Assessment of veld utilisation practices and veld condition in the Little Karoo

Clement F. Cupido

Thesis presented in partial fulfillment of the requirements for the degree of Masters of Science (Agriculture), Department of Conservation Ecology at the University of Stellenbosch.

Project Supervisor: Prof. S. J. Milton

Co-Supervisor: Ms. N. Visser

April 2005

Declaration

I, the undersigned, hereby declare that the work contained in the thesis is my own original work and that I have not previously in its entirety or in part submitted it at any university for a degree

Signature: ………………………………………   **Date: ………………….**

Thesis summary

The veld condition in the Little Karoo is in various states of degradation and grazing by domestic livestock is considered as the major anthropogenic force that changed the landscape. This region with its extremely rich plant species diversity and endemics, has supported small livestock for at least 2 000 years, and since colonization (250 years ago) been intensively used for the production of a variety of livestock. Ostrich production developed as the major source of income for this region.

The first part of this study investigates the current veld management practices employed by livestock farmers in the Little Karoo region. Recommended veld management practices considered in this study are grazing rotation, moderate stocking rate control, moderate veld utilisation, separation of ecotopes, veld rehabilitation, controlling declared weeds and alien vegetation and regular assessment of veld condition. One hundred randomly selected farmers were personally interviewed by means of a structured questionnaire. Questions were grouped into the following categories: (a) demography of farmers, (b) ostrich farming, (c) perceptions and knowledge of farmers on farming practices, (d) grazing rotation, (e) stocking rate, (f) veld utilisation and veld assessment, (g) separation of ecotopes, (h) veld rehabilitation, (i) control of alien vegetation and (j) farmers' knowledge on legislation. This was used to obtain information on the Little Karoo farming community, sizes of farms and camps, types of farming enterprises and on adoption of recommended veld management practices in the region. The main findings from this section are that relatively small farming units with few camps, poor separation of ecotopes and a low estimated grazing capacity, limit extensive livestock farming within the region. Perceptions of farmers on veld condition, grazing rotation, stocking rate, separation of ecotopes are fairly optimistic. As a result grazing capacities are overestimated and overstocking occurs within this region. The current stocking rate in ostrich camps (67.7% overstocked) and mammalian livestock camps (55.1% overstocked) is evidence that farmers overstock to compensate for these limiting factors in order to make a living from the land. The majority of farmers are well aware of the Articles in the Conservation of Agricultural Resources Act of 1983, which are applicable to veld management. Only more that 50% comply with this legislation by rehabilitating veld and 80% of them control invasive alien species on their farm.

In the second part, veld assessments were done in randomly selected veld camps, using the multi-criterion, semi-subjective Quick Rangeland Health Assessment (QRHA) Method. Veld condition was significantly poorer closer to water or feeding points due to the piosphere effect caused by livestock. Veld condition in the Little Karoo can be related to altitude, vegetation types and land use. Therefore, the low-lying Little Succulent Karoo vegetation type is in a poorer condition compared to Spekboom Succulent Thicket and South and South-west Coast Renosterveld. Ostrich production on plains in the Little Succulent Karoo vegetation type is the main cause for the degradation of this vegetation type. It would seem as if historically high stocking rates cannot be ignored in explaining the current veld condition. A positive correlation between veld condition and the diversity of plant species (species density) were found, which highlights the importance of good veld management practices in sustainable agriculture.

The third part tested whether all indicators in the QRHA method are equally sensitive and whether there is a positive correlation between the QRHA method and the Grazing Index Method. A significant positive linear correlation was found between the two methods. Cover was the least sensitive indicator of rangeland condition, and livestock induced disturbances (which include the indicators grazing intensity, disturbance indicators, soil health and species richness) were the most sensitive for Karoo veld assessment. A major benefit of the QRHA method is heuristic; therefore this method may have value in agricultural extension work.

