA to enforce of a program of livestock registration and collect levied taxes on livestock. By early 1998, all livestock control boards had ceased operation, and their assets were transferred to industry trusts which now provide services such as market information, export advice, and product development. Price controls were removed and free markets were established when control boards were abolished (Simbi 1998).

Supplemental Feed and Nutrients

In general, rainfall follows a seasonal pattern with the highest level of rainfall occurring during the summer months of December, January and February, and the lowest rainfall occurring during the winter months of June, July and August. The crude protein and phosphorous content of natural forage in the study area varies closely with rainfall. During the dry season, the crude protein content of forage declines from around 10% to below 6%. This reduction of food quality is usually associated with a negative nitrogen balance in cattle (Bembridge 1993, Elliott 1994) and is generally thought by the SADA to account for the loss of mass in cattle during the dry season. Research by the SADA has shown that, in the study area, common supplemental nutrients and feeds will increase weight gain, reproductive capacity, or general health of range-fed livestock (SADA 1999d).

Drought Relief

Prior to the 1980s, government programs for drought relief and planning in the study area were primarily aimed at livestock farmers in districts proclaimed as drought-stricken. The primary goal of these programs was to assist farmers in the maintenance of their herds during and after exceptionally dry seasons. Drought assistance was given by the state in successive phases. During early stages of severe drought, farmers received rebates on transportation costs. If drought conditions persisted, farmers were then given additional loans and higher amounts of subsidies (Vogel 1995). However, managing seasonal drought impact for any single season was still the responsibility of the individual farmer, and thus drought relief was given only in times of severe and/or prolonged drought (Brewer and Hunter 1989).

Beginning in 1980, new drought policies were implemented to provide more long-term drought assistance with a focus on natural resource conservation. The primary objective of new drought policies was to ensure optimal utilization of pasture lands without instigating detrimental effects on them (Vogel 1995). These new supportive government policies tended to weaken farmers' inclination to adopt risk-coping strategies, and maintained their reliance on high-value, high-risk mono-culture crops instead of supporting the conversion of marginally productive and usually subsidized cropland into pastureland. Drought relief policies remained biased towards white commercial farmers. The culmination of this policy was the 1992-1993 drought-relief program which provided 3.8 billion Rand (about $1.2 million U.S. at the 1992 exchange rate) to consolidate and write off debts of commercial farmers (Rwelamira 1997). Abrams et al. (1992) as cited by Vogel (1995) illustrate the differential assistance given to commercial and communal farmers (Table 2.3). Drought relief money was also allocated for use by industry, municipalities, and game conservation. The South African government now recognizes drought as a normal phenomenon and farmers are encouraged to adopt low-risk technologies and maintain their livestock numbers in a sustainable manner, rather than plant drought-susceptible crops or maintain inappropriately high numbers of livestock in areas prone to effects of drought (Simbi 1998, Rwelamira 1997). Consistent with this philosophy, the national government abolished all drought relief programs to farmers starting in 1994 (Simbi 1998).

Table 2.3 Government allocations for drought relief in1992-1993

Assistance to:	Amount I n Millions Rand (Dollars)	% Allocation
Commercial Farmers	1,093.6 (312.6)	64
Communal Farmers	130.0 (37.1)	8
Other	478.4 (136.7)	28
Total	1,702.0 (486.3)	100

Adapted from: Abrams et al. 1992, in Vogel 1995
Dollar amounts are at the 1963 exchange rate of 3.5 Rand per Dollar

Rotational Grazing

Rotational grazing, the practice of dividing pasture lands into smaller grazing areas, allows farmers to more effectively manage their grassland resources. This livestock management technique is supported by government farming policies as an important practice to help increase the sustainable stocking level of livestock in communal farming districts.

In one commonly used scheme of rotational grazing, pasture is divided into three sections and livestock rotated over a three-year cycle (Table 2.4). The scheme starts out during the first year at the beginning of the growing season. Cattle remain in area A for a period of 4 months. During this period the remaining two thirds of the pasture area receives a full growing season's rest. This usually results in a rapid and dramatic

Table 2.4 System of rotational grazing

Pasture Rotation			
Year	Dec 1 to March 31	April 1 to July 31	Aug 1 to Nov 31
1	A	B	C
2	B	C	A
3	C	A	B
4	A	B	C

improvement of pasture conditions in terms of species composition and productivity. After the first 4 months all the cattle are moved to area B and then after another 4 months, to area C. The sequence of grazing at the beginning of the next growing season then changes as illustrated in Table 4.6, with the fourth year beginning a new cycle. By rotating livestock in this manner, the farmer ensures that the pasture grazed upon during the present growing season will have rested for the previous season (SADA 1999d).

Chapter 3

METHODS

The Multi-Method Approach

The multi-method approach to data gathering is useful as a data collection technique and as an analytical tool. This approach allows a researcher to view research problems from different methodological viewpoints. It also enhances a researcher's ability to more accurately analyze and portray pertinent study findings (Taylor 1999). The multi-method approach to data collection combines quantitative and qualitative investigations, thereby allowing for deeper exploration of the problems under investigation. It also provides the opportunity for inductive, theory-generating analysis (Taylor 1999). Qualitative methodology allows human values to be present and explicit in scientific investigations that are usually explored only with quantitative methodology. This allows an enhancement of data quality and improves the quality of data interpretation (Taylor 1999, Brewer and Hunter 1989).

This study used a combination of methodologies for hypothesis testing, including participant observation, case study methods, and personal interviews. The research instrument was a questionnaire having direct and open-ended questions as suggested by Creswell (1998), Fowler (1993), Diesing (1991), and Bernard (1988). Personal interviews were especially appropriate for this study because of their effectiveness in allowing the interviewer to establish a personal bond with the interviewee. This bond is generally considered necessary to elicit potentially sensitive information (Creswell 1998). Structured questionnaires with open-ended and fixed-format questions were administered in addition to informal interviewer-directed discourse (Appendix A).

Due to the comprehensive nature of the interview and potential for inappropriate use of sensitive information, names of farmers, associated villages, and farm names were not collected in order to insure utmost confidentially of respondents. Also to insure confidentiality of the respondent identities, GIS positions were taken at interview sites but changed to intersection points with nearby farm boundaries. The national government is in the process of instituting a new system of livestock registration and taxation which is unpopular with farmers in the study area. Therefore, to elicit more accurate information about numbers of livestock and other potentially sensitive information, protection of respondent identity and utmost anonymity was stressed with each respondent at the beginning of the interview. Information was not recorded which could be traced back to an individual in order to ensure respondent comfort in answering questions, increase the security of recorded data, and thereby increase the accuracy of reported data.

Extensive personal interviews lasted from one to three hours. Information was gathered on household demographics, drought-coping strategies, livestock and land management practices, and the use of climate forecast information. Only portions of the information from interviews are used in this thesis. No information was gathered at the household level from sources other than the farm's major decision-making person (usually the head of household). For the purpose of this thesis *head of household* is defined as the decision-maker for livestock management practices pertaining to animals owned by his/her household. *Household* is defined as the nuclear family and any next of kin or permanent residents in the home (Babbie 1998).

All but one interviewee met the criteria of livestock owner. In this case, the interviewee was a commercial farmer who was the future son-in-law of the farm owner. Since this person was acting as the farm manager, with sole and total responsibility for making management decisions for the farm, he was deemed eligible to participate as head of household in the study.

Sampling Techniques

I interviewed 25 commercial farmers and 35 communal farmers from August to December (winter and early spring) of 1999. Interviews typically took place in the respondent's home or place of residence. In some remote communal areas, interviews took place at a Department of Agriculture Field Extension Office located in or near the farmer's village. Many interviews in commercial and communal areas were conducted with the help of Field Extension Officers who provided language translation between Afrikaans, Tswana, and English. Since most Afrikaner and Tswana children learn English in school, communicating with the farmers was generally not problematic. Although Afrikaans is usually spoken when Afrikaners and English farmers communicate with each other, Afrikaners typically have a high level of English language competency. Tswana farmers, although less conversant in English than their Afrikaner counterparts, were usually able to communicate in English. Two interviews with communal farmers required language translation. However, Extension Officers were used occasionally in other interviews to help explain technical terms and explain cross-cultural differences in terminology. In order to help minimize sampling bias, Extension Officers were not present when questions of a more sensitive nature were asked (for example, the number of animals owned and supplementary income). In communal and commercial areas, Extension Officers are usually people who have lived all their lives in the village or area which they serve. Thus, they are knowledgeable of local customs, know most people in their village, and have contacts with people of other villages. In general, Extension Officers were primarily used to get permission from tribal leaders for interviewing villagers, to help gain the trust with heads of households, and provide a valuable "gatekeeper" function (Creswell 1998). Whenever possible, any single Field Extension Officer was not used for interviewing more than one farmer. Numerous Field Extension Officers were used in order to help minimize sampling bias.

Households were chosen using a combination of stratified random spatial sampling and modified snowball sampling techniques. This was done to maximize spatial distribution of respondents within each district studied, decrease sampling selection times, and eliminate logistical problems associated with absentee owners and unwilling participants (Fowler 1993, Bernard 1988). The modified snowball sampling method helped to maximize spatial distribution of respondents by having an interviewee to provide the name of another farmer, often a friend or relative located a substantial distance from their location, (usually over 10 km) who might be willing to participate in the study (Babbie 1998). On four occasions, field officers from the Department of Agriculture aided in providing farmers' names as potential interviewees but this practice was avoided as much as possible in order to minimize biasing the sample.

Farms within a district were chosen in an attempt to spatially sample all areas of the five districts in the study area. However, in commercial areas a large number of farms have been assimilated into larger holdings, thereby distorting the uniform spatial distribution of respondents. Also, a number of farms in commercial areas are owned collectively by absentee owners. Numbers of absentee owners were not readily available in the study area but were estimated by the Department of Agriculture (SADA 1999d) to be about 5 to 7% of the farmers in the two commercial districts. Absentee owners were reported as typically being individual or consortium owners residing in urban areas such as Johannesburg, Pretoria, and Cape Town (SADA 1999d). Due to logistical problems and the lack of daily "hands on" experience in farm management, these owners were intentionally excluded from the study.

In communal areas, uniform spatial distribution was further hampered by the non-uniform clustering of villages into specific areas such as along valley bottoms and against hillsides. This pattern of habitation leaves large areas with virtually no inhabitants. Therefore, uniform spatial sampling was not meaningful in communal areas. Permission for interviewing residents in communal areas was obtained from the tribal chief, his representative, or by an SADA extension officer. In two cases, tribal authority was not available to grant permission. One tribal chief refused permission to interview people in his village.

No communal farmers and only one commercial farmer refused to participate in the study. The commercial farmer, who wishes to remain anonymous, refused to participate in the study and stated that he would not give livestock numbers nor reveal how much land he owned because "Only my accountant, not even my wife, knows how much land and animals I own. I don't want to answer these questions because my neighbors might find out."

Because of the reasons described above, as well as time constraints and logistic problems of interviewing in such a large geographic area, the goal of complete and uniform spatial distribution of respondents was not achieved. The sample size in this study was too small to perform many statistical procedures; therefore, descriptive statistics are mainly used to analyze data.

Data Collected

Household Demography and Economics

Demographic information was gathered at the farm level. Each head of household was asked questions regarding ages and sex of all household members. They were asked what primary and secondary languages were spoken in their household, their farming history, and other farm demographics. Farmers were asked to list sources of non-farm income and the amount of money the household received from those sources. Yearly incomes were not asked but relative wealth was inferred from current livestock holdings and the reported number of livestock sold within the past year.

Land Use and Livestock Management

Livestock and rangeland management-related questions were designed to gather information on the farmer's current operating methods. First, farmers were asked to list the amount of grazing area available for their livestock, including rental of additional pastures from other farmers. Then they were asked questions regarding present stocking rates and whether or not they participate in a livestock rotation system; their perceptions of their current and past rangeland condition; the number, type, and composition of livestock herds; the type and cost of veterinary services; the amount and cost of supplemental feeds; market changes due to seasonal or climate effects; and distances to markets. Since water is of major concern in semi-arid lands, farmers were also asked questions about the quality and quantity of water for their livestock.

Heads of household were asked the type (if any) of agricultural products (crops) they produced, how many hectares were planted, and their annual yield. They also were asked about their use of fertilizers, herbicides, and whether specialized hybrid species were planted, including the cost of these items.

Drought and Forecast Information

I asked interviewees direct and open-ended questions about their perceptions of the early signs of drought, their worse drought, their latest drought, drought coping strategies, effects that drought had on their operation, and types of resources they can draw upon during drought conditions. They were asked whether they can get or want climate forecast information and how they use that information. Farmers were also asked questions about ENSO events and if they associated any past ENSO events with drought. Since the 1997-98 ENSO was forecast to have dire effects in South Africa, warnings were widely dispensed prior to the 1997-98 growing season to farmers by climate forecasters in the South African weather Bureau and by the South African Department of Agriculture. Farmers were asked what changes in management practices they made because of those ENSO forecast warnings. They were also asked what the results of those management changes were on their operations.

Chapter 4

RESULTS

Introduction

Results are organized first into characteristics of commercial and communal farms including: demographics, description of farms, pastures, water issues, scale of operation, and livestock management practices. Second, results of issues associated with drought are discussed and include: drought coping, effect of drought on livestock market, strategies for managing drought, the use of forecast information, and effects of the El Niño related droughts of 1991-1992 and 1997-1998 on farmers in this region.

Results presented here are from interviews conducted at the farm location, or at a nearby Department of Agriculture Field Extension Office. All persons interviewed are the head of their household which, for the purpose of this study, is defined as the person who is responsible for, or delegates responsibility for, decisions regarding livestock management.

Farm Description and Management

Demographics

Data were collected on primary language spoken, age, gender, farm size, animal numbers, and other descriptive data necessary to differentiate between commercial and communal farmers, and provide information necessary to understand the resources available to people in this region.

Results indicate that approximately twice as many Afrikaans-speaking farmers as English-speaking farmers live in the two commercial districts (Table 4.1). The sample survey and interviews with local farmers also show that native African people residing in the commercial districts do not own their own farmland nor do they make a living from having their own livestock. The only native African people residing in the commercial districts are engaged in either the labor or service economies of towns, or are permanent workers on white owned farms.

Table 4.1 Primary language of farmers.

Primary Language % of Respondents (# of Respondents)			
Commercial		**Communal**	
Afrikaans	68 (17)	Tswana	97 (34)
English	32 (8)	Xhosa	3 (1)
Commercial Total	100 (25)	Communal Total	100 (35)

The three communal districts are part of the former Bophuthatswana homeland, which was set aside for Tswana-speaking people. Thus it is not surprising that, with the exception of one Xhosa farmer, all farmers interviewed in the three communal districts are of Tswana descent, and spoke Tswana or a Tswana dialect in the home. The Xhosa farmer resides in the Tswana communal district because he married into a Tswana family.

Reported ages for the heads of household were similar between commercial and communal farmers (Table 4.2). Both groups of farmers have the same age range (51 years) and essentially the same maximum, minimum, and median ages. The difference in age between the two groups is that the average age of communal farmers is 5 years older than the commercial farmers.

Table 4.2 Age statistics of farmers.

	Commercial	**Communal**
Minimum	25	24
Maximum	76	75
Range	51	51
Mean age	49	54
n	25	35

Research results show that the relative proportions of sex demographics are similar for commercial and communal farmers. In all five western districts, female heads of household made up a small proportion (8% of commercial and 11% communal) of the farming population (Table 4.3).

Table 4.3 Household heads by sex.

Gender	Percent of Respondents (number of respondents)		
	Commercial	**Communal**	Totals
Male (n)	92 (23)	89 (31)	90 (54)
Female (n)	8 (2)	11 (4)	10 (6)
Total respondents (n = 60)	100 (25)	100 (35)	100 (60)

Livestock production was found to be the primary source of income for communal and commercial farmers, but income from other sources was also reported (Table 4.4). Although a larger percent of communal farmers (49%) than commercial farmers (34%) receive income from sources other than farming, communal farmers' average income from non-livestock sources was only one-tenth of the average income commercial farmers obtained from these sources. Communal farmers reported obtaining income from wage and migrant labor, small industry, and government pensions. Commercial farmers reported obtaining income from business ventures and investments.

Table 4.4 Farmers receiving supplemental income

	Percent of Farmers (n)	Average Monthly Income in Rand (U.S. Dollars *)
Commercial (n)	36 (9)	6844 (1141)
Communal (n)	49 (17)	562 (109)

* at 6 Rand/Dollar

as scale of operation increases profit will increase at a greater rate than labor and other fixed costs (Lewis 1955 and 1978). This implies that scale of operation can be estimated by the number of people supported by farms, number of livestock, number of boreholes, and pasture size. These factors are used to test the hypothesis that commercial farmers have a larger scale of operation. Commercial farmers will thus be better able to respond to adverse climate conditions because larger farming operations have more resources, including greater numbers of livestock and more pastureland as resources from which to draw upon in times of drought. Owning more cattle than sheep and goats is assumed to be correlated with increased resources because the market value of cattle is much larger than sheep or goats. In years of ample rainfall, farmers having a larger scale of operation and more livestock can sell more animals thus reaping greater profit than farmers having a smaller scale of operation. In years of less rainfall, farmers with a smaller scale of operation reap less profit than farmers who have larger scale operations because they operate closer to the profit margin. Not only do they have fewer animals, their animals are usually in worse physical condition due to overgrazing.