Tesisopsomming

Die veldtoestandveldtoestand in die Klein Karoo is in verskeie stadia van agteruitgang. Oorbeweiding deur vee word as dié belangrikste faktor beskou wat verandering in hierdie landskap teweeg gebring het. Die Klein Karoo plantegroei wat oorvloediglik ryk is aan plantspesies, waarvan 'n groot persentasie endemies is, onderhou kleinvee vir die afgelope 2 000 jaar. Na kolonisasie (250 jaar gelede) is hierdie area intensief benut om 'n verskeidenheid van vee te produseer. Die volstruisbedryf het egter as dié belangrikste bron van inkomste in die streek gegroei.

Die eerste deel van hierdie studie ondersoek die huidige veldbestuurspraktyke van veeboere in die streek. Aanbevole veldbestuurspraktyke sluit in 'n goeie beweidingstelsel, matige veebelading en veldbenutting, skeiding van veldsoorte, veld rehabilitasie, beheer van indingerplante en gereelde assessering van die veldtoestand. Een honderd veeboere in die Klein Karoo is ewekansig geselekteer en besoek. 'n Vraelys met vrae wat gegroepeer is in die kategorieë (a) demografiese inligting (b) volstruisboerdery, (c) persepsies en kennis van boere i.v.m. veldbestuurspraktyke, (d) beweidingstelsels, (e) veebelading, (f) veldbenutting en veldassessering, (g) skeiding van veldsoorte, (h) veld rehabilitasie (i) beheer van indringerplante en (j) boere se kennis van wetgewing, is gebruik om data in te samel. Hierdie data is gebruik om inligting te bekom i.v.m. die Klein Karoo boere, grootte van plase en kampe, tipe boerderye en die toepassing van toepaslike veldbestuurspraktyke. Die belangrikste bevinding uit hierdie data is dat die relatief klein plaaseenhede met min kampe, swak veldskeiding en 'n lae weidingskapasiteit veeboerdery in die streek kortwiek. Die persepsies van veeboere oor hul veldtoestand, weidingsrotasie, veebelading en skeiding van veldsoorte, is relatief optimisties wat tot gevolg het dat die weikapasiteit oorskat word en oorbeweiding plaasvind. Die huidige veebelading in volstruiskampe (67.7% oorbelaai) en groot- en kleinveekampe (55.1% oorbelaai) dui daarop dat veeboere kompenseer vir die beperkende faktore om 'n bestaan op hul plase te voer. Meeste van die veeboere dra kennis van die Artikels in die Wet op die Bewaring van Landbouhulpbronne (1983) wat van toepassing is op goeie veldbestuurspraktyke. Slegs sowat 50% van veeboere kom hierdie wetgewing na deur versteurde veld te rehabiliteer en sowat 80% bestry indringerplante op hul plase.

In die tweede deel van hierdie tesis is die veldtoestand in ewekansig gekose veldkampe bepaal deur gebruik te maak van ‘n multi-kriteria, semi-subjektiewe veldassesseringsmetode. Veldtoestand was beduidend swakker in opnames nader aan die water- of voerpunt as verder weg a.g.v. vertrapping en beweiding deur vee. Veldtoestand in die Klein Karoo hang tot ‘n groot mate af van die tipe vee, hoogte bo seevlak en die veldtipe. Om die rede is die laagliggende Klein Sukkelente Karooveld, waar die meeste volstruise gevind word, se veldtoestand beduidend swakker as die van Spekboom Sukkulente Karooveld en Suid- en suidweskus Renosterveld. Vrytropparing met volstruise op Klein Sukkulente Karooveld is verantwoordelik vir die swak toestand van hierdie veldtipe, maar historiese baie hoër beladings met volstuise kan nie buite rekening gelaat word nie. ‘n Belangrike uitkoms uit hierdie deel van die studie is die positiewe korrelasie tussen veldtoestand en plantspesierykheid. Hierdie bevinding wys op die belangrikheid van goeie veldbestuurpraktyke vir hierdie gebied met ‘n besondere verskeidenheid van plante.

In die derde deel van die studie is daar vasgestel dat daar ‘n beduidende positiewe korrelasie is tussen die multi-kriteria, semi-subjektiewe veldassesseringsmetode en die objektiewe Weidingsindeksmetode is. Daar is ook vasgestel dat veldbedekking die swakste indikator is vir veldtoestand in die Klein Karoo. Versteuringsindikators, wat die indikators beweidingsintensiteit, plantversteuringsindikators, grondtoestand en spesierykheid insluit, is die mees sensitiewe om veldtoestand in hierdie streek te bepaal. Hierdie semi-subjektiewe metode van veldassessering kan met vrug aangewend word deur landboukundige voorligtingsbeamptes en veeboere.

Acknowledgements

I extend my sincere gratitude to the following:

To Him who equipped me with the abilities to successfully complete this study. This thesis is testimony to what is written in *Phillipians 4:13*. All the Glory to God!

My supervisor, Sue Milton, for sharing her extensive knowledge and for guiding me during the course of this project. It was an honour being supervised by an ‘academic celebrity’. Also to my co-supervisor, Nelmarie Visser, for her open-door policy and unselfish support and guidance. Thank you also for mentoring me during the course of the Young Professional Programme (YPP).

To the Department of Agriculture: Western Cape for financing this study and providing logistic support. Also to the South African Ostrich Business Chamber for financial support. To all at the Institute for Plant Production who offered support, especially to Anelda Van Huysteen, Annelene Swanepoel and Miskha Abrahams (YPP) for taking care of administrative matters during the course of the project.

To Professor Nel at the Centre for Statistical Consultation for his assistance with the statistical analysis. In the same regard, also to Zuhayr Kafaar and Ashia Petersen for unselfishly sharing their knowledge.

To the farmers of the Little Karoo for their time and allowing me to work on their farms.

To my fellow students and friends at the Department of Conservation Ecology and also to Ben August, Clyde Lambert, Bernadette (Witbooi) Abrahams, Helena Faasen, Willem Williams, Frankie and Mudley for keeping my spirit up during difficult times.

To my wife, Althea, for her love, support and sacrifices during this period. Also to my kids Melissa and Clint, my parents and sisters - a big thanks to all of for your patience and belief in me.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF PLATES

LIST OF APPENDICES

CHAPTER 1 GENERAL INTRODUCTION

1.1 Background and motivation for the research

Rangelands (veld) occupy between 18% and 23% of the world's land area and provide fodder for about 360 million cattle and over 600 million sheep and goat, which account for 9% of the world's beef and 30% of the sheep and goat meat (Blench and Sommer, 1999). The degradation of arid and semi-arid rangelands is recognised by the United Nations Conference on Desertification as a worldwide reality (UNCCD, 1995). Ninety percent of Africa's surface is considered arid, semi-arid or dry-humid (UNCCD, 1995); therefore the natural capital and ecological services rangelands have to offer to developing countries should not be underestimated. According to Hoffman and Ashwell (2001) more than 80% of South Africa's land surface is considered grazing land or natural veld and is used for agricultural purposes. Significant vegetation change has occurred on the southern African continent since it was colonized and large areas of rangelands have become less productive than they were in the past (Roux and Vorster, 1983; Dean and Macdonald, 1994; Dean *et al*., 1995). It is generally assumed that poor livestock management is responsible for this observed deterioration in rangeland condition or health (Acocks, 1938; Roux and Vorster, 1983; Milton *et al*., 1994; Milton and Hoffman, 1994; Hoffman and Ashwell, 2001; Archer, 2004). An overall decline of livestock numbers in the 1900's possibly reflects a decline in the carrying capacity (De Klerk, 1986; Downing, 1978). A similar trend of decline in livestock numbers in the previous century was experienced in neighbouring countries (Lange *et al*., 1997). South Africa is signatory of various international conventions such as the United Nations Convention to Combat Desertification and the Convention on Biodiversity and therefore committed to combat land degradation and conserve biodiversity.