Since the amount of land on which communal farmers graze their livestock is not directly available, (it is crudely estimated in a later section), much of the argument for commercial farmers having a larger scale of operation relies upon other measures. For the purpose of this thesis, scale of operation is defined as the size of a farming operation in terms of the number of people supported, the number of animals produced, the market value of those animals, the number of boreholes, and the amount of land available for grazing.

Size of Farms

The data show that commercial farmers have definite farm boundaries that are enclosed by well-maintained fences. These farmers know the exact area of land they have available for grazing and livestock production. Analysis of interview data reveals that commercial farmers have a mean farm size of just over 4,100 ha with a mode and median farm size of 3,000 ha (Table 4.5). The displacement of the mean toward the higher end of the curve, compared with the mode and median, indicates the skewing influence of a few very large farms.

Table 4.5 Farm sizes.

Descriptive	**Commercial** (ha)	**Communal** (ha)
$\bar{x}$ size of farms	4,103	n/a
Median size of farms	3,000	n/a
Modal size of farms	3,000	n/a
Maximum	16,000	n/a
Minimum	299	n/a
Std Dev	3,542	n/a

In all but one case, communal farmers were unable, and had no desire, to give a rough approximation of how much land is available for their livestock to use. One of the communal farmers stated that most communal farmers did not want their communal lands to be surveyed or fenced. He said that the general feeling in his village is that, if communal lands were surveyed and fenced, then grazing boundaries could be enforced and his village's grazing land would be reduced.

Tropical Livestock Unit Calculation

Calculations of the relative grazing impact of large and small livestock commonly use the Tropical Livestock Unit (TLU) system. Although not completely accurate, the TLU provides a rough estimate for determining sustainable animal stocking rates for pastureland (SADA 1999d). Several variations of TLU assessment have been adapted for specific localities, but a widely used TLU assessment method is based on the estimated amount of forage needed by a mature cow with an average weight of 450 kg. It assumes an animal's average daily intake will be equal to 2 or 3% of its body weight (Cordova et al. 1978). The TLU system assumes that five sheep will consume the same daily amount of material as one cow, and that six goats consume the same amount as one cow. However, goats are browsers instead of grazers, and, if the pasture is lacking woody plants, the quality and availability of forage is less for goats (Bembridge 1993). TLU methods ignore seasonal variation in feeding, breed of animal, type of forage, and numerous other factors. However, the utility of the TLU method is its ability to provide an easy system for determining a pasture's approximate stocking rate.

Estimating the Area of Communal Pastureland

To approximate the area of communal pastureland, the following assumptions were made. One, although commercial farms are fairly evenly distributed spatially across the two commercial districts, communal farms are not. Although it is known that communal farmers and their livestock tend to be clumped in villages and pastures along the bottom of valleys and washes, in order to estimate the area of communal grazing lands, it is assumed

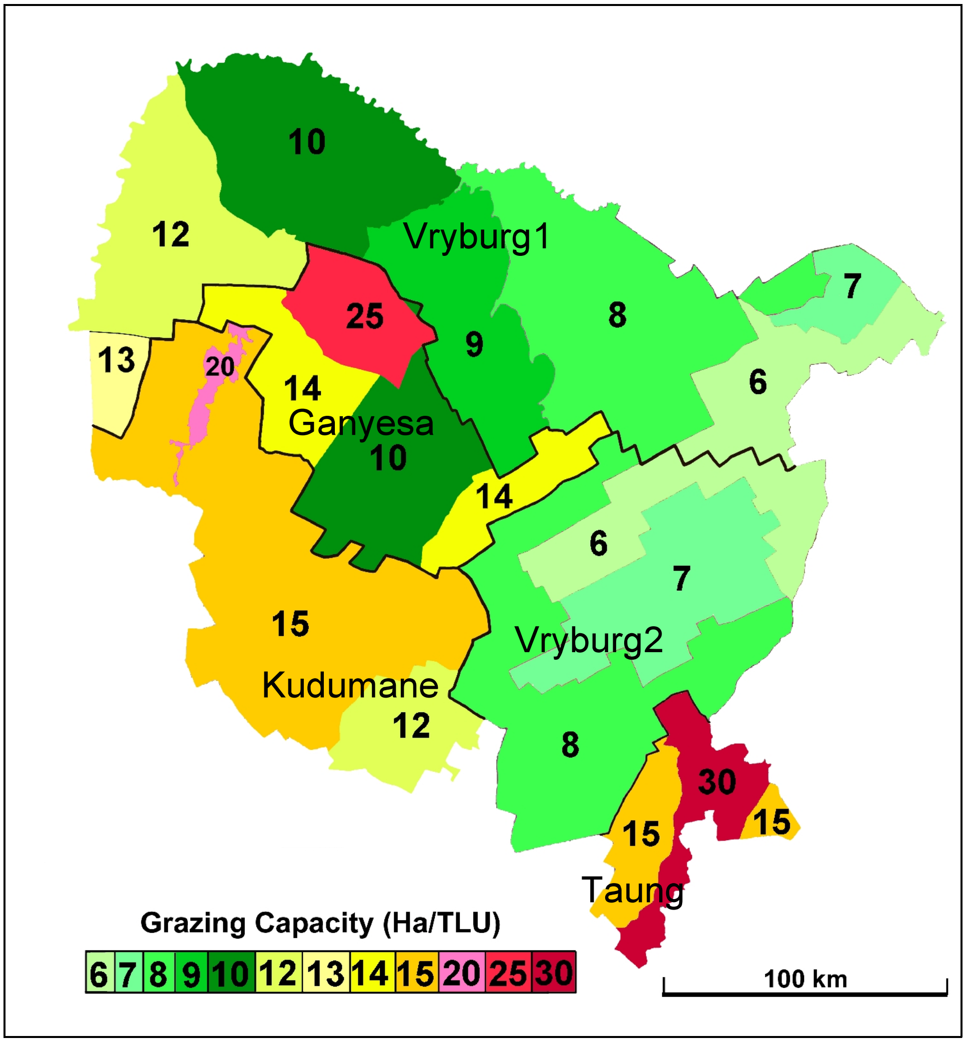

Figure 4.2 Grazing capacities for the western region, North-West Province. Adapted from SADA 1999e.

contribution was 7.8. By adding these two proportions of grazing area contributions, 15.1 and 7.8, the weighted grazing capacity for Taung was found to be 22.9 ha/TLU . This procedure was followed for each of the five districts, and again to estimate total communal and commercial farming areas. In this manner, the weighted stocking rate was found to be 8.6 ha/TLU for commercial areas and 15.8 ha/TLU for communal areas (Table 4.6).

If we assume that communal farmers are stocking as incongruously as commercial farmers in relation to SADA recommendations (overstocked by 32%), their average stocking rate is calculated at:

$$15.8 \text{ ha/TLU} / 1.32 = 11.9 \text{ ha/TLU}.$$

According to reported data, communal farms average 60 TLU. Using the calculated stocking rate, the estimated amount of pastureland used by communal farmers would be:

$$11.9 \text{ ha/TLU} * 60 \text{ TLU} = 714 \text{ ha}.$$

By way of comparison, if the SADA's suggested stocking rate of 8.6 ha/TLU is used, then the average communal farmer's pasture size is estimated to be substantially (28%) smaller:

$$8.6 \text{ ha/TLU} * 60 \text{ TLU} = 516 \text{ ha}$$

Likewise, if communal farmers overstock by 50% as believed by the SADA, then the average estimated communal farmer's pastureland is only:

$$(11.9/1.5) \text{ ha/TLU} * 60 \text{ TLU} = 476 \text{ ha}.$$

Table 4.7 Farm size and stocking rates.

	Calculated Stocking Rate (ha/TLU)	Reported Stocking Rate (ha/TLU)	Overstocking Rate (%)	Average Farm Size (ha)	Difference in Average Farm Size
Commercial	8.6	6.5	32 (Calculated)	4,103 (Reported)	5.7
Communal (Best Case)	15.8	11.9	32 (Assumed)	714 (Estimated)	.17

Table 4.7 summarizes calculated and estimated stocking rates and size of commercial and communal farms. By using the largest area (best case scenario) of 714 ha per communal

overstock. Livestock numbers reported from commercial and communal farmers (Figure 4.3) show commercial farmers to own more than 13 times the cattle and about 1.5 times the number of sheep than communal farmers. Thus, commercial farmers, by this measure, have a much larger scale of operation. Communal farmers are shown to rely on goats and sheep almost as much as cattle.

Both TLU (Figure 4.4) and livestock numbers show that cattle are the primary animal species that communal and commercial farmers rely on for their livelihood. Cattle

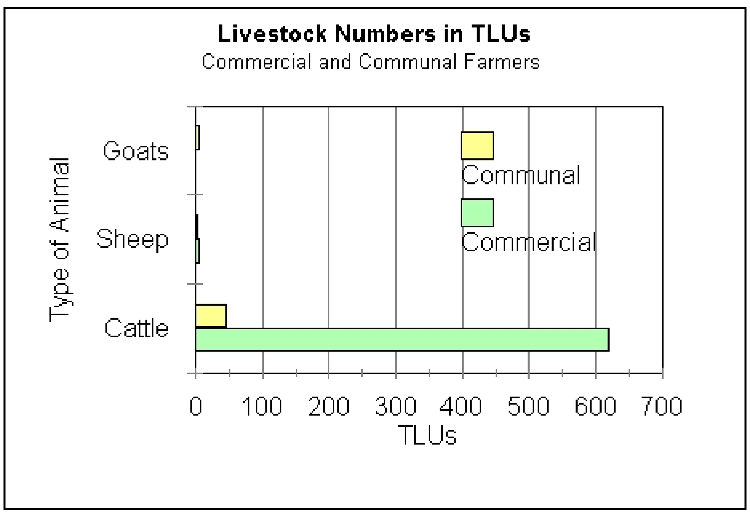

Figure 4.4 Animal numbers in Tropical Livestock Units.

command the highest market price per head of any commercial animal species raised for profit in these districts, with the average price per head for cattle greater than ten times the average price for small livestock (SADA 1999d). Thus, in a market economy, numbers of cattle compared to numbers of small livestock can also be used as another indicator to measure a farm's scale of operation. However, it is an error to assume that producing livestock for the market economy (as shown in a later section) is the primary reason all livelihood, while communal farmers rely more on goats. The communal farmers' reliance on goats is evidence for different production goals between commercial and communal farmers, as discussed earlier.

Rotational Grazing

The rotational grazing technique is one of the management practices that the SADA believes could improve pasture condition of communal lands. Rotational grazing or some variation thereof is widely practiced among commercial farmers, and most (88%) periodically rotate their livestock among three or more pastures. Only about half of the communal farmers (51%) rotate their livestock between two or more pastures, but less than 10% allow a full growing season's rest for pasture grasses.

Water Availability and Quality

Surface water is scarce in the five districts of the North-West Province. Almost all water for human and livestock consumption is obtained via boreholes (wells) from the vast quantities of underground water which underlies the study area. The water table is relatively high, and average borehole depths in commercial (24 m) and communal (24 m) areas are sufficient to provide adequate water for livestock. Across the study area, commercial farmers average eleven boreholes per farm for their livestock use, with an average use of 57 TLUs/borehole. The typical communal farmer has, on the average, two boreholes and an animal usage of 25 TLUs/borehole.

and lime content in the water, but still considered water to be of sufficient quality for their livestock, and generally good enough for human consumption. All commercial farmers

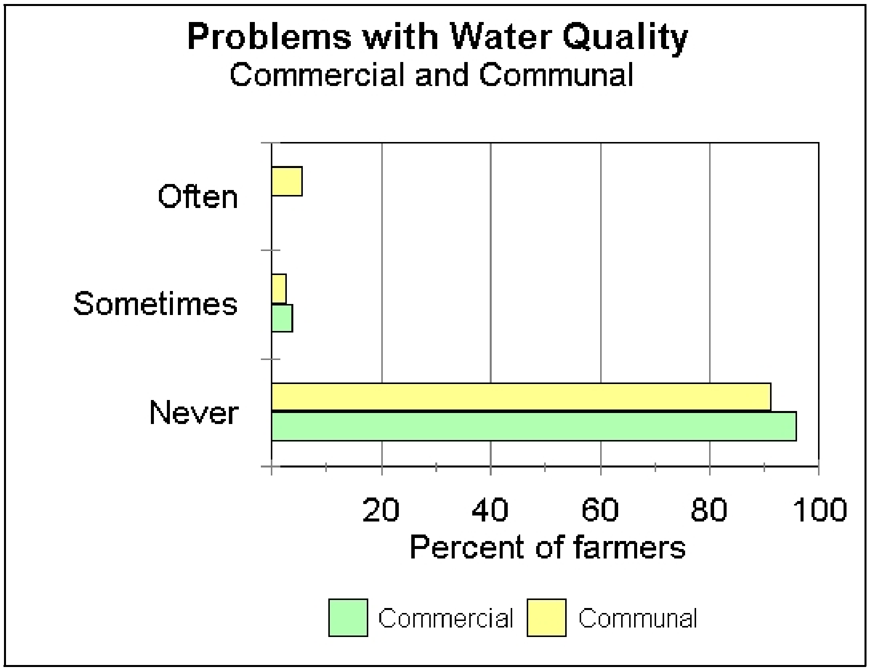

Figure 4.7 Water quality.

reporting water quality problems farm in the extreme northwest part of the Vryburg 1 district. No communal farmers reported having water quality problems due to salt or lime. In communal areas, livestock and humans often use the same boreholes for their water supply, and consequently, communal farmers reported contamination from livestock usage to be their biggest problem with water quality.

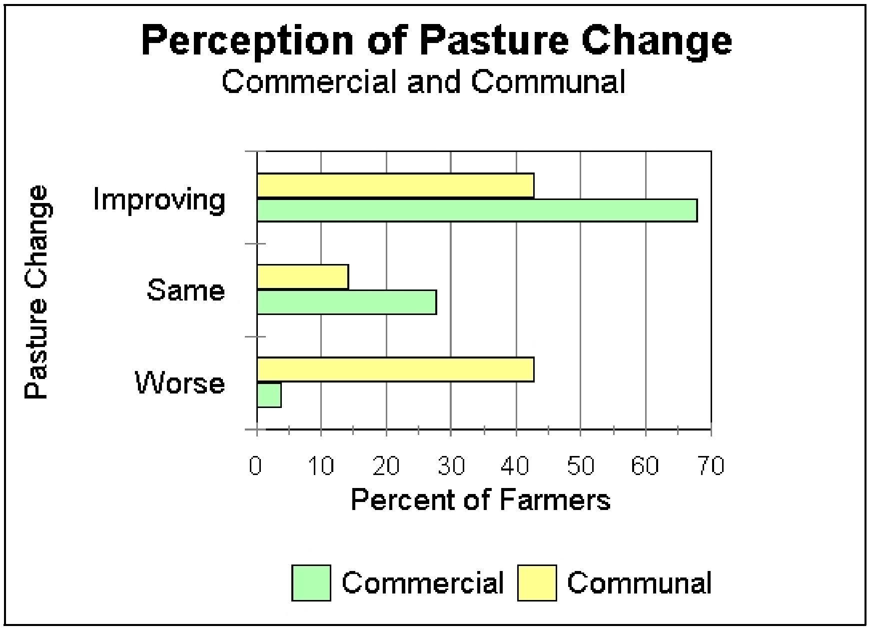

Figure 4.9 Perception of pasture change.

conditions were becoming worse. On the other hand, communal farmers were evenly split between thinking their pastures were improving (43%) and becoming worse (43%). Twice as many commercial farmers (28%) reported that range conditions have stayed the same for the past few years than did communal farmers (14%).