The Succulent Karoo biome is of international importance and is recognised as one of 25 biodiversity hotspots in the world. A biodiversity hotspot is an area, which is extraordinary rich in biodiversity, containing more than 0.5% of the world's endemic plants and had more than 70% of their original areas transformed (Myers *et al*., 2000). According to the State of the Environment Overview Report (2004) only 3.5% of this biome is formally conserved, therefore this high species richness and unique global status of the biome require urgent conservation attention. The Critical Ecosystem Partnership Fund (CEPF) considers the

Central Little Karoo a priority area in terms of conservation (Anonymous, 2003). Within the Central Little Karoo alone there are more than 1 325 species, which include 182 endemics of especially Mesembryanthemacea, bulbs and other succulents with extremely small ranges of less than 50 km^2 (Anonymous, 2003). Approximately 90% of the Succulent Karoo biome is stocked with sheep, goats, ostriches and game and signs of overgrazing is evident (Anonymous, 2003). To conserve the major ecological processes and further loss of biodiversity, several bioregional programmes were launched. The Succulent Karoo Ecosystem Plan (SKEP) was launched in the area in 2002, which identified the Little Karoo as one of nine geographic priority areas in the Succulent Karoo biome (Frazee *et al*., 2003). Also, the Cape Action Plan for the Environment (CAPE) identified the need to establish the Gouritz-Little Karoo Mega Reserve as one of three priority mega-reserves (Cowling *et al*., 1999). Furthermore, the Subtropical Thicket Ecosystem Plan (STEP) was launched which identified the need to establish the Gouritz-Little Karoo Mega-conservancy network (Anonymous, 2005).

The Little Karoo as a livestock-producing region is world renowned for the production of ostriches (*Struthio camelus*). Ostrich farming as a new agricultural practice has started in the Little Karoo between the years 1857 and 1864 (Talbot, 1961; Smith, 1964; Nel, 1995). In the industry's early development Wallace (1896) predicted that '*the profit per bird will be greatest when ostriches do not exceed a certain, and not an excessive, proportion of the stock upon a farm*'. The industry however boomed and the region quickly developed into the ostrich capital of the world with mammalian livestock production providing only additional income to the farmers in the region. The 'golden era' of 1863 to 1913 saw the rise in the ostrich industry with ostrich feathers becoming the fourth most important export product of South Africa. The industry crashed during the period of the two World Wars and recovered again when ostrich leather and biltong (dried meat) replaced feathers, as the most important marketable products of the industry in the early 1970's (Nel, 1995). Up until 1973 breeding birds were kept in small breeding camps with one male and one female to improve genetic selection for high quality feathers (personal communication Kobus Nel, 2004). The demand for feathers became less important after this era and ostrich leather and the demand for low cholesterol meat became more important. From 1973 until the late 1980's the industry relied more on the production of slaughter and free-range birds, which were kept in natural veld camps. Due to the high density of ostriches on veld, visible degradation became evident and forced *Bodembewaring* (the Soil Conservation division of the Department of Agriculture) in 1988 to put pressure on the ostrich industry to remove all ostriches from the veld for a period of three years. In the end only slaughter birds was removed from veld and kept in feeding lots (personal communication Kobus Nel, 2004). In recent years ostrich farming has been blamed for the severe degradation of vegetation and soils in the region (Department of Agriculture: Directorate Resource Conservation, 1992; Hoffman, 1996; Van Eeden, 1996; Western Cape Nature Conservation Board, 2001). Increased public awareness locally and internationally about the impact of domesticated ostriches on natural veld has focused attention on an area that has not been involved in any comprehensive research programme.

The unique political development in South Africa gave rise to a dual agricultural economy in the rural areas that was split between a subsistence-oriented sector and a well-developed commercial sector. Today about 90% of hotspots in southern Africa are in the hands of commercial farmers or communal farmers (Cowling and Hilton-Taylor, 1994). Grazing management systems aim to optimize livestock production while conserving or improving veld condition. This implies that soil, water and botanical resources are used in an efficient and sustainable way. In order to improve the veld and to maintain this improved condition, it is necessary to control the impacts of grazing animals, and sometimes the habits of man (Edwards, 1972). The increasing demands for food production and increasing financial pressures negatively affect the farmer's ability to apply veld management recommendations (De Klerk, 1986). It is therefore necessary to firstly develop a detailed understanding of the impact that grazing/browsing have on vegetation and soils. Secondly, it is important to understand the socio-economic factors, which influence farmers' decision-making in terms of veld management in order to ensure the maintenance and conservation of the biodiversity within the Little Karoo.