Supplemental Feed and Nutrients

Without exception, all commercial and communal farmers in the study give some form of supplemental feed and nutrients to their livestock throughout the year (Figure 4.10). Amounts and type of feed varied widely but salt was given most often by both commercial and communal farmers. Over half of the communal farmers give bonemeal and over half of the commercial farmers give phosphorous to their cattle. More commercial farmers give protein, molasses, urea, and calcium than communal farmers, and

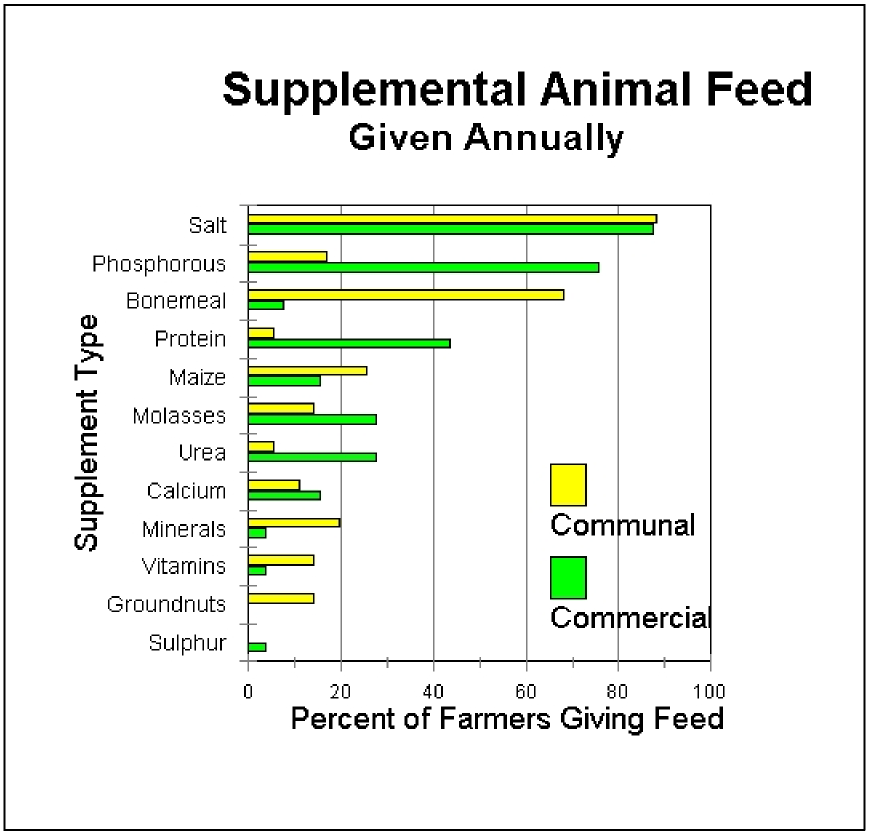

Figure 4.10 Supplemental feed given to cattle.

more communal farmers reported giving maize, minerals, and vitamins than commercial farmers. Only commercial farmers reported giving sulfur, and only communal farmers reported giving groundnuts (peanuts). Most farmers change the relative amounts and type of supplemental feed given to cattle during summer and winter months, but they do so in a

highly individualized manner. No consistent pattern of supplemental feed was found within or between the two farmer types, except for a consistent pattern of increased salt given to cattle during summer months. Supplemental feeds are generally given as preventative maintenance for livestock rather than food during drought, and are given in a fairly consistent manner from year to year, by farmers, regardless of how they perceive rangeland conditions.

Drought Coping, Climate Forecasts, and El Nino

Farmers in the study area depend on sufficient rainfall to produce enough fodder to sustain their livestock from one growing season to the next. If summer rains come late then farmers must either wait for rain or take active measures to minimize livestock and financial losses. Since drought has such a direct impact on their livelihood, advance knowledge of forthcoming droughts can empower farmers to make herd management decisions earlier in the season such as selling livestock. These tactics can help minimize their financial losses. Knowledge of forthcoming El Niño events are potentially valuable to farmers because some of the more severe droughts in southern Africa have been associated with El Niño events.

Perceptions of the Ability to Cope with Drought

Drought is a recurrent phenomenon in the southern Kalahari to which farmers must continually adjust their livestock management practices. It is common for one drought year to follow another, and occasionally farmers experience several years of sequential drought. Only 4% of commercial farmers reported that one year of severe drought year would be devastating for them, but 37% of communal farmers reported that a single year of severe drought would be devastating (Figure 4.11). No communal farmers reported

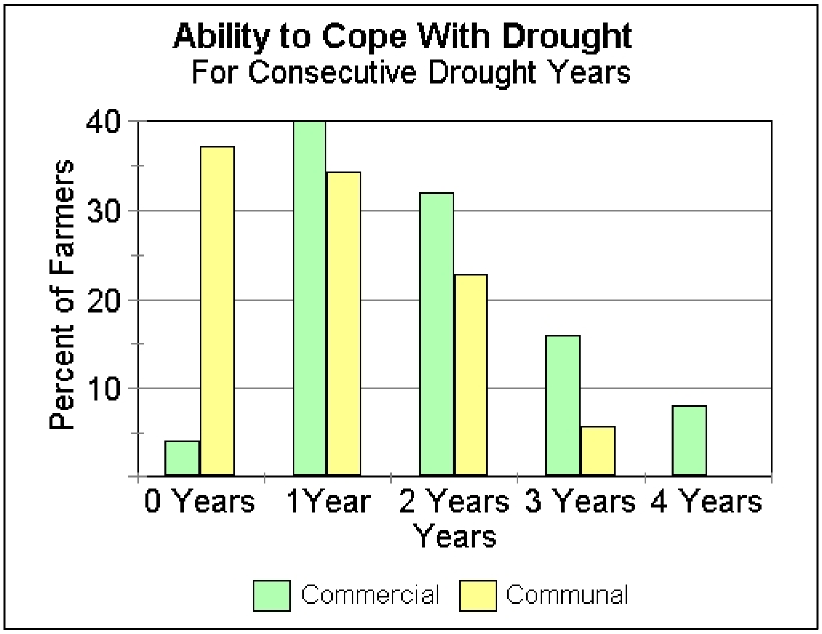

Figure 4.11 Ability to cope with consecutive droughts.

being able to cope with four years of consecutive drought, but 8% of commercial farmers believe they could survive four consecutive drought years.

Previously available government subsidies are no longer available to farmers in times of drought (see background section), and if farmers need help they must seek alternative sources. Friends and relatives are a potential source of drought aid, but in general, a farmer's friends and relatives will be just as affected by drought and thus be unable to offer assistance. Figure 4.12 shows that 80% of the commercial and 83% of the communal farmers report not being able to turn to friends or relatives for help in times of drought. Only 16% of commercial and 6% of communal farmers definitely thought they could get help from these sources. In the communal areas, these findings demonstrate the lack of traditional egalitarian customs at the tribal or group level. They also illustrate communal farmers' growing dependency on the market economy. For this study, *help* was not defined, but left to the farmer's interpretation. The similarities of responses between

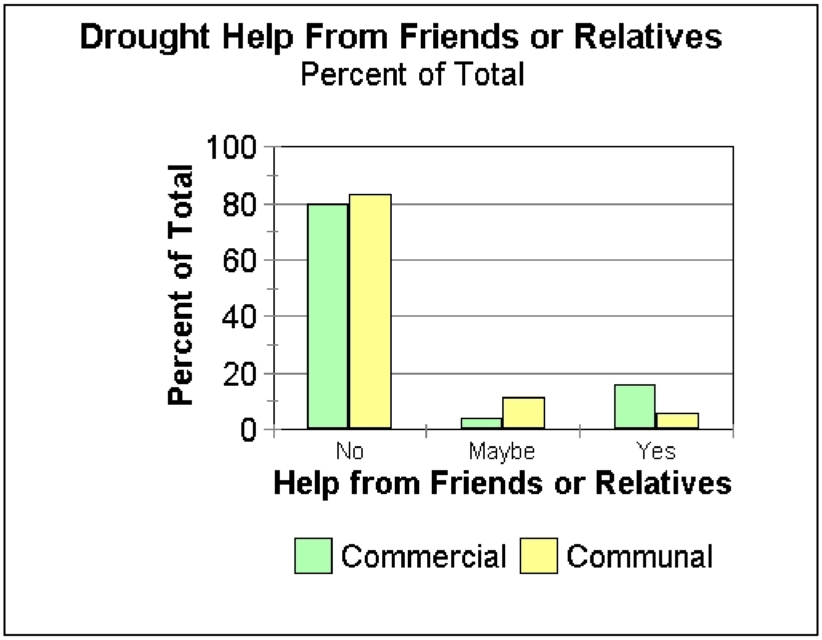

Figure 4.12 Farmers getting help from friends or relatives when drought occurs.

commercial and communal farmers are attributed to widespread effects of droughts because, in general, farmers feel that if conditions were severe, their friends and relatives would also be having a bad time economically.

Strategies for Managing Drought

The certainty of seasonal rainfall variability means that farmers have devised diverse livestock management strategies to minimize anticipated effects of drought conditions. Strategies to cope with drought vary, depending upon factors such as culturally determined goals, the amount of resources available, and the type of resources available to farmers. These resources may be natural or social, as well as economic.

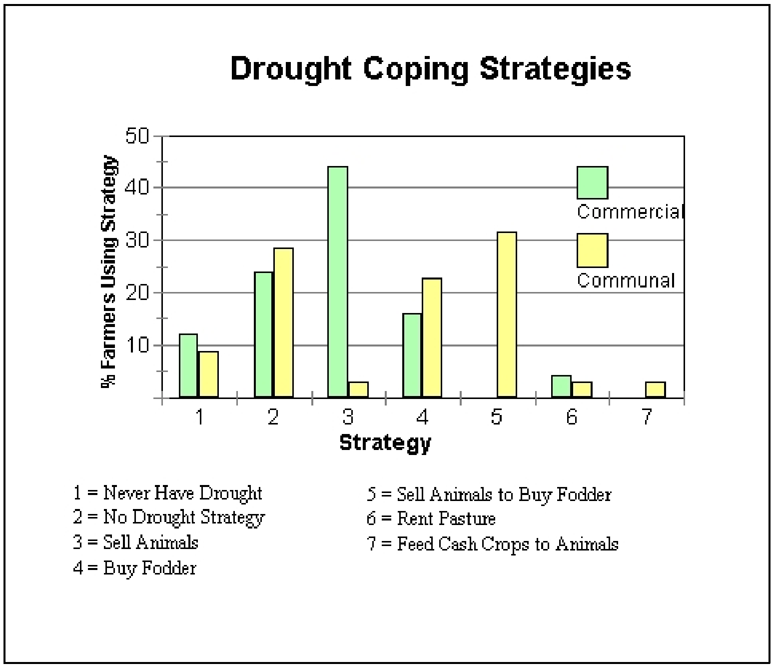

Figure 4.13 Drought coping strategies for commercial and communal farmers.

The primary coping strategies for drought occurrence as reported by farmers in the study area are shown in Figure 4.13 These strategies include selling animals, buying fodder, obtaining grazing rights in additional pastureland, feeding crops to animals which would otherwise be sold for cash, and combinations of these strategies. A relatively small percentage of commercial (12%) and communal farmers (9%) report never experiencing drought, and a substantial number report not having a drought strategy (24% commercial and 28% communal). Eleven times as many commercial farmers (44%) as communal farmers (3%) report that their primary drought strategy is to decrease their herd size by selling animals. More communal farmers (23%) than commercial farmers (16%) buy fodder as their primary drought strategy. The coping strategy of choice among commercial farmers who feel the need to alleviate drought-related stresses on their herds is to reduce herd size by selling animals (44%). Communal farmers, by comparison, tend to either buy fodder (31%) or sell only enough animals to get money for maintaining the rest of their herd (23%). Communal farmers will sell animals only in the most severe of circumstances, preferring to maintain herd numbers at the cost of animal health and condition. Only communal farmers reported feeding crops which would otherwise be sold for cash, to their animals (3%). Communal (3%) and commercial (4%) farmers reported that they would rent additional pastures as a drought coping strategy. When communal farmers rent additional pasture, they usually rent from commercial farmers and typically use livestock for payment, further reducing their stock. In addition to the primary drought coping strategies shown in Figure 4.13, commercial and communal farmers also reported using secondary coping strategies such as maintaining a lower than optimal herd size to ensure an adequate feed supply or decreasing herd size prior to an anticipated drought.

Effect of Drought on Livestock Markets

During drought conditions, some farmers feel forced to sell part of their livestock herd. The resultant glut of animals being sold on the market is thought by farmers to drive livestock prices down. Livestock prices can be further reduced if the animals are not well fed and maintained.

Farmers' perceptions of drought effects on livestock prices vary widely (Figure 4.14). Although about 33% of the commercial and 20% of the communal farmers report that drought has no effect on livestock prices, most farmers think that livestock prices fall from 10% to 50% during drought. On the average, commercial farmers report that cattle

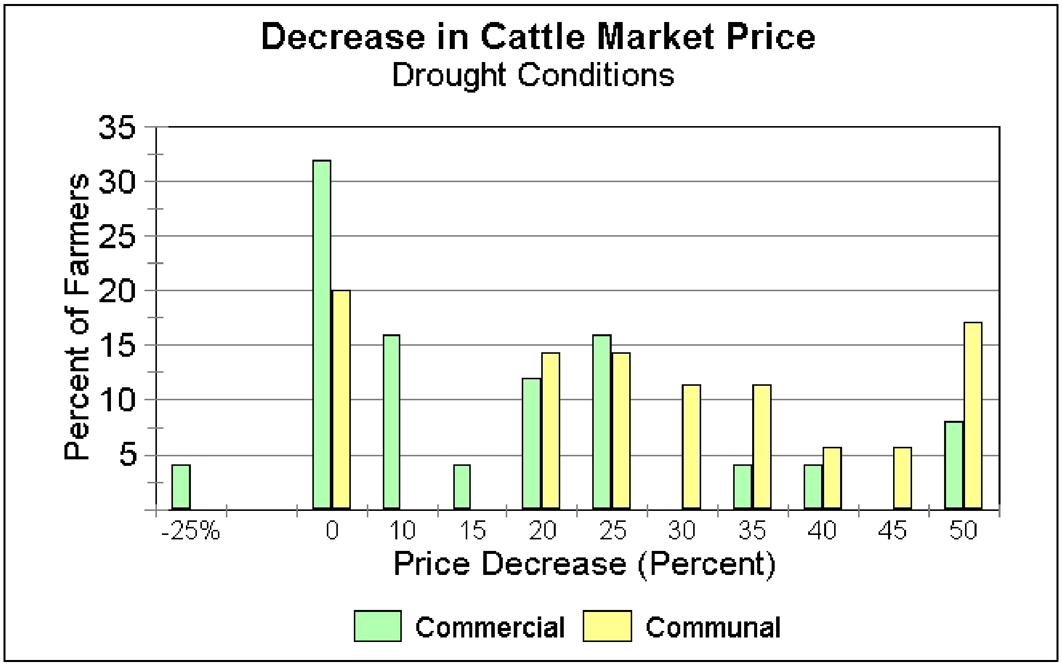

Figure 4.14 Drought induced changes in market prices.

prices decrease about 15% during drought conditions, and communal farmers report an average decrease of 27%. Due to the lower market prices of livestock, many commercial farmers do not sell animals in drought conditions unless they can receive the normal price for their animals. One commercial farmer purposefully understocks his pastures in order to keep his animals in excellent market condition and consequently reports receiving a 25% increase in livestock prices during times of drought. He attributes his extra profit solely due to the excellent health and better condition of his animals compared to other animals being sold. These numbers reflect farmers' perceptions of livestock market price decreases after a single year of drought. Perceptions of price decreases for multiple years of drought were not gathered.

Drought Prediction by Farmers

Drought prediction by some farmers in the study area has been traditionally based on the observation of natural phenomena. However, approximately two thirds of all the farmers interviewed, (68% of the commercial and 63% of the communal farmers) reported believing that droughts could not be predicted by observing natural phenomenon (Figure 4.15). Of farmers believing natural indicators of approaching drought exist, 14 different indicators were given. These indicators are grouped into 6 categories. Since some farmers listed multiple natural indicators of drought, category totals represent the percentage of responses for the category, not the number of farmers.

The category *winds* includes no wind or no strong wind, winds from the north, winds from the west, dust-devils, or whirlwinds. Many farmers uniquely associated some specific wind patterns with drought, but there was not a discernable pattern for drought prediction across farmer responses. For example, one farmer associated drought with early seasonal winds from the north, and another farmer associated drought with early seasonal winds from the south. A different farmer associated the lack of strong winds from the south as an omen of forthcoming drought. Since the study area is relatively homogeneous ecologically, neither variations in topography, vegetative cover, or other known physical phenomena is likely to account for disparity in farmers' association of wind and forthcoming drought. The *timing* category includes responses predicting drought if rain does not come by the end of February, there is no rain by the end of November, there is no rain starting by September or October, if there are no spring winds, or if winds are late. The *animal* category includes drought predictions when there is the appearance of termites, when termites build mounds

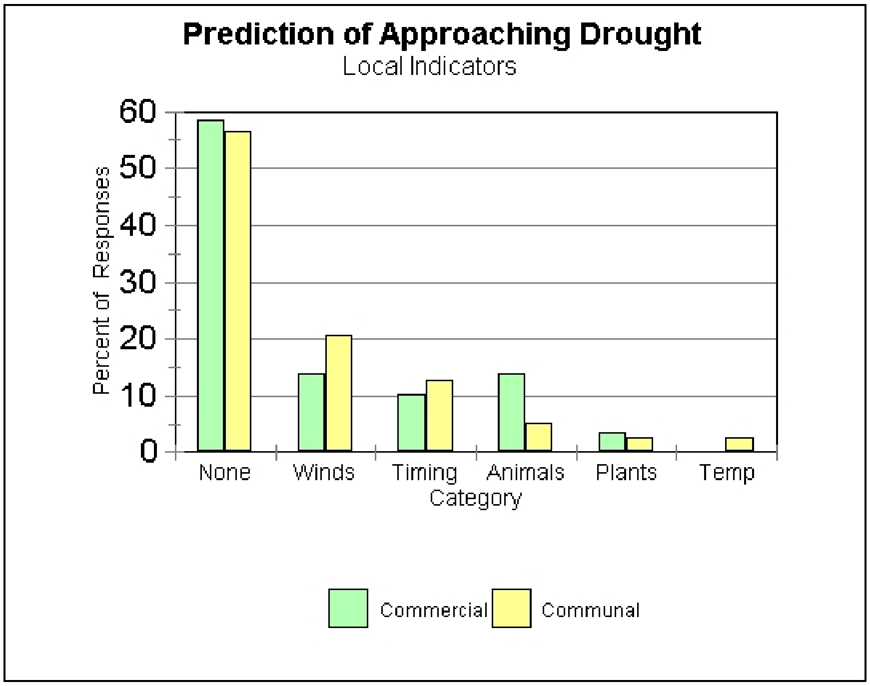

Figure 4.15 Local indicators of approaching drought.

rather than towers, when the hair on cattle stays down rather than stands slightly up, or when there is an absence of mole hills. The presence of certain poisonous *plants* in early spring, and higher than normal *temperatures*, constitutes the remaining two categories for predicting drought.

In summary, farmers' prediction of drought by observation of natural phenomena remains unclear, and apparently, often contradictory. In all cases, drought predictors were not reported as being indicators of drought intensity or duration but merely as omens of approaching drought.

Availability of Climate Forecasts

Whether farmers utilize traditional methods, modern forecast information, or a combination of both, virtually all farmers (95% of commercial and 100% of communal) wish to have climate forecast information made more available from mass media sources such as radio, television, and printed material. Figure 4.16 shows that twice as many commercial farmers (64%) as communal farmers (34%) are able to get climate forecast information on a regular basis. Approximately the same proportion of commercial and communal farmers (8% and 6% respectively) report that sometimes they can get climate forecast information. This access does not indicate if the information is used or received in a useful format. Weather forecasts are generally available Saturday morning on a television show targeted for farmers and on various radio stations during the weekend.

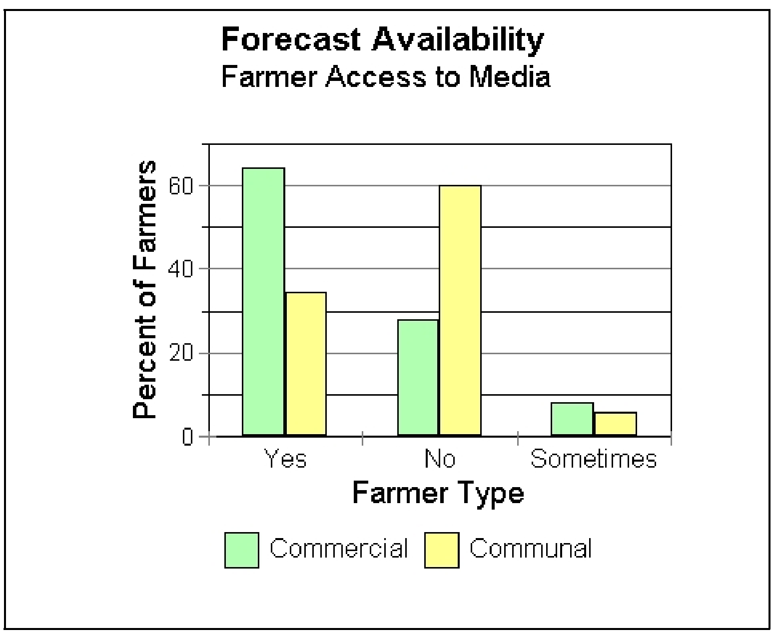

Figure 4.16 Climate forecast availability.

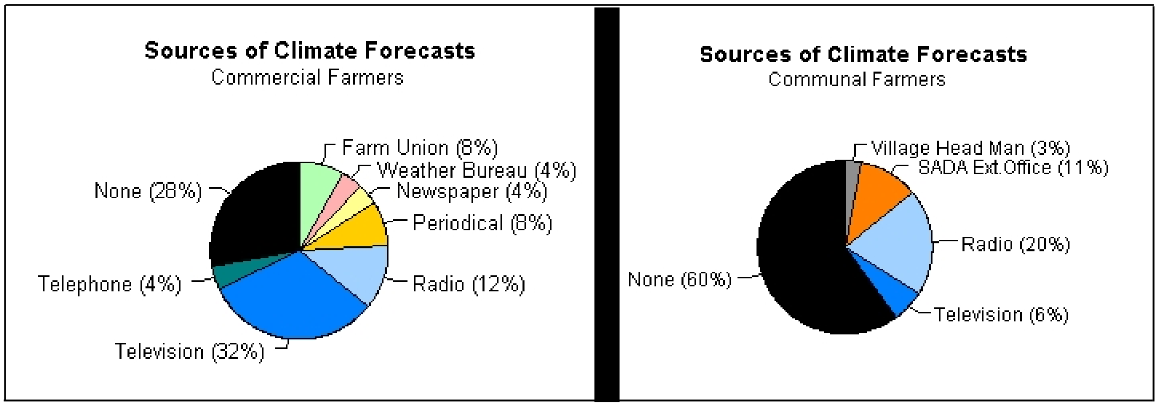

Figure 4.17 Sources of climate forecast information.

These television and radio programs are targeted toward crop farmers who desire climate forecasts prior to the planting season. To meet crop farmer demands, the South African Weather Bureau (SAWB) usually reports three and six month climate forecasts only during the spring season. These forecasts are updated weekly from spring to mid-summer but are not broadcast on a regular basis during much of the year. During these research interviews, most farmers complained that climate forecasts are usually unavailable for much of the year through mass media broadcasting. Commercial and communal farmers tend to get their climate forecast information from different sources as shown in Figure 4.17. Of nine sources reported, only two (radio and television) were common to both commercial and communal farmers. Almost twice as many communal farmers receive their climate forecast information from radio as do commercial farmers, and five times as many commercial farmers get their information from television as do communal farmers. A possible reason for the greater number of commercial farmers getting climate forecasts than communal farmers is that commercial farmers are better able to obtain information

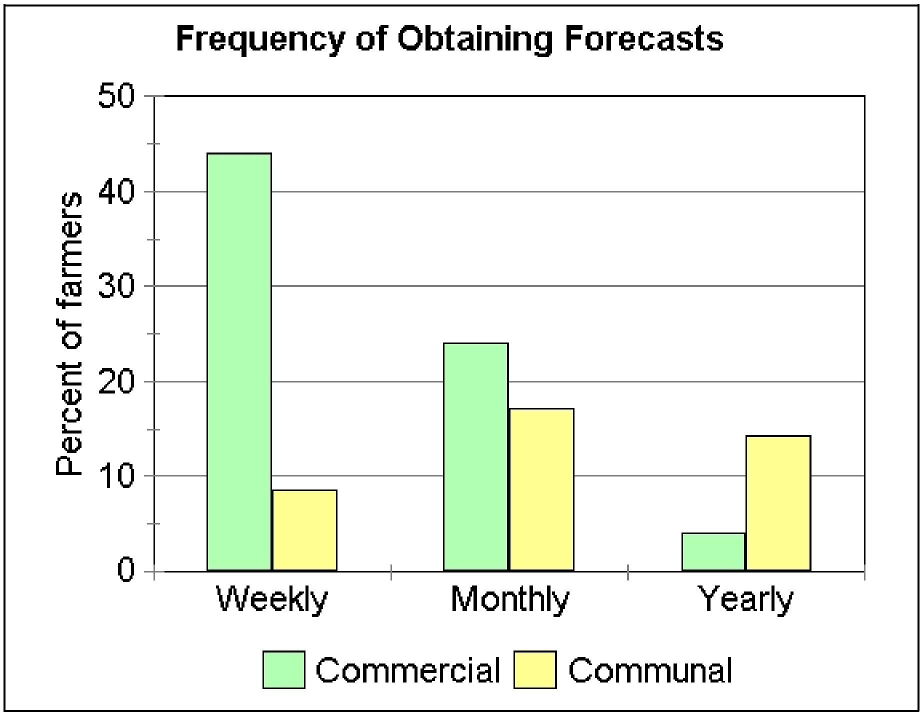

Figure 4.18 Frequency of receiving climate forecast information.

from a greater diversity of sources. Of the commercial farmers receiving forecast information from magazines and newspapers, most (65%) state that these sources of long-term climate information are not printed on a regular basis. Communal farmers report having fewer sources of information . Of all the farmers interviewed, 28% of the commercial and 60% of the communal farmers never receive climate forecast information.

Although many farmers report not being able to get climate forecast information in a timely manner from their preferred source, commercial and communal farmers who get forecasts generally report getting them on a fairly regular basis during times of the year when forecasts are available. Of farmers who receive climate forecast information, more commercial farmers (43%) report getting forecast information on a weekly basis and more communal farmers (18%) report getting their information on a monthly basis (Figure

4.18). English and Tswana farmers report that when forecasts are available, they are usually only available in Afrikaans. In general, many mass media broadcasts (other than climate forecasts) are spoken in English and Afrikaans; there are few broadcasts spoken in indigenous languages, including the Tswana language. Virtually all communal farmers expressed the desire to have climate forecasts broadcast in their own language on radio and television.

The frequency with which farmers receive climate forecast information is much less than the frequency with which farmers would like to have information available (Figure 4.19). Most commercial farmers would like to have climate forecasts available on a weekly basis, and most communal farmers would like to get this information on a monthly basis. Indeed, 62% of commercial and 88% of communal farmers feel that forecast information is not available in a timely manner. Although it was found that virtually all

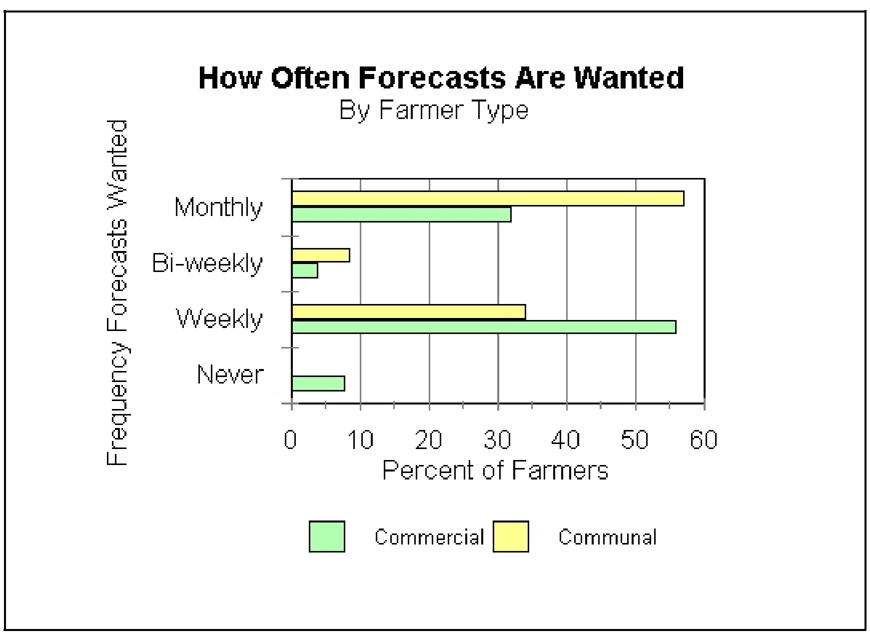

Figure 4.19 The desired frequency of obtaining climate forecast information.

farmers want climate forecast information, intended uses of this information by commercial and communal farmers are quite different. Commercial farmers (92%) overwhelmingly state that they want this information only as a supplement to their existing herd management practices. This is in contrast with most communal farmers (83%) who state that they wish to have climate forecast information for use as a primary guideline for herd management.

Climate Forecast Perceptions

Results from this research show that 80% of commercial farmers and 46% of the communal farmers report forecasts as being *not at all valuable* or only *somewhat valuable*. Conversely, 20% of commercial and 54% of communal farmers report

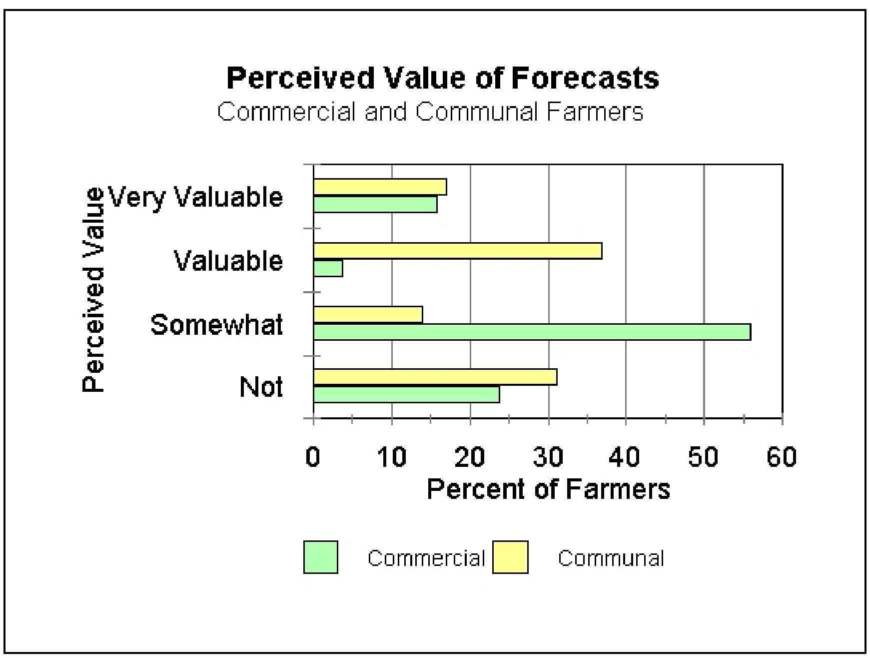

Figure 4.20 Perceived value of climate forecasts.

forecasts as being *valuable* or *very valuable* (Figure 4.20). Thus, the ratio of communal to commercial farmers believing that forecasts are valuable or very valuable is 2.7:1. One explanation for this ratio difference could be the fact that these data were collected a year after the 1997-1998 El Niño was predicted to have a devastating effect on South Africa. Many farmers prepared for the inevitable drought that did not come, and lost a substantial amount of money by following warnings and guidelines from the SAWB. It is likely that responses to the *value of forecast information* questions gathered during this study was unfavorably biased by that event.

A comparison between commercial and communal farmers reveals a large difference in perceptions of climate forecast accuracy (Figure 4.21). The majority of commercial farmers (60%) and the minority of communal farmers (5%) think that climate

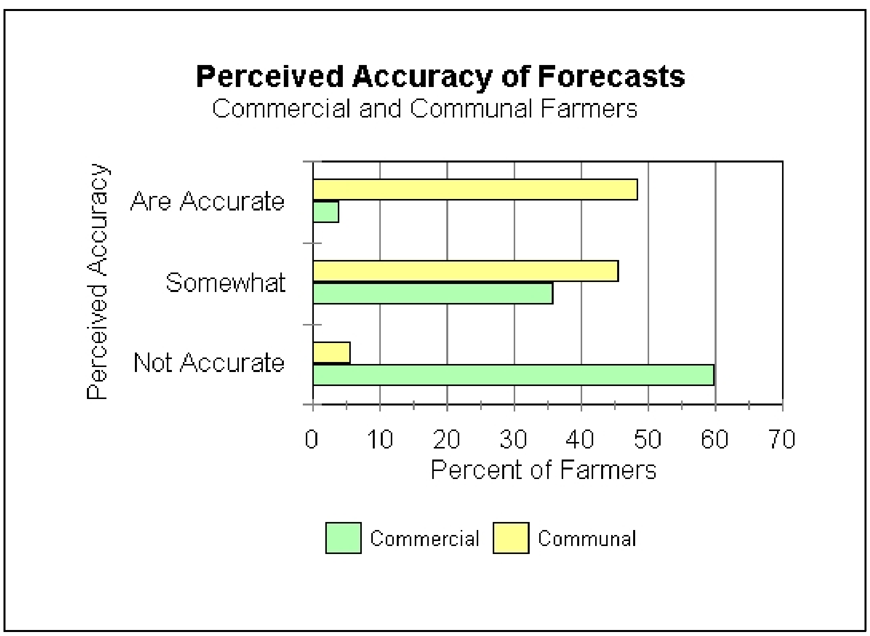

Figure 4.21 Perceived accuracy of climate forecasts.

forecasts are not accurate. Conversely, a minority of commercial farmers (4%) and about half of the communal farmers (49%) believe forecasts are accurate. The proportions of commercial (36%) and communal (46%) farmers reporting in the *somewhat* accurate category are much closer than in the other two categories.

Climate forecasts from the SAWB are issued via radio, television, and other media sources from 3 to 6 months in advance. Forecasts are given in terms of probabilities for the average monthly rainfall being above, below, or near normal for a geographic region. This method of seasonal prediction is considered unduly complex by many farmers who want to know if they should prepare for a good or bad farming year (SADA 1999d).

Of farmers who get forecast information, slightly more commercial farmers (32%) than communal farmers (26%) report making farm management decisions based on that information (Figure 4.22). This is one area where there is not much difference between commercial and communal farmers.