In the past, research involving ostriches was focused mainly on breeding and feeding. Little research was also done on the impacts of mammalian livestock on the veld in this region. It is therefore essential that this study had to be conducted in order to get an understanding of the current veld management practices within the region. Also, the allegations against the ostrich industry of the degradation of natural veld in the Little Karoo have never been tested before. This study will therefore form a sound base for further research. As a result of the study the ostrich industry should be able to (i) initiate further research if specific needs are identified and (ii) advise their producers on improved sustainable rangeland management practices.

1.2 Objectives

1.2.1 Project Aims

1. To produce a literature review on: The effects of livestock production on vegetation and soil in the Little Karoo,
2. To determine current veld management practices for livestock, in particular ostrich farming, in the Little Karoo,
3. To determine the veld condition in the Little Karoo region through veld assessments within camps using the Quick Rangeland Health Assessment method of Milton and Dean (1996),
4. To determine whether there is a correlation between the above-mentioned method and more conventional assessment methods, and
5. To determine which environmental factor or veld management practice has the greatest effect on the deterioration of veld condition within the region.

1.2.2 Targeted outcomes

- To advise ostrich and mammalian livestock producers in terms of better veld management practices.
- To identify research needs in order to initiate further research with specific questions regarding veld management practices in the mammalian livestock and ostrich industry.

1.3 Thesis structure

Chapter 2 reviews the literature on the effects of livestock production on vegetation and soil in the Little Karoo. Chapter 3 provides information on the study area in terms of topography and soils, rainfall, vegetation, agricultural regions and the socio-economics of the region.

In Chapter 4 the results from data that was collected by means of personal interviews, using a questionnaire, are discussed. This chapter provides background information on the demography of the Little Karoo farming community (age structure, farming experience and education level), sizes of farms and camps, types of farming enterprises and on adoption of recommended veld management practices in the region. This chapter mostly provides results from descriptive statistics and will give the reader an understanding of the current veld management practices that are used by livestock farmers within the region. Information on the farming community and their management practices and motives can be used in developing future agricultural policies or improve training, management and service provision within the region.

In Chapter 5 the results from data that was collected by assessing the veld condition in camps on farms within the sample is discussed. The objectives of this part of the research are to link the socio-economic and management findings (from Chapter 4) with rangeland condition to achieve a predictive understanding on which management practices mainly drive changes in veld condition. Furthermore, the veld condition scores were used to determine which variables are mainly responsible for the poor veld condition that is found in the region.

In Chapter 6 the Quick Rangeland Health Assessment method, which was used to determine the veld condition on each farm, is compared with a more conventional method of veld assessment to see if there is any correlation between the two methods. This would indicate whether the Quick Rangeland Health Assessment method (Milton and Dean, 1996) could be used as a veld condition assessment tool. Furthermore, the different effects small stock, large stock and ostriches have on the various veld condition indicators used, is discussed.

Chapter 7 summarizes the findings of the study and recommendations are made on priority needs for future research and on the sustainability of veld management practices used by ostrich and mammalian livestock producers within the Little Karoo region.

1.4 References

Acocks, J. P. H. 1938. The vermeerbos problem in Griqualand West – a preliminary survey. Pages 76-85 in Pasture Research Progress Report 1, Department of Agriculture and Forestry, Pretoria.

Anonymous. 2003. The Succulent Karoo Hotspot: Namibia and South Africa, Final Version. February 12, 2003. Critical Ecosystem Partnership Fund.

Anonymous. 2005. SKEP: Subtropical Thicket Ecosystem Planning. http://cpu.uwc.ac.za/step.htm. Accessed 09/03/2005.

Archer, E. R. M. 2004. Beyond the "climate versus grazing" impasse: using remote sensing to investigate the effects of grazing system choice on vegetation cover in the eastern Karoo. *Journal of Arid Environments*, **57**:381-408.

Blench, R. and Sommer, F. 1999. Understanding rangeland biodiversity. Working Paper 121. London.