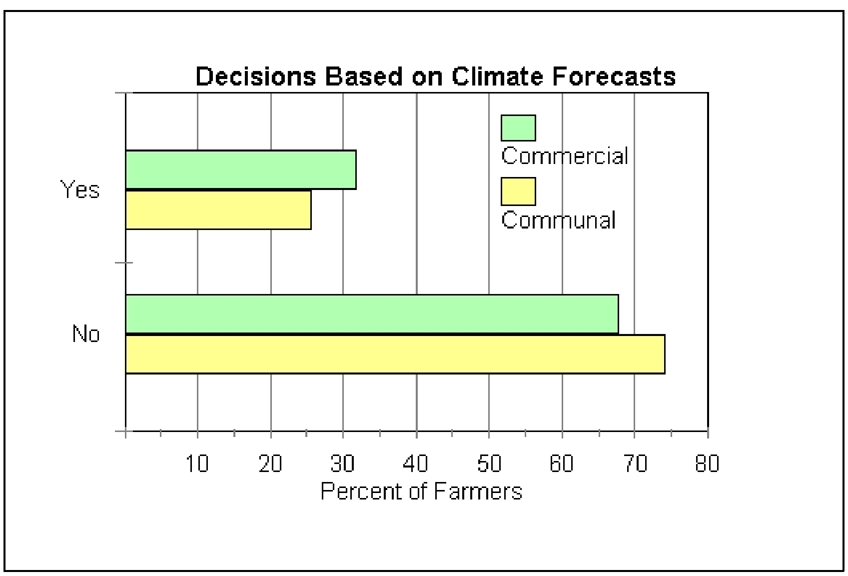

Figure 4.22 Management decisions based on climate forecast information.

El Niño Forecast Information

It is likely that climate forecast information could potentially add value to farmers drought management practices. Information about predicted El Niño events could also help farmers alleviate impacts of severe droughts associated with El Niño. The most significant recent El Niño event to affect the study area occurred in 1991-92. A stronger El Niño event was predicted for 1997-98 but it failed to have any effect on weather in the study area. Results of research data on these two El Niño events are presented below.

Although the El Niño-related drought of 1991-92 has been called the worst drought of the century, the majority of farmers in the study area reported that the 1991-1992 growing year was normal, thus the El Niño event had little effect on their weather (Figure 4.23). Slightly more commercial (76%) than communal (69%) farmers reported the year

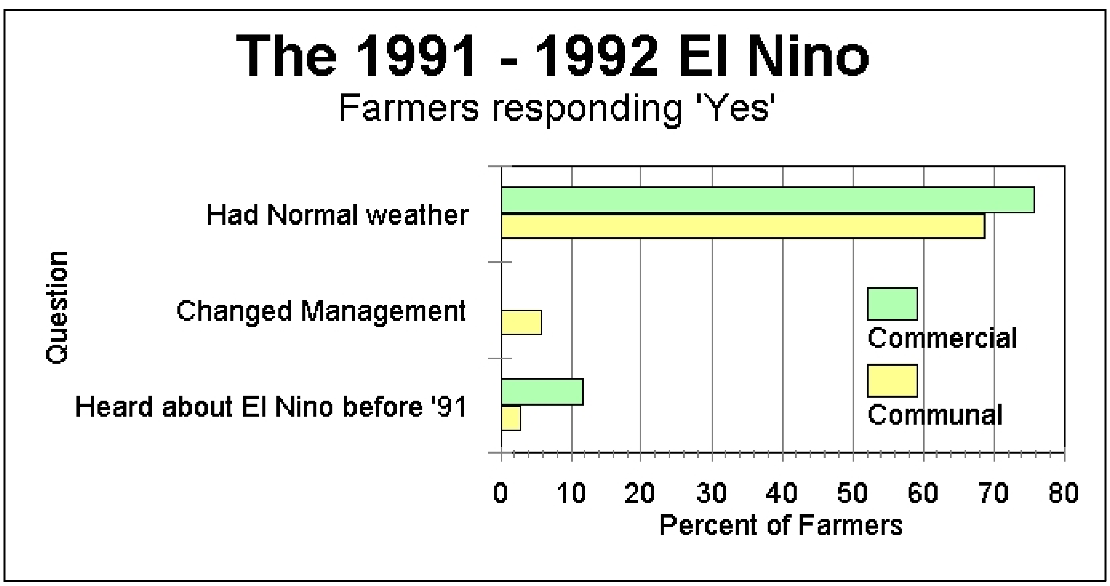

Figure 4.23 Farmers' information about and responses to the 1991 - 1992 El Niño.

as having a normal amount of rainfall and that they did not experience drought that year. In general, farmers in the study area did not hear about El Niño events impacting South Africa prior to the 1991 drought associated with El Niño (93%). No commercial farmers and only two (6%) communal farmers changed their livestock management practices due to forecast warnings prior to the El Niño event of that year.

As discussed earlier, the drought that was expected to follow the 1997-1998 El Niño event was forecast to be more severe than any in recent history. The SAWB forecasts and warnings to farmers were widely disseminated to farmers in commercial and communal areas (Figure 4.24) with the help of SADA field extension officers, and through mass communication avenues such as radio, television, newspaper, and special interest periodicals. In contrast to the drought of 1991-92, most farmers (95%), including those not normally receiving climate forecast information were warned in advance about the

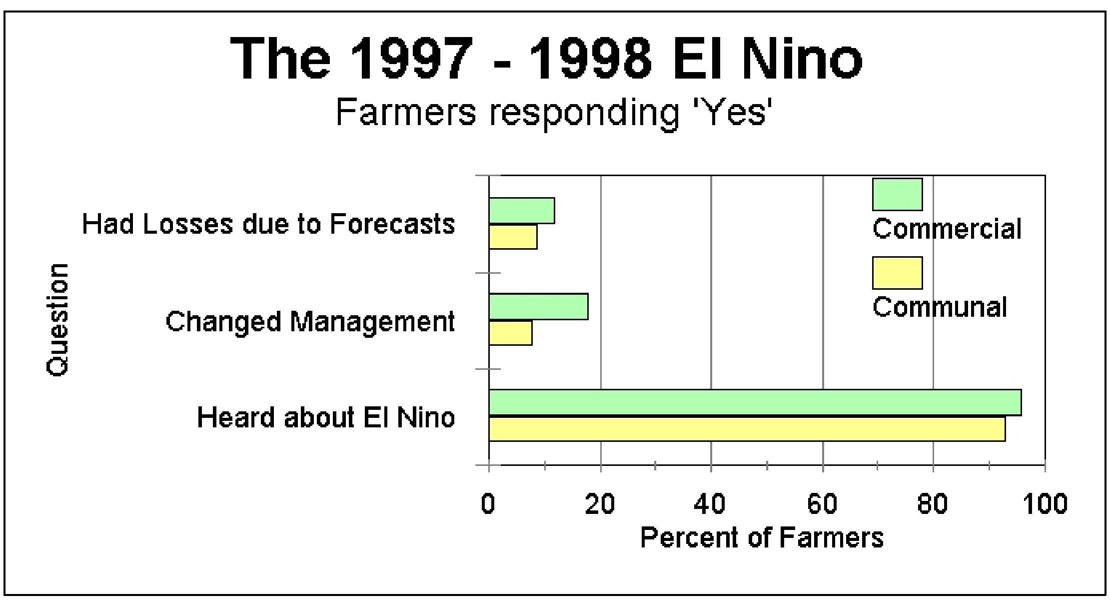

Figure 4.24 Farmers' information about and responses to the 1997 - 1998 El Niño.

anticipated 1997-98 El Niño-caused drought. Farmers in the study area were thus warned of severe drought, and although they did not experience drought as forecast, many farmers prepared by selling livestock earlier than normal, decreasing herd sizes, or stockpiling fodder. These measures were taken to alleviate the expected drought, and consequently many farmers reported having losses due to inaccurate forecast information.

About 12% of the commercial farmers and 9% of the communal farmers reported having sustained financial losses because they decreased livestock numbers in preparation for the El Niño-associated drought. Commercial farmers reported decreasing herd size by up to 30% and communal farmers, under pressure from government officials, also reporting reducing their livestock numbers up to 20% in preparation for the drought (SADA 1999d). Although many farmers made preparations for the predicted drought, all of the commercial farmers and 86% of the communal farmers interviewed thought that the El Niño event did not have a detrimental effect on their weather.

Chapter 5

DISCUSSION AND CONCLUSIONS

The primary focus of this research is to compare drought management strategies of commercial and communal farmers in the western region of the North-West Province of the Republic of South Africa. Although operating in comparable physical and ecological environments, commercial and communal farmers have different social, economic, political, historical, and cultural backgrounds which are reflected in their livestock management practices, use of climate forecasts, and in their responses to drought conditions (see conceptual model page 19).

Results of the hypotheses tests are reported in this chapter, with additional discussion and observations based on information acquired during the field research. Variables for each hypothesis are examined and summarized. This is followed by a section on drought and drought mitigation strategies. The last section is a discussion of the uses of forecast information.

Results of Hypotheses Testing

Hypothesis 1: *Commercial farmers have larger farms which support larger numbers of people, numbers of livestock, and have a greater number of boreholes. Together, scale (size of the farm) and scope (farm support, infrastructure) of operation are greater for commercial farmers.*

Number of People Supported by Farms

Data from this research shows that communal farmers, on the average, have larger families and support 1.75 times as many family members as commercial farmers. However, when permanent workers who live on and are supported by the farm are included, commercial farmers support over 4 times as many people as communal farms. If the total number of people supported by the farm were used as the sole measure of scale of operation then commercial farms would have a much larger scale of operation. However, this measure cannot be used as the sole determinant because it is too simplistic and confounding factors are present. For example, the number of people supported does not consider the amount of resources available, the degree to which resources are utilized, or sustainability of resource utilization. These factors must be considered to fully operationalize the scale of operation.

Number of Livestock

Although descriptive statistics for communal areas about individual farm sizes, total numbers of livestock grazed on village pastures, or size of village pastures are not available for communal areas these statistics have been estimated by calculation. The relative sizes of commercial to communal farms can be used as supporting evidence for the hypothesis. It is known that commercial farmers own 61% of the land in the western region (30,110 km^2) and communal farmers have the remaining 39% (19,122 km^2). However, conclusions about cattle numbers or grazing capacity in communal lands cannot be directly inferred because of the non-uniform distribution of village sizes and spatial clumping of villages. Much of the communal pastureland is not utilized because of its remoteness.

In lieu of individual or collective data about grazing areas in communal lands, the number of livestock owned by individual communal farmers compared to livestock owned by commercial farmers, and estimated pasture size of communal farmers is used as a measure for scale of operation.

Data show that the typical commercial farmer has over 13 times the number of cattle and about 1.5 times the number of sheep as the typical communal farmer. In terms of TLUs, commercial farmers have approximately 8 times the livestock units as communal farmers. The disparity between numbers of livestock and TLUs show the communal farmers' disproportionately high reliance on goats.

Grazing Capacity

Calculations of estimated communal pastureland reveals that commercial farmers can stock at almost twice the rate as communal farmers (8.6 compared to 15.8 ha/TLU), and have, on the average 5.7 times the pasture area for their livestock as communal farmers. Differences in grazing capacity are attributed to a history of overgrazing within proximity of boreholes on communal lands, compared to conservative farming methods, including understocking, livestock rotation among numerous camps, and control over land usage on commercial farming areas.

Number of Boreholes

Because surface water is scarce and very few farmers have water sources for their livestock other than boreholes, the average number of boreholes that farmers can access is used as an indicator for scale of operation. This proxy can be used because cattle require a certain volume of water for every pound of fodder. Since pasture located far from water is not utilized by livestock, there is some optimum ratio of boreholes per pasture area. This proxy assumes the number of animals utilizing each borehole is approximately the same in commercial and communal rangelands. It also assumes that the number of boreholes a farmer's animals have access to is a limiting factor in the number of animals the farmer can maintain. However, commercial farmers can utilize boreholes to a much higher degree in terms of the number of animals using each borehole by a factor of three or four by piping water from one borehole into several pastures. Thus this proxy is an extremely conservative estimate of scale of operation for commercial farmers. An average of 11 boreholes were used by livestock on a commercial farm, and communal farmers were found to use an average of 2 boreholes for their livestock. Thus commercial farmers average 5.5 times the number of boreholes that communal farmers have. Since commercial farmers graze an average of 630 TLUs, they typically have 57 TLUs per borehole. Communal farmers average 50 TLUs which have 2 boreholes for their use.

This gives communal farmers 25 TLUs per borehole, roughly half that of commercial farmers.

Scale of Operation Hypothesis: Summary and Conclusions

In the study region, the combined areas of commercial farming districts are 1.6 times as large as the combined areas of communal districts. However, direct measurement of average pasture sizes, to which communal farmers have access, is not possible due to the lack of local knowledge about sizes of communal grazing areas and overlapping patterns of rangeland use by multiple farmers and multiple villages. Estimates of communal grazing areas were made based on grazing capacities of commercial farmers. When numbers of permanent workers and their family members who live on farmland are included in the total numbers of people supported by each type of farm, the average commercial farmer supports 4 times as many people as the average communal farmer. Commercial farmers, on the average, have 6 times as many head of animals than communal farmers which is about 12 times the animal biomass when calculated in TLUs. If only cattle are considered, the typical commercial farmer has 13 times as many head of cattle as the typical communal farmer. Goats and sheep have low importance in terms of total TLUs for commercial farmers, but are important hedges against drought for communal farmers.

Commercial farmers also have 5.5 times the number of boreholes and twice the number of animals per borehole as communal farmers. No difference in borehole depth, water production from boreholes, or overall water quality, was found between commercial and communal farming districts. This finding implies that water resources in commercial and communal farming districts are equally plentiful but are not developed to the same extent nor utilized in the same manner.

By the measures of hectares per TLU, number of people supported, number of animals kept, type of animals kept, number of boreholes, and the number of animals per borehole, commercial farms consistently have a much larger scale of operation than communal farmers. This evidence supports the hypothesis that commercial farmers have a larger scale of operation.

Hypothesis 2: *Commercial farmers can cope more readily with drought as indicated by scale of operation; different production goals; strategies to minimize effects of drought; and the number of years farmers perceive they can cope with drought.*

Scale of Operation

Strong evidence exists to support the assumption that commercial farmers have a larger scale of operation. A larger scale of operation implies having more resources and greater reserves. Thus farmers with a larger scale of operation will be in a better position draw upon these reserves and combat the effects of drought. Data tend to support this hypothesis.

Production Goals

Different production goals have been associated with commercial and communal farmers. Commercial farmers manage their herds in a manner consistent with their goals of maximizing calf production on a yearly basis. Likewise, communal farmers maximize their animal production in a manner consistent with their more severe resource constraints of water and pastureland. Thus resource availability was found to be a significant contributor to differences in management strategies and responses to drought. Cultural differences certainly play a significant role in differences between commercial and communal farmers, however, resource availability is a more significant factor. Given the lack of control over pastureland, inadequate resources to effectively institute rotational grazing methods, and lack of sufficient boreholes, communal farmers would surely not be able to survive using the more conservative farming practices of commercial farmers. Production goals of communal farmers are highly adaptive and successful considering the constraints placed on their farming practices.

Strategies to Minimize Effects of Drought

Results from reported drought coping strategies are not straightforward (as most results thus far). Most commercial farmers who have a drought strategy report that they will sell livestock to decrease their herd size thereby conserving their resources, and most communal farmers report they will buy fodder or only sell enough animals to buy fodder. Logic dictates the reverse because, assuming the scale of operation hypothesis is true and commercial farmers have more resources, they would buy fodder, and communal farmers would sell livestock. This apparent anomaly in the data is resolved when production goals are considered. A commercial farmer's primary goal is to produce livestock for sale on the market, so it stands to reason that their primary response to drought is to sell livestock. Communal farmers, by comparison, have a goal of retaining livestock and consequently their primary response to drought is to buy fodder to maintain their herd size. They know that drought is a temporary event and that animal weight loss during drought years will be regained in years following droughts. These results could also be explained by the fact that commercial farmers have fewer hectares per TLU, perceive that their pastures are not overgrazed because they understock their pastures, and consequently perceive that pasture conditions are getting better.

Perceived Years Farmers are able to Cope with Drought

About 4% of commercial and 33% of communal farmers claim they could not cope with any drought. More commercial than communal farmers report thinking they could cope with drought for 1, 2, and 3 years. Although four years of consecutive drought is a highly unlikely event according to farmers, 8% of commercial and no communal farmers think they could cope with droughts lasting that long. More commercial farmers reported being able to cope with each successive year of drought than communal farmers. This result is consistent with the hypothesis that commercial farmers have more resources to draw upon in times of drought and therefore can cope with successive drought years.

Coping with Drought Hypothesis: Summary and Conclusions

Farmers are in a good position to estimate their ability to survive drought. This measure, when considered in tandem with the scale of operation measure is sufficient to support the hypothesis. Coping with drought was not found to be a good measure for hypothesis testing because it did not support nor give evidence to reject the hypothesis. An unexpected result of the survey data is that over a third of both commercial and communal farmers report either never having experienced a drought or having no strategy to cope with drought. These farmers consider drought to be a natural event in their semi-arid environment and farm accordingly. This means these farmers either underutilize their resources, as in the case of many commercial farmers, or as in the case of many communal farmers, they do nothing but let drought run it course and wait for better conditions to follow in subsequent years.

Hypothesis 3: *Commercial and communal farmers have different production goals as determined by species of animals kept and reasons for selling livestock.*

Type of Animals Kept

Commercial and communal farmers were found to raise both cattle and sheep; communal farmers also raise goats. However, commercial farmers were found to primarily rely on the production of cattle for market and communal farmers were found to rely heavily on goats for their livelihood. Goat keeping, which is known to be a valuable hedge against drought for marginal or subsistence farmers, is not practiced by commercial farmers. However, goats make up the largest proportion (40%) of all livestock owned by communal farmers. The lack of goat-keeping on commercial farms could be an indicator of greater resource security or availability that makes the utilization of goats an unnecessary hedge against drought. Not keeping goats also allows commercial farmers to use resources, which would be used by goats, to be used for additional cattle, thus reaping greater profits from the market economy.

Reasons for Selling Livestock

Commercial farmers produce calves for the market economy. Thus their primary farming goal is to have a quick turn-over in calf production and they sell livestock to meet that objective. Calves are normally kept for about a year until they have been weaned and weigh enough to bring optimal market prices. Selling calves and culling the herd of non-optimal reproducing animals are consistent with this goal.

Communal farmers, on the other hand, maintain livestock as a "walking bank account," and consequently view livestock reproduction as payment of a high interest rate paid into that "account." As a result, communal farmers tend to maintain as large a herd as possible, and sell large portions of their livestock only when they need cash, for example for ceremonial and other social events, when they need extra cash, or in times of urgent necessity, such as in the severest of droughts.

Production Goals Hypothesis: Summary and Conclusions

Different production goals between commercial and communal farmers mean that different species of livestock are raised, and management practices are expected to differ. Consistent with these expectations, farming methods and livestock management decisions of communal farmers are viewed as illogical by commercial farmers and vice-versa. Commercial farmers and the SADA perceive communal farmers as practicing overgrazing, keeping non-reproductively active livestock, and not maintaining livestock in the best condition possible. Communal farmers perceive commercial farmers as wasting time and money because of commercial farmers' practice of selling livestock, and underutilizing available pastureland. Thus, the variation in production goals explains much of the variation in livestock management practices between commercial and communal farmers. The types of livestock kept by commercial and commercial farmers and their reasons for selling livestock support the hypothesis.

Hypothesis 4: *Commercial farmers consider climate forecast information as being more important than communal farmers as determined by forecast availability and use, the perceived accuracy of forecasts, the perceived value of climate forecasts, and decisions based on forecasts.*

Availability of Climate Forecast Information

Twice as many commercial as communal farmers obtain forecast information (2.1:1 ratio), indicating that this variable supports the hypothesis. The majority of commercial farmers (61%) get forecasts on a weekly basis during the growing season, while a majority of communal farmers (43%) get forecasts on a monthly basis. Not only do more commercial farmers get forecasts, they get forecasts more often. Thus, both the number of farmers and frequency of obtaining forecasts support the hypothesis.

Perceived Accuracy of Climate Forecasts

Over 12 times as many communal farmers as commercial farmers (12.3:1) report that climate forecasts are accurate, and roughly the same proportion of communal and commercial farmers (1.3:1) report that forecasts are somewhat accurate. One explanation of the higher number of communal farmers perceiving forecasts to be accurate is that forecasts are less available for them. Perhaps by not having frequent access to forecasts, communal farmers are not as aware of errors in forecasting as commercial farmers. This variable does not support the hypothesis.

Perceived Value of Climate Forecasts

Although the numbers of farmers who perceived value of forecast to be *very valuable* was essentially the same, (16% for commercial and 17% for communal) and the numbers of farmers who perceived value of forecasts to be *not at all valuable* (24% commercial and 32% communal) were greater, the other two categories *valuable* and *somewhat valuable* had vastly different numbers of farmers reporting these categories. Within these four categories, more commercial farmers (56%) reported forecasts to be *somewhat valuable* than communal farmers and more communal farmers (37%) reported forecasts to be *valuable* than commercial farmers. This implies that commercial farmers perceive climate forecasts as having less value than communal farmers. This finding is contrary to the hypothesis.

Decisions Based on Forecasts

Roughly the same proportion of communal and commercial farmers have made livestock management decisions based on climate forecast information. The commercial to communal ratio for those who made decisions with climate forecasts is 1.2:1. Thus this variable does not conclusively support nor give evidence to reject the hypothesis.

Use of Climate Forecasts Hypothesis: Summary and Conclusions

Overall, variables used to measure the hypothesis do not give strong evidence supporting the hypothesis. Only two variables, those pertaining to the availability and frequency of receiving forecast information give evidence in support of the hypothesis. Two variables, forecast accuracy, and perceived value of forecasts both show strong evidence for rejecting the hypothesis. The last variable tested for the hypothesis, regarding decisions based on forecasts, did not conclusively support nor give evidence contrary to the hypothesis.

Drought and Drought Mitigation Strategies

The following four sections address farmers' perceptions of drought and their strategies for coping with drought. This study revealed that definitions of drought found in the literature are subjective and generally do not describe the timing or duration of drought, which are factors important to farmers. Many definitions of drought (see Chapter 2) would characterize most years in South Africa as being drought years. Likewise, drought definitions in many geographic regions imply a short-term event of water scarcity during the summer growing season which does not consider the effect of last year's drought on this year's production. However, South Africa usually has little or no precipitation from late fall through winter, and well into spring. Thus, farmers typically know by the end of the summer growing season whether or not they will have ample forage to last their livestock through the coming winter and into the next spring. A common definition of drought in South Africa is when there has not been enough plant biomass production to last livestock through the winter and into the next growing season.

During the wet summer season, rainfall is highly variable, both temporally and spatially. Data from this study taken in the 1999-2000 growing season, for example, exemplified both the temporal and spatial variability of rainfall patterns in the southern Kalahari. The wet summer season started with drought conditions because of the late onset of the springtime rains and lower amounts of rainfall than normal. The first rain in most parts of the study area fell fairly late in the spring, October 2nd 1999, and was of sufficient amount to initiate substantial grass growth. The following rains, some two weeks later, were enough to sustain grass shoots in much of the area until more frequent rains started in early November.

The above weather patterns indicate that two forms of drought exist for farmers in this region. The first type of drought occurs when spring and summer rains come later than normal. Thus farmers must either wait for the dry spell to end or implement drought mitigation strategies. The second type of drought occurs when rains during the rainy season are insufficient to produce enough biomass for livestock to sustain them from late spring, through the dry winter months, and into the spring-time growing season. Thus, the first form of drought usually arises from the timing of rainfall, and the second type arises from the problem of rainfall quantity.

Rainfall, as indicated earlier, is not only variable in time but also across space. Some farmers, at the beginning of a rainy season, enjoy several substantial rains, while neighbors located a few kilometers away would still be waiting for the first rainfall of the season. Although dry weather during winter is reliable and predictable, summer rains start and end unpredictably. The growing season of 1999-2000 again provides an example. Although some farms started getting their summer rains in early October, other farms (even some neighboring ones) had still not received rain by the first week in December. This season started with a fairly widespread drought, but unusually high amounts of rain came late in the summer and fall, making this the wettest growing season in over 50 years. This variability in the timing and distribution of rainfall makes it more complicated for farmers to make plans for drought, and many farmers consider drier seasons as normal climatic variability. Data from this study show that in this climate of highly variable rainfall, farmers have readily adapted their livestock management practices such that about one-third of both commercial and communal farmers report that they either have not experienced a drought, or that they have no special drought strategy. These farmers simply wait for spring rains to come.

Rangeland Condition

In general, commercial farmers perceive rangeland conditions more optimistically than communal farmers. Likewise, more commercial farmers report that rangeland conditions are improving, while more communal farmers report that rangeland conditions are becoming worse. Commercial farmers and the SADA believe rangeland conditions are improved by using the rangeland management practice of the rotational camp system. This grazing method is used by almost 90% of the commercial farmers and only about half of the communal farmers. The lower rate of animal numbers per unit of land on commercial farms, combined with the higher incidence of rotational grazing, are the two main factors from the research data thought to explain the difference in the perceived condition of rangelands. Rotational grazing in communal rangelands is currently impaired by the lack of boreholes and fencing.

During early stages of field research, water quantity and quality were considered as possible variables in the disparity of livestock numbers between commercial and communal farmers. However, this was found not to be the case. All five districts have vast underground water sources which are seldom, if ever, affected, in even the most severe of droughts. Commercial and communal farmers report that water availability is usually a problem only when there is not enough wind to power windmills, but most commercial and some communal farmers have back-up diesel power to pump borehole water. Commercial farms were found to have, on the average, eleven boreholes for livestock usage. Communal households, on the other hand, have access to two boreholes on the average. This translates into an average of 57 TLUs per commercial farmer's borehole and 25 TLUs per communal borehole. Because water is seen as the main limiting factor of livestock production in this environment, it appears that communal boreholes are underutilized. However this is not necessarily true because sheep and goats use them too.

Although these data appear to support the scale of operation hypothesis, this is a simplistic portrayal of the importance of water availability, as explained below.

Water and Pastureland

Communal farmers did not report water availability as their main limiting factor of herd size; instead they reported pasture availability as their main limitation. In most communal areas the limiting factor of livestock production and health is not simply the underutilization of boreholes, nor lack of available pastureland, but rather a problem of not having access to both water and pasture.

Livestock on communal lands were observed to graze in a manner consistent with the central-place model developed by Copolillo (2001). This model describes a situation of decreasing grazing intensity with distance from water sources, and can be used to explain the variance in grazing intensity observed with cattle on communal lands. Although there is sufficient borehole water for livestock grazing in most communal districts, animals are forced to travel further and further from borehole water as they consume nearby fodder, and spend substantial amounts of time and energy traveling from boreholes to pasture. In years of below-normal or late rainfall, the daily energy animals expend to travel to and from their water supply becomes greater than the energy animals can obtain from fodder, especially considering the decreasing time animals have for grazing as they travel further. This problem is compounded by the fact that cattle need approximately three pounds of water for every pound of dry fodder, and in hotter temperatures, water is more readily lost through sweating (Matsushita 1979, Lloyd et al.

1978, Roubick 1969). Without adequate water, cattle eat less and have less energy to make the daily trip for fodder. These factors can contribute to a negative energy balance, meaning that animals slowly starve to death, a common problem for many pastoral peoples (Little and Leslie 1999, Salzman 1982).

Although communal farmers see available pasture land rather than water as their primary limiting factor for herd size, they have half the number of cattle per borehole as commercial farmers. A possible explanation of the apparent underutilization of boreholes by communal farmers is that many commercial farmers pipe water from individual boreholes to several camps on their land. This effectively increases their number of boreholes and helps to prevent overgrazing of pastureland by dispersing livestock over a wider area. It also decreases the time and energy livestock spend on traveling to forage.

Simply increasing the number of boreholes or laying a system of pipes for water dispersal in communal areas could potentially help communal farmers; however, this is a simplistic view which would not necessarily improve the situation. As this study has shown, cultural norms and livestock production goals are different between commercial and communal farmers. Since communal farmers have a livestock production strategy of maintaining the maximum number of animals, increasing the number of boreholes or dispersing water through pipelines in communal areas might possibly only result in substantially increased herd sizes and contribute to more land degradation and decreased sustainability of pastureland (Little and Leslie 1999, Salzman 1982). Potentially, the resultant effect could be that in good years with ample rain, farmers' herds would expand dramatically, but in years of drought, farmers could face a greater degree of devastation than they currently face.

Another “western solution” would be to institute a more widespread practice of rotational grazing combined with additional boreholes or pipelines, and increase communal farmers’ reliance on the market economy. Although this solution might be advocated by development professionals, it would mean changing the production goals of communal farmers. Western solutions to economic development requiring changes in cultural norms, such as production goals, have been shown to fail miserably (Handelman 2000, Peet 1999). Therefore, communal farmers need to decide their own, more culturally-appropriate, solutions.

Economic Security Related to Livestock Species

Three main factors have been identified in which commercial and communal farmers differ in their livestock management practices. First, goats have been found to be the most numerous livestock kept by communal farmers. Goat-keeping has been shown to be highly advantageous for subsistence level farmers because goats survive and flourish in harsh conditions where cattle and sheep perish. Thus, the practice of keeping large numbers of goats is a highly adaptive and successful livestock management strategy, especially for farmers with limited resources, and in times of drought.

Commercial farmers have more resources, such as water and pastureland, and typically under-utilize these resources as a hedge against drought. Because they have ample resources, it is economically sensible for commercial farmers to concentrate their livestock production efforts on cattle, thus taking advantage of the higher market price per pound of cattle compared to sheep and goats. Likewise it is more economical for them to supplement their income with sheep products whose value is relatively high. The market demand for goats is virtually nonexistent, so it is not economically feasible and not reasonable for commercial farmers to raise or keep goats. Second, commercial farmers, with a larger scale of operation, and therefore the benefits of economy of scale, are less affected by drought than communal farmers because they have more resources, such as pastureland, boreholes, and rotational camps for livestock. In times of drought, commercial farmers report that they are more affected by the lowered market price of cattle, due to market saturation, than effects of drought on their livestock.

Forecast Information as a Drought Mitigation Strategy

In addition to providing more strategies for drought mitigation, advanced and timely climate information can help farmers develop better drought-coping strategies. Farmers using climate forecast information to implement drought mitigation plans prior to its event are able to act in a prescriptive rather than a reactive manner.

It was found that virtually all farmers want climate forecast information for their use as an advance drought mitigation strategy. Commercial farmers overwhelmingly want this information to supplement their existing practice of optimizing calf production. This is in contrast to communal farmers who state that they wish to have climate forecast information to use as a primary guide for herd management. In essence, the difference between commercial and communal farmers' expectation of climate forecasts is the difference between supplementary utility versus utility for informed decisions pertaining to livestock management. These results were found to be consistent despite the severe drought of 1991-92, and the incorrect dire consequences forecasted by the SAWB for the 1997-98 El Niño event.

Forecast Information

Perceptions of Forecasts

Farmers were asked how they perceived forecast accuracy and if they did make or would make herd management decisions based on climate forecast information. These data show that almost one-third of all farmers believe that forecasts are accurate and said they had made or would make management decisions for the coming growing season based on climate forecasts. Proportionally, almost ten times as many communal farmers as commercial farmers believe that climate forecasts are accurate, but nearly equal proportions of communal and commercial farmers make decisions based on these forecasts. Data for this research were gathered in the growing season after the 1997-1998 El Niño related drought. This El Niño event was forecast to be the worst in recent history but it failed to materialize. This inaccurate forecast probably had a negative impact on data about forecasts gathered during the research phase of this thesis. Increasing forecast accuracy is one of the major goals of the SAWB and they wish to avoid erroneous dire predictions in the future (Landman 1999).

In summary, results suggest that farmers have a great need and desire for forecast information, and it is reasonable to assume many more farmers would want to use climate forecasts if forecast accuracy were improved.

Dissemination of Forecast Information

In addition to perceived problems of forecast accuracy, other obstacles prevent farmers from using climate forecast information. These obstacles include: the language in which forecasts are disseminated; problems interpreting the meaning of forecasts; lack of systematic distribution of forecasts; and concerns about the value of regional-scale forecasts for local-level decision making. Also, incomplete coverage across the study area by mass media through which forecasts are available is problematic. For example, television and radio coverage is not reliable throughout much of the Vryburg1 region, especially in the extreme north and west part of the district that borders Botswana and Namibia. In this district people tend to receive climate forecast information in published periodicals such as local newspapers and the *Farmers Weekly*. Farmers in the Vryburg 2 region rely more on information from the Department of Agriculture's Extension Office but are equally skeptical of climate forecasts as their Vryburg 1 peers. Commercial farmers in both groups see long-term forecasts as not being available during much of the year.

Communal farmers rely heavily on Extension Officers for forecast information. While somewhat skeptical of forecast information, they utilize forecasts more than white commercial farmers even though the information is less readily available in the communal areas. Communal farmers would like to see climate forecast information made more widely available with more frequent updates. They list accessibility problems as paramount: information is often not in their native tongue, they lack access to newspapers or magazines, and information is not always available via word of mouth sources, such as village meetings or from extension officers. However, it was found that neither commercial nor communal farmers could consistently obtain information from their preferred sources.

Use of Forecasts

Drought in southern Africa occurs on a frequent but irregular basis, which affects the livelihood of livestock producers in the region. Drought's impact upon the economic well-being of inhabitants in the southern Kalahari region mainly depends on the resources farmers have to draw upon in bad times such as drought. Additionally, resources available to farmers are shown to be correlated with historical, racial, and cultural factors. Commercial farmers in the study area are shown to have more resources than their communal counterparts. In lieu of greater natural resources to draw upon, the impact of drought on people's lives can be minimized by effective preparation for, and contingency responses to drought by having accurate and timely seasonal weather and climate forecast information. The lack of natural resources available to communal farmers could be offset with enhanced information resources such as timely climate forecasts.

El Niño Forecasts

Not only is climate forecast information potentially valuable for farmers, but information about El Niño events could further help farmers alleviating impacts of severe drought, and improve their food and economic security.

The El Niño-related drought of 1991-92 is considered the worst drought of the past century in southern Africa by many researchers (Chagnon 2000, Glantz 1994, Harsch 1992). During the growing season, drought-related famine threatened the lives of up to 80 million people. However, farmers in the study area overwhelmingly reported the El Niño event of 1991-92 had no effect on their weather nor their livestock management practices. Only about one-sixth of commercial farmers and a sixth of communal farmers reported a severe or very severe effect on the growing season for that season. One explanation for the lack of drought impact for this season is that livestock production is less susceptible to rainfall timing and spatial patterns at the local level than is crop production.