Cowling, R. M. and Hilton-Taylor, C. 1994. Patterns of plant diversity and endemism in southern Africa: an overview. *Strelitzia*, **1**:31-52.

Cowling R. M., Pressey R. L., Lombard A. T., Heijnis, C. E., Richardson, D. M and Cole, N. 1999. Framework for a Conservation Plan for the Cape Floristic Region (IPC Report 9902). Institute for Plant Conservation, University of Cape Town.

Dean, W. R. J. and Macdonald, I. A. W. 1994. Historical changes in stocking rates of domestic livestock as a measure of semi-arid and arid rangeland degradation in the Cape Province, South Africa. *Journal of Arid Environments*, **26**:281-298.

Dean, W. R. J., Hoffman, M. T., Meadows, M. E. and Milton, S. J. 1995. Desertification in the semi-arid Karoo, South Africa: review and reassessment. *Journal of Arid Environments*, **30**:247-264.

De Klerk, C. H. 1986. *'n Ondersoek na faktore wat wat in die weg staan van aanvaarding van aanbevole veldbeheerpraktyke.* Departement van Landbou en Watervoorsiening, Pretoria.

Department of Agriculture: Directorate Resource Conservation, 1992. Official letter to land owners, 23/03/1992. Reference number: 10/2/5-ST/7.

Downing, B. H. 1978. Environmental consequences of agricultural expansion in South Africa since 1850. *South African Journal of Science*, **74**:420-422.

Edwards, P. J. 1972. *A system of Veld Classification and Management Planning.* Department of Agricultural Technical Services, Technical Communication No. 102.

Frazee, S. R, Cowling, R. M., Pressey, R. L., Turpie, J. K. and Lindenberg, N. 2003. Estimating the costs of conserving a biodiversity hotspot: a case-study of the Cape Floristic Region, South Africa. *Biological Conservation*, **112**: 275-290.

Hoffman, T. 1996. Little Succulent Karoo. Page 61 in Low, A. B. and Rebelo, A. G. (eds.). *Vegetation of South Africa, Lesotho and Swaziland*. Department of Environmental Affairs and Tourism, Pretoria.

Hoffman, M. T. and Ashwell, A. 2001. *Nature Divided – land degradation in South Africa*. University of Cape Town Press, Cape Town.

Lange, G., Barnes, J. I. and Motinga, D. J. 1997. *Cattle numbers, biomass, productivity, and land degradation in the commercial farming sector of Namibia, 1915 to 1995.* Research Discussion Paper. No. 17, Ministry of Environmental Affairs and Tourism, Windhoek.

Milton, S. J. and Dean, W. R. J. 1996. *Karoo Veld: ecology and management*. ARC-Range and Forage Institute, Lynn East, South Africa.

Milton, S. J. and Hoffmann, M. T. 1994. The application of state-and-transition models to rangeland research in arid succulent and semi-arid grassy Karoo, South Africa. *African Journal of Range and Forage Science*, **11**:18-26.

Milton, S. J., Dean, W. R. J., du Plessis, M. A. and Siegfried, W. R. 1994. A conceptual model of arid rangeland degradation: the escalating cost of declining productivity. *BioScience*, **44**:70-76.

Myers, N., Mittermeier, R. A., Mittermeier, C. G., da Fonseca, G. A. B. and Kent, J. 2000. Biodiversity hotspots for conservation priorities. *Nature*, **403**:852-855.

Nel, C. J. 1995. *Volstruisboerderystelsels.* Pages 6-8 in Anonymous (ed.). *Riglyne vir suksesvolle volstruisboerdery*. Klein Karoo Landbou-ontwikkelingsentrum, Oudtshoorn.

Roux, P. W. and Vorster, M. 1983. Vegetation changes in the Karoo. *Proceedings of the Grassland Society of Southern Africa*, **18**:25-29.

Smith, D. J. 1964. *Volstruisboerdery in die Klein Karoo*. Pamflet No. 358. Departement van Landbou Tegniese Dienste, Staatsdrukkers, Pretoria.

State of the Environment Overview Report. 2004. Department of Environmental Affairs and Development Planning, Report No. 329585/1.