What really matters to livestock producers is the effects of rainfall for forage production in the wet season and onset of the dry season.

When asked if the 1991-92 season was normal, nearly 75% of all farmers said they had a normal year. This is an example of a generalized forecast not being of value at the local level, considering the severity this drought and the general widespread effect it had on the country. Although there are many possible explanations for these findings, two are perhaps the most obvious: the first explanation is that this drought was the first one to be widely publicized in South Africa as being associated with El Niño, and then it was only publicized after the event had begun (Glantz 1994). Another explanation is that this drought, while having a disastrous effect on crop farmers in most of southern Africa, had little impact on livestock owners in the study area. This is generally attributed to the spatial component of the drought and the fact that livestock are less susceptible to a single year of drought than crops.

In contrast to the drought of 1991-92, even farmers not normally receiving climate forecast information got advance warnings about the anticipated 1997-98 El Niño. The drought that was expected to follow this El Niño event was anticipated to be much more severe than any in recent history because the sea surface temperature off the coast of Peru, the primary indicator of El Niño's intensity, rose higher and faster than at any previously recorded time (Allan et al. 1996). Thus, forecasters reasoned that the world-wide droughts associated with the 1997-98 El Niño would be comparably severe. This El Niño was the first major event in which world-wide forecasting groups participated in the real-time prediction of El Niño- driven weather changes. Consequently, dire warnings were spread in El Niño-associated drought regions, including South Africa. Even farmers living in the most remote villages, who had never heard of or understood the term El Niño, were informed about the upcoming drought. Across South Africa, many farmers undertook preparations for the most severe of droughts to occur. In the end, this preparation was unwarranted, at least in the study area, because the yearly rainfall was more than enough to alleviate drought, and was actually sufficient to provide a "typical" growing season. All of the commercial farmers and 71% of the communal farmers interviewed thought the 1997-98 El Niño had "no effect", and that the weather was normal or wetter than normal.

Some farmers, however, believed the dire forecasts and took measures to alleviate the approaching drought. Commercial farmers reported decreasing herd size by up to 30% in order to prepare for a severe drought. Communal farmers, under pressure from government officials, also reduced their animal numbers in preparation for the El Niño-caused drought. Overall, ten percent of all farmers in the study area reported having sustained losses because they prepared for drought that didn't occur.

In conclusion, livestock farmers in the North-West Province raise livestock under conditions of intra- and inter-annual climate variability. Not surprisingly, commercial farmers and communal farmers have different resources available to them, have different production goals, and different management strategies. Thus, drought affects each differentially. The commercial farmers having more resources are currently in a better position to cope with drought. However, with the improvement of climate forecast capability, both commercial and communal farmers could benefit from the added value offered by timely and accurate forecasts. At the time of this research, the SAWB is trying to reach out to all farm producers, to get forecasts out in a format (native tongue and in non-technical terminology) that is easier to obtain and understand so that forecasts can more readily be utilized by current and potential users.

Goals of this study have been met, and the importance of human factors such as culture, history, government policy, and market conditions have been shown to be important factors in determining how different animal management practices and drought coping strategies, including the use of climate forecast information, are used by commercial and communal farmers.

One implication of this study is that if communal farmers are forced to adapt commercial farming practices, without concurrently having their resource base increased, it will surely have dire affects on their ability to maintain their livelihood. Sustainable farming practices require conservative use of natural resources, but because communal farmers are highly marginalized, their basic survival needs cannot be met with the conservative practices required for sustainable resource management. Thus, without an increased base of resources from which to draw, there will be a continual degradation of communal pastureland.

Another implication of this study is that if farmers have access to accurate and timely forecast information about coming drought, they will be in a better position to minimize the effects of drought.

REFERENCES CITED

Abrams, L., et al. (1992). Root Cause and Relief Constraint Report. Johannesburg: National Consultative Forum.

Acocks, J.P.H. (1975). Veld types of South Africa. In *Memoirs of the Botanical Survey of South Africa. no. 57*. Pretoria: Botanical Research Institute.

Acocks, J.P.H. (1953). Veld Types of South Africa. In *Memoirs of the Botanical Survey of South Africa no 28*. Pretoria: Botanical Research Institute.

Adams, L. (1983). *A Rural Voice: strategies for drought relief*. Indicator South Africa. 10:4 p41-46.

Allen, R., et al. (1996). *El Niño, Southern Oscillation and Climatic Variability*. Collingwood, VIC, Australia: CSIRO Press.

Babbie, S. (1998). *The Practice of Social Research.* Albany: Wadsworth Publishing.

Balie, W. (ed.)(1998). *Advances in Historical Ecology*. Columbia: University Press

Baudelaire, J.P. (1972). Water for livestock in semi-arid zones. *World Anim. Rev*. **3**:1-9

Bembridge, T.J. (1993). Protein supplementary feeding of breeding stock proves profitable under watershed ranching conditions. *Rhod. Agric. J.* 60:89-100.

Bernard. (1988). *Research Methods in Cultural Anthropology*. Newbury Park, CA: Sage Publications.

Bidwell, C.E. and J.D. Kasarda, (1998). An Ecological Theory of Organizational Structuring. In *Continuities in Sociological Human Ecology*. M. Micklin and D.L. Poston Jr., eds. New York: Plenum Press.

Boonzaier, E., et al. (1996). *The Cape Herders: A History of the Khoikhoi of Southern Africa*. Cape Town: David Philip.

Breutz, P.L. (1958). Tswana tribal government to-day. *Socoilogus* 8:2.

Breutz, P.L. (1959). *The Tribes of Vryburg District*. Ethnological Publications no 46. Pretoria: Government Printer.

Breutz, P.L. (1963). *The Tribes of the Districts Kuruman and Postmasburg*. Ethnological Publications no 49. Pretoria: Government Printer.

Breutz, P.L. (1968). *The Tribes of the Districts of Taung and Herbert*. Ethnological Publications no 51. Pretoria: Government Printer.

Brewer, J., and A. Hunter (1989). "The Multimethod Approach and its Promise". In *Multimethod Research: A Synthesis of Styles.* Newbury Park: Sage Publications.

Bromley, D.W. (1995). South Africa - Where Land Reform Meets Land Restitution. *Land use Policy*. 12:2, pp 99 -103.

Carrillo, C.N. (1892). Disertacion sobre las Corrientes Oceanicas y Estudios de la Corriente Peruana o de Humbolt. (Micorficha). *Bol. Soc. Geog. Lima*, 11: 52-110.

Cashdan, E. (1990). *Risk and Uncertainty in Tribal and Peasant Economies*. Boulder, CO: Westview Press.

Changnon, S.A. (2000). What Made El Niño 1997 - 1998 famous? The Key Events Associated with a Unique Climate Event. In *El Niño 1997 - 1998: The Climate Event of the century* (ed.) S.A. Changnon. Oxford: Oxford University Press.

Comaroff, J.L. (1974). Chiefship in a south African Homeland: a case study of the Tshidi cheifdom of Bophuthatswana. *Journal of South African Studies*. October, 1974.

Coppolillo, P.B. (2001). Central-place analysis and modeling of landscape-scale resource use in an east African agropastoral system. *Landscape ecology*. 16: 205-219.

Cordova, F.J., et al. (1978). Forage intake by grazing livestock: A review. *Journal of Range Management* 31:430-438.

Cowling, R.M., et al. (1997). *Vegetation of Southern Africa.* Cambridge: University Press.

Crais, C.C. (1992). *White Supremacy and Black Resistance in Pre- Industrial South Africa: The making of the colonial order in the Eastern Cape, 1770-1865.* Cambridge: Cambridge University Press.

Creswell, J. W. (1998). *Quallitative Inquiry and research Design*. London: Sage Publications.

Crumley, C.L. (ed.) (1994). *Historical Ecology: Cultural knowledge and changing landscapes*. Santa Fe: School of American Research Press.

Delius, P. (1996). *A Lion Amongst the Cattle: Reconstruction and Resistance in the Northern Transvaal*. Johannesburg: Raven Press.

Diesing, P. (1991). *How Does Social Science WorK? Reflections on Practice*. Pittsburgh: Univ of Pittsburgh Press.

Dilley, M., and Heyman, B. N. (1965). ENSO and Disaster: Droughts, Floods and El Niño/Southern Oscillation Warm Events. *Disasters, 19*, 181-193.

Donaldson, C.H. (1967). The Immediate Effects of the 1964-66 Drought on the Vegetation of Specific Study Areas in the Vryburg district. *Proceedings of the Grassland Society of Southern Africa*. 2:137-141.

Drummond, J.H. (1990). *Rural land Use and Agricultural Production in Dinokana Village, Bophuthatswana*. GeoJournal 22:335-343.

Elliott, R.C. (1994). *Some nutritional factors influencing the productivity of beef cattle in Southern Rhodesia with particular reference to the effect of seasonal changes in the compositin of veld, the provision of nutritional supplements to veld grazin and observations on maintenance protein reuirements of tow breeds of African cattle.* Ph.D. Thesis, University of London.

ETA (Ecological Task Force) (1985). Bophuthatswana's Agricultural Resources; their Status and Problems and the Proposed Solutions. Mafikeng: Agricor

Evenari, M.I., et al., eds. (1986). *Ecosystems of the World: Hot Deserts and Arid Shrublands, B*. New York: Elsevier.

Festenstein, M. and C. Pickard-Cambridge (1987). *Land and Race: South Africa's group areas and land acts*. Johannesburg: South African Institute of Race Relations.

Fossett, M.A. and C.M. Cready (1998). Ecological Approaches in the Study of Racial and Ethnic Differentiation and Inequality In *Continuities in Sociological Human Ecology*. M. Micklin and D.L. Poston Jr., eds. New York: Plenum Press.

Fowler, F. J. (1993). *Survey research Methods (2nd Ed)*. Newbury Park, CA: Sage Publications.

Fratkin, E., et al. (1994). *African pastoralists systems: an integrated approach*. Boulder: Lynne Reinner.

Freeman, C.B. (1988). The Changing Impact of Drought on Rural Tswana Society. M.A Dissertation. Johannesburg: University of the Witswatersrand.

Glantz, M.H. (1994). Drought, desertification and food production. In *Drought follows the plow: cultivating marginal areas* (ed.) M.H. Glantz. Cambridge: University of Cambridge Press.

Glantz, M.H., R.W. Katz, and N. Nicholls, eds. (1991). *Teleconnections Linking Worldwide Climate Anomalies: Scientific Basis and Societal Impact*. Cambridge: Cambridge University Press.

Glantz, M.H., et al. eds. (1987). *The Societal Impacts Associated with the 1982-83 World-Wide Climate Anomaly*. Boulder: national Center for Atmospheric Research.

Glynn, P.W., ed. (1990). *Global ecological consequences of the 1982-83 El-Nino-Southern Oscillation*. New York: Elsevier.

Goodman, A.H., et al. (1988). Biocultural Perspectives on Stress in Prehistoric, Historical, and Contemporary Population Research. Yearbook of Physical Anthropology. 31(9): 169-202.

Handelman, H. (2000). *The Challenge of Third World Development*. Upper Saddle River, N.J: Prentice Hall.

Harris, D.R. (1980). Tropical Savanna Environments: Definition, Distribution, Diversity, and Development. In *Human Ecology in Savanna Environments* (ed.) D.R. Harris. London: Academic Press.

Harsch. (1992). Drought Devastates Southern Africa. *Drought Network News (Reprint from Africa Recovery, April 1992), 4*, 17-19.

Hugo, W.J. (1968). *The Small Stock Industry in South Africa.* Pretoria: South Africa Government Printer.

IDS (Institute of Development Studies) (1992). *Drought and Famine in southern Africa*. Proceedings of a conference held on 20 July 1992 at IDS, Sussex, UK.

IRI (International Research Institute for Climate Prediction) (1999). Internet site: http://iri.ucsd.edu/forecast/sup/index.html, accessed June 14, 2000.

Isichei, E. (1997). *A History of African Societies to 1870.* Cambridge: Cambridge Press.

Johnson, S.R. and M.T. Holt (1997). The Value of Weather Information. In *Economic Value of weather and Climate Forecsts*. R.W. Katz and A.H. Murphy, eds. Cambridge: Cambridge Univ Press.

Keay, R.W.J. (1959). *Vegetation Map of Africa South of the Tropic of Cancer.* London: Oxford University Press.

Kellerman, T.S., et al. (1988). *Plant Poisonings and Mycotoxicoses of Livestock in Southern Africa.* Capetown: Oxford University Press.

King,J.M. (1983). Livestock water needs in pastoral Africa in relation to climate and forage. *H.CA Res. Rep. No. 7.* International Livestock Center for Africa: Addis Ababa.

Klopper, E. (1999). The use of seasonal forecasts in South Africa during the 1997/98 rainfall season. *Water SA* **25**:3, 311 - 316.

Laing, M.V. (1992). Drought update 1991- 1992: South Africa. *Drought Network News* 4:15-16.

Landman, W. (1999). Users Of Seasonal Forecasts Workshop presentation. Armoedsvlakte, Vryburg, South Africa. October, 1999.

Leppan, H.D. and G.J. Bosman (1923). *Field Crops in South Africa.* Johannesburg: Central News Agency, Ltd.

Levin, R.and.D.Weiner. (1994). *Community perspectives on land and agrarian reform in South Africa*. Final project report prepared for John D. and Catherine T. MacArthur Foundation Chicago, Illinois (USA). Johannesburg: Univ of the Witswatersrand Press.

Lewis, W.A. (1955). *The Theory of Economic Growth*. London: George Allen & Unwin Ltd.

Lewis, W.A. (1978). *Growth and Fluctuations 1870 - 1913*. London: George Allen & Unwin Ltd.

Lindesay, J.A. (1986). *Relationships between the Southern Oscillation and atmospheric circulation changes over southern Africa, 1957-1982.* Ph.D. Thesis: University of the Witwatersrand.

Little, M. A., and Leslie, P. W. (1999). *Turkana Herders of the Dry Savanna: Ecology and biobehavioral response of nomads to an uncertain environment*. Oxford: Oxford Univ Press.

Little, M.A. (1995). Adaftation, Adaptability, and Mutlidisciplinary Research. In Biological Anthropology: The State of the Science. N.T. Boaz and L.D.Wolfe, eds. Bend, Or: International Institute for Human Evolutionary Research.

Little, M.A., et al. (1990). Ecosystem Approaches in Human Biology: Their History and a Case Study of the South Turkana Ecosystem Project. In *The Ecosystem Approach in Anthropology: From Concept to Practice.* Emilio Moran, ed. Ann Arbor: University of Michigan Press.

Little, M.A. (1982). The Development of Ideas on Human Ecology and Adaptation. In A History of American Physical Anthropology 1930-1980. F. Spenser, ed. New York: Academic Press. pp. 405-433.

Little, M.A. (1980). Designs for Human-Biological Research among Savanna Pastoralists. In *Human Ecology in Savanna Environments.* D. R. Harris, ed. London: Academic Press.

Lloyd, L. E., et al. (1978). *Fundamentals of Nutrition*. San Francisco: W.H. Freeman and Co.

Magubane, P. (1998). *Vanishing Cultures of South Africa: Changing customs in a changing world.* London: Struck.

Matsushima, J. K. (1979). *Feeding Beef Cattle*. New York: Springer-Verlag.

Maynard, L. A., et al. (Eds.). (1979). *Animal Nutrition*. New York: McGraw-Hill.

Meyers, T. C. (1999). *The Effect of Drought on Rangelands.* Paper presented at the Department of Agriculture Managers Meeting, Vryburg, South Africa.

Millin, S.G. (1953). *The People of South Africa.* London: Constable and Co.

Ministry of Agriculture (1997). *Drought Alert.* Web site: http://wn.apc.org/afwater/drought.htm. Accessed April 25, 1989.

Mungazi, D.A. (1998). *The Last Defenders of the Laager : Ian D. Smith and F.W. de Klerk.* Westport, Conn.: Praeger, 1998.

Partridge, T. C. (1997). Evolution of Landscapes. In R. M. Cowling, D. M. Richardson, & S. M. Pierce (Eds.), *Vegatation of Southern Africa* . Cambridge: University Press.

Peet, R. (1999). *Theories of Development*. New York: Guilford Press

Richerson, P. J., et al. (1996). *Principles of Human Ecology*. Needham Heights, MA: Simon and Schuster.

Riebsame, W.E. (1989). *Assessing the social implications of climate fluctuations: a guide to climate impact studies.* United Nations Environment Programme: Nairobi.

Roodt, J.J. (1988). Bophuthatswana's State Framing Projects: Is Failure Inevitable? In Cross, C. and R. Haines (eds), *Towards Freehold: Options for Land and Development in South Africa's Black Rural Areas*. Capetown: Junta.

Roubicek, C. B. (1969). Water Metabolism. In E. S. E. Hafey & I. A. Dyer (Eds.), *Animal Growth and Nutrition* (pp. 353-373). Philadelphia: Lea and Febiger.

RSA (Republic of South Africa) (1975). *Bophuthatswana*. Department of Information. Pretoria: Government Printer.

RSA (Republic of South Africa) (1972). *Population Census*. Department of Statistics. Pretoria: Government Printer.

Rutherford, M.C. and R.H. Westfall. (1994). *Biomes of Southern Africa: An Objective Categorization.* Cape Town: National Botanical Institute.

Rwelamira, J.K. (1997). *Background Paper on the Economic and Financial Implication of Drought to the State and to the Economy of South Africa*. Ministry of Agriculture, Pretoria South Africa.

SADA (South African Department of Agriculture)(1999a). *Climate Map of the North-West Province, South Africa*. Potchefstroom: GIS Unit.

SADA (South African Department of Agriculture)(1999b). *Topographic Map of the North-West Province, South Africa*. Potchefstroom: GIS Unit.

SADA (South African Department of Agriculture)(1999c). *Farm Boundaries Map of the North-West Province, South Africa*. Potchefstroom: GIS Unit.

SADA (South African Department of Agriculture)(1999d). *North-West Province Database*. Vryburg District Office.

SADA (South African Department of Agriculture)(1999e). *Grazing Capacity Map of the North-West Province, South Africa*. Potchefstroom: GIS Unit.

SADA (South African Department of Agriculture)(1999f). *Animal Production in North-West Province*. Vryburg District Office.

SADS (South African Department of Statistics) (1997, 2000). Agricultural, Economic, and Demographic Statistics. Pretoria.

Salzman, P. C. (Ed.). (1982). *Contemporary Nomadic and pastoral Peoples: Africa and Latin America*. Williamsburg, VA: College of William and Mary.

Schmidt, I. (1992). The Relationship Between Cattle and Savings, a Cattle Owner Perspective. *Development Southern Africa* 9: 433-434.

Schulze, R. E. (1997). Climate. In R. M. Cowling, D. M. Richardson, & S. M. Pierce (Eds.), *Vegetation of Southern Africa* . Cambridge: University Press.

Sheepers, J.C. (1982). The Present Status of Vegetation Conservation in South Africa. *Bothalis* **14**, 991-995.

Shellington, K. (1995). *History of Africa.* New York: St. Martin's Press.

Simbi, T. (1998). *Agricultural Policy in South Africa - A Discussion Document.* Ministry for Agriculture and Land Affairs, RSA. Pretoria: Government Printing Office.

Smith, A.B. (1992). *Pastoralism in Africa: Origins and Development Ecology.* London: Hurst and Company.

Stellaland Tourist Board. (1999). *Stellaland: North-West Province, South Africa.* Vryburg: Edson Clyde Press.

Taylor, P.L. (1999). "Qualitative Cowboy or Qualitative Dude: An Impasse of Validity, Politics, and Ethics? " *Sociological Inquiry* 69 (1):1-32.

Thomas, R.B. (2001). The Evolution of Human Adaptability Paradigms: Toward a Biology of Poverty. In Biocultural Synthesis: Building a New Political Economic Perspective on Human Ecology. Alan H. Goodman and Thomas L. Leatherman, eds. Ann Arbor: University of Michigan Press.

Thomas, R.B., et al. (1979). An Anthropological Approach to Human Ecology and Adaptive Dynamics. Yearbook of Physical Anthropology 22:1-46.

Thompson, L. M. (1995). *History of South Africa*. New Haven: Yale University Press.

Tyson, P.D. (1986). *Climatic Change and Variability in Southern Africa.* Cape Town: Oxford University Press.

Tyson, P.D. (1980). Temporal and spatial variation of rainfall anomalies in Africa south of latitude 22^0 during the period of meteorological record. *Climatic Change*, 2: 363-371.

Valentine, T.R. (1993). Drought, transfer Entitlements, and Income Distribution: The Botswana Experience. *World Development* 21:1 pp109-126.

Vogel, C.H. (1995). People and drought in south Africa: reaction and mitigation. In *People and Environment in Africa*. Tony Binns, ed. New York: Wiley and Sons.

Vogel, C. H. (1994). South Africa. In *Drought Follows the Plow* (ed.) M.H. Glantz. Cambridge: Cambridge University Press.

Vryburg Development Center. (1999). *Bophimira Agriculture Tours.* Vryburg: Edson Clyde Press.

Weiner, J.S. (1980). Commentary: Human Biology of Savanna Peoples. In *Human Ecology in Savanna Environments.* D. R. Harris, ed. London: Academic Press.

Werger, M.J.A. (1986). The Karoo and Southern Kalahari. In *Ecosystems of the World 12B: Hot Deserts and Arid Shrublands, B.* M. Evenari and I. Noy-Meir, eds. New York: Elsevier.

Wilson, W. and L Thompson (ed.) (1969). *The Oxford History of South Africa: South Africa to 1870*. New York: Oxford University Press.

Wright, P.B. (1977). The Southern Oscillation: patterns and mechanisms of the teleconnections and the persistence. *Report HIG-77-13 of Hawaii Institute of geophysics.* University of Hawaii Press.

APPENDICES

APPENDIX A

CLIMATE FORECAST AND LIVESTOCK QUESTIONNAIRE

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(1) (2) (3) *Date* ___________ *Participant Number* _________ *Interview Code #* ___________

(4) (5) (6) *Lat / Long:* ___________ *S* ___________ *E* *Waypoint* _________________

(7) *Village, Farm, or Other Id* ____

RESPONDENT INFORMATION (General Info)

Personal Information

(8) (9) Female ___ Male ___ Age _____

Population Group

(10) African ___ White ___ Other (specify)_____________

Language(s) You Speak (1= primary, 2= secondary, etc.)

(11) English ___ Afrikaans ____ Tswana ___ Other (specify) _________

Respondent Is Representative Of: (If category is not clear check all that apply and explain)

		Check		# People in Hh/Op
(12,13)	Individual or family small-scale operation (entrepreneur)	1)_____	(H)	______
	Co-op, small multi-family, or group operation	2)_____	(I)	______
	Communal	3)_____	(G)	______
	Larger or commercial operation	4)_____	(C)	______

Notes:

(14) **Please Describe the Organization of Your Livestock Operation**
Please specify history of production; land tenure or ownership system (kinship, friendship, community, group, etc),

RESPONDENT INFORMATION (General Info)

(15) **Who owns the land primarily used for <u>your</u> livestock?** ___________________

(16) **What is the primary use of <u>your</u> land?** ___________________

What is the total number of acres (all locations):

(17) grazed by your animals? ___________________ (ha or a)

(18) farmed for animal food? ___________________ (ha or a)

(19) used for other purposes ? ___________________ (ha or a)

(20) **How long has this livestock operation been producing livestock?** _________ yrs.

(21) **How long have you been with this operation?** _________ yrs.

(22) **What is your position, title, or relation to the livestock owner(s)?**___________________

(23) **What is your relationship to the former decision maker?** ______________________

(24) **Who will be the next decision maker for the operation?** __________________________

(25) **Please explain your livestock production goals:** (For short term <5 yrs and long term >10 yrs)

(26) **Other Income Sources:** (List amount earned and <u>specify all sources</u>)

Household Member #	*Total Income*	*From Livestock*	*From Crops*	*From Outside Jobs*	*From Social Security*	*From Pensions*	*From Other*
#1							
# 2							
# 3							
# 4							
# 5							
# 6							
# 7							
# 8							

(27) **What are your present stocking rates? How does that compare with ADC guidelines?**
Does the rate change seasonally?

(28) **What condition do you consider land(s) used by your (or other's) animals to be in?**
Please explain, and give max stocking rates, with pasture id or location.

(29) **Has the land condition changed?** *If so, how and over what time period? Which lands?*

(30) **Land Usage and Exchange**

In Acres ❑ or HA ❑	Unimproved Pasture (sfg)	Improved Pasture (sfg)	Irrigated Farmland	Unirrigated Farmland	Feedlot	Pan Area	Bad land	Other-Specify	Total
Amount of land now owned									
Land bought in the past year									
Money payed for buying land									
Land sold in the past year									
Money received on land sales									
Land rented from someone									
Money paid for land rental									
Land rented to someone else									
Money received on land rent									
Other land gain (litigation, etc.)									
Other land loss (tax, litigation, etc.)									
Use someone's land (non-rent)									
Someone uses your land (non-rent)									
Communal land used									
Other:									

Notes: For pastures indicate if savanna (S), forest (F) or grassland (G). For grassland, denote natural or planted.

(31) **Livestock: Current Numbers**

	Horses	*Cattle**	*Goats*	*Sheep*	*Pigs*	*Poultry*	*Other*
Total animals now owned							
Adult males							
Adult females (total #)							
Milking				n/a	n/a	n/a	
Non-Milking				n/a	n/a	n/a	
Immature males			n/a	n/a	n/a	n/a	
Immature females			n/a	n/a	n/a	n/a	
Yearlings			n/a	n/a	n/a	n/a	
Colts/ calves/ lambs/ kids							
Number of animals born in past 12 mo.							
Number of animals sold in past12 mo							
Money gotten from sale in past 12 mo							
Bought in the past 12 mo							
Cost of buying in the past 12 mo							
Slaughtered in the past 12 mo							
Lost in the past 12 mo (stolen, died, etc.)?							
Now on loan to someone else							
Loaned in past 12 mo							
Now borrowed from someone else							
Borrowed from someone in past 12 mo							
*Other peoples animals in your herd **							
*Your animals in someone else's herd **							

Note: get cattle breed and use back for herd(s) of multiple breeds

* Please explain on back (describe duration, how, when and why herds are mixed)

(32) **Do you seasonally move any livestock?** Yes___ No___

Animal Type	*Number*	*Season*	*Duration of stay*	*From Location*	*To Location*

Please explain if you pasture another person's livestock or if someone else pastures your livestock, etc.

(33) **Do you normally use supplemental feed or nutrients (not grown by you):** Yes____ No____

(34) (Horses, cattle, sheep, goats, etc; but exclude poultry and pigs)

Animal Type	*Feed Type*	*Quantity of Feed*	*Estimated Cost*	*Time Period*	*(Other)*

(35) **Do you use veterinary services?** Yes___ No___

If so, how often, what type, for which animals, and what do these services cost?

Agro-pastoral production

(36) **Do you grow food <u>mainly</u> for your own animals?** Yes_____ No_____

(37) **Do you <u>also</u> grow animal food for sale/ trade?** Yes_____ No_____

(38) **Do you grow food for human or other household use?** Yes_____ No_____
Please explain

(39) **Agro Production Amounts:**

Type (Grass, Oats Wheat, etc)	*Acarage (acres, ha)*	*Yield (per acre)*	*Grown For (Animal Type)*	*Irrigated (y/n)*	*Amount Used (own animals)*	*Used by (House hold)*	*Sold, Trade, etc*

Notes:

(40) **Do you use fertilizers or herbicides?**
If so, what types, where do use them, how often, when, how much do you use, and what is the cost to you.

(41)**Do you grow native species, special hybrid species, or readily available commercial species?**
Please list and explain: include seed, planting, and harvest costs, and where used.

(42) **Markets For Your Animals and Animal Products**
List your market locations (where they are, how far from your operation, how often and when you go there, what you sell and how much you usually get):

(43) **How do markets differ in drought and non-drought conditions?**
Please explain if there are differences in availability, quality, or prices of goods bought or sold, etc.

(44) **Water for animals and crops for animals comes <u>mainly</u> from:** _______________
(Ex: Borehole, Rainwater, Springs, Irrigation Canals, etc.)

(45) **Water availability is a problem:** Never___ Rarely___ Occasionally___ Often___ Usually____
(Explain and describe)

(46) **Water quality is a problem :** Never___ Rarely___ Occasionally___ Often___ Usually____
(Explain and describe)

OPERATIONAL INFORMATION - PRESENT (Water and Drought)

(47) **Do you pay for water?** Yes____ No____

Please explain (for animals and/or crops or household, to whom, how often, what time of year, quantity, cost, etc.)

(48) **Have you received anything for government drought relief programs?** Yes___ No ___

(49) *Please explain*

Year	*Received From*	*Money (R)*	*Other goods / Services*

(50) **What are current government programs or projects for drought?**

(51) **How has this changed, and over what time period?**

For example, has the funding for programs been increased or decreased; some programs dropped or new ones started?

(52) **When drought comes, are there early signs of its approach other than weather reports and forecasts? What are they?** *Please explain*

(53) **When was your last drought?** *(year or season)* ____________________

(54) **The last drought was:** Very severe ___ Severe ___ Moderate ___ Mild ____

(55) **During the <u>last</u> drought did you have enough forage or feed for your livestock?**
Please explain shortages or surpluses and what you did with them

(56) **What else did you do to cope with the <u>last</u> drought?**
Please include changes in management strategies, livestock relocation, herd size, etc.

(57) **When was the worst drought?** *(year or season)* ____________________

(58) **During the <u>worst</u> drought did you have enough forage or feed for your livestock?**
Please explain shortages or surpluses and what you did with them

(59) **What else did you do to cope with the <u>worst</u> drought?**
Please include changes in management strategies, livestock relocation, herd size, etc.

(60) **How long of a drought could you <u>now</u> cope with? How would you cope?**
A season? A year? , Two years? Please explain.

(61) **Would you get help from relatives, friends, or other non-government source?**
Please explain

(62) **How would you get capital or other resources to get through a drought?**
Please explain

Forecast Information

(63) **Do you now receive seasonal weather forecast information?** Yes___ No ____

(64) If so, what was the first year you ever received seasonal forecasts? __________________

(65) **If you don't receive weather forecast information, would you like to?** Yes___ No ____

(66) What would be your preferred source of forecast information? _____________________

If Seasonal Weather Forecasts are Obtained, they are Usually Obtained Through:

(67) (Include Village Meetings, Word of Mouth, Newspapers, AM- FM- SW Radio, TV, Internet, etc.)

Source Type (ex: newspaper)	*Name of Source*	*Language of Source*	*How often listen to, read, etc.*	*How often do you get forecast info from this source*	*Prefer to get forecast info from (priority 1,2,3, etc.)*

Notes:

(68) **Do you think that forecasts are generally accurate?** Yes___ No ___

Which source(s) do you consider most accurate:

(69) **How valuable are seasonal climate forecasts to you?**

(70) Not at all valuable_____ Somewhat valuable_____ Valuable_____ Very valuable_____

(71) **How far in advance <u>would you like</u> to have forecast information?** _______ mos / wks/ days

(72) **How far in advance <u>can you get</u> forecast information?** _______ mos / wks/ days

WEATHER AND FORECAST - PRESENT (Perceptions)

(73) **Is seasonal forecast information provided suited to your needs?** Yes ___ No___

Please explain (include what could be changed to better suit your needs):

(74) **Have you made decisions this year based upon seasonal climate forecasts?** Yes____ No ____

If yes, please explain

(75) **If you had received long term forecasts for drought early this year how would this affect your management decisions?** (For example, information used to decide when or what to plant, where and when to move animals, veterinary services, preparation for drought/ disaster, etc.)

(76) **Do you hear about government or other organizational forecast meetings?** (for example the Southern Africa Regional Climate Outlook Forum (SARCOF); National Meterological Service; Drought Monitoring Centre; or others)? *If so how often and please list.*

(77) If so, what kind of information did you get? _______________

(78) Did they provide information you can use? Yes ___ No___

(79) Have you ever <u>used</u> information from them? Yes ___ No___

(80) When did you use that information? _______________

(81) How did you use that information?

OPERATIONAL INFORMATION - El Niño 1997-1998

(Note: This El Niño event may have impacted normal seasonal rains from September to May by increasing drought, increasing rainfall, or having a negligible effect. For this questionnaire, the terms *before, during and after El Niño* are used to describe various aspects of the livestock sector before, after, and during effects of El Niño as you perceived them)
(before El Niño is the time before normal Nov rains start, after El Niño is the time after normal May rains end)

(82) **Was the weather of the 1997 - 1998 wet season 'normal' ?** Yes ___ No ___
If not, how was it different?

How severe was the El Niño event of 1997-1998?

(83) For You: Very Severe ___ Severe ___ Moderately Severe ___ No effect ___

(84) For other people in your area: Very Severe ___ Severe ___ Moderately Severe ___ No effect ___

(85) For all of South Africa: Very Severe ___ Severe ___ Moderately Severe ___ No effect ___

(Please Explain if necessary)

(86) **Did you get climate forecast information for this El Niño?**
If so, from where and how far in advance?

(87) **Did you change your animal production before, during or after the 1997-1998 El Niño?** Yes___ No___
Please explain (herd size, species, composition, location, feed, etc):

OPERATIONAL INFORMATION - El Niño 1997-1998

(88) **Did you change your crop production <u>before, during or after</u> the 1997-1998 El Niño?** Yes___
No___

Please explain (Type grown, amount, planting/ harvesting time, etc)

(89) **What was El Niño's greatest affect on your operation?**

For example: culling herd, cost of supplemental feed, animal loss, etc.

(90)**Please describe any <u>other</u> changes in livestock or crop management practices due to this El Niño.**

(91) **Were there any <u>other</u> droughts caused by El Niño? If so what year (s) .** _______________

(92) **How severe were the El Niño related droughts?** _________.

(93) **What else did you do to cope with these droughts?**

Please include changes in management strategies, livestock relocation, herd size, etc.

*** End of Survey ***