Talbot, W. J. 1961. Land utilisation in the arid regions of southern Africa. Part 1: South Africa. Pages 299-338 in Stamp, L. D. (ed.). *A History of Land Use in Arid Regions. Arid Zone research*, Vol. 17. UNESCO, Paris.

UNCCD. 1995. United Nations Convention to Combat Desertification in Those Countries Experiencing Serious Drought and/or Desertification Particularly in Africa. *United Nations Environment Programme.* Geneva.

Van Eeden, F. 1996. Waak teen veldagteruitgang. *Landbouweekblad*, April, 19. pp. 36-38.

Wallace, R. 1896. *Farming industries of Cape Colony.* P. S. King and Son, London.

Western Cape Nature Conservation Board, 2001. Official letter to South African Ostrich Business Chamber 04/12/2001.

Personal communication:

Kobus Nel, 2004. Department of Agriculture: Western Cape, Klein Karoo Agricultural Development Centre, Oudtshoorn.

CHAPTER 2 LITERATURE REVIEW: THE EFFECTS OF LIVESTOCK PRODUCTION ON VEGETATION AND SOIL IN THE LITTLE KAROO

2.1 Introduction

The degradation of arid and semi-arid rangelands is a worldwide phenomenon (UNCCD, 1995). The White Paper on Agricultural Policy of 1984 made reference of the alarming deterioration of the South African natural rangelands (Du Toit *et al.,* 1991). These rangelands have for centuries been used for grazing purposes by domestic livestock. The vegetation of the Little Karoo is quite diverse and includes Mountain Fynbos, Central Mountain Renosterveld, South and South-west Renosterveld, Afromontane Forest, Grassy Fynbos, Spekboom Succulent Thicket, and Little Succulent Karoo and can therefore sustain a variety of livestock such as sheep, goats, cattle, ostriches and game. Downing (1978) considers grazing by domestic livestock as the major anthropogenic force that led to the degradation of semi-arid and arid rangelands in southern Africa. The Succulent Karoo biome is extremely rich in plant species with 4 849 species of which 1 954 (40.3%) are endemic (Cowling and Hilton-Taylor, 1999). The region is therefore of international importance as it is considered to be one of the 25 biological hotspots in the world (Myers *et al.,* 2000). Degradation of this biome in particular is of great concern for both ecologist and agriculturalists.

It is commonly accepted that a significant vegetation change has occurred on the southern African continent since it was colonized and that large areas of rangelands have become less productive than they were in the past (Roux and Vorster, 1983; Dean and Macdonald, 1994; Dean *et al.,* 1995). In the Little Karoo, the magisterial commercial farming districts of Oudtshoorn and Calitzdorp are considered as the most degraded areas in the Western Cape (Hoffman and Ashwell, 2001; State of the Environment Overview Report, 2004).

This literature review is a summary of literature that was published on the effects livestock production has on the vegetation and soil of the rangelands of the Little Karoo and semi-arid or arid rangelands.

2.2 Historical overview on livestock production in the Little Karoo

2.2.1 Pre-colonial era

The first agricultural people that appeared in southern Africa about 2 000 years ago brought with them domestic animals (Smith, 1999). The Khoi and San, who were the early inhabitants of the southern tip of Africa, were herders and hunters and did not have much interest in cultivating the land or probably did not have the necessary skills to do so. Therefore, before colonization, the veld was mainly used for grazing purposes by their large flocks of fat tailed sheep and herds of long horned cattle (Pollock, 1974). According to Hoffman (1997) there is little archeological evidence to suggest that the 1 500 years of Khoi pastoralism resulted in environmental degradation or that the colonists inherited a wasteland. The bow and arrow and the use of fire were the only tools available for major modification of the landscape (Downing, 1978). The blue antelope (*Hippotragus leucophaeus*) was probably the only animal under pressure from the domestic livestock of the Khoi that was introduced as early as 400 AD (Ledger, 1997). However, Sampson (1986) suggests that the pre-colonial occupants of the Karoo, caused soil erosion and localized changes to the plant communities through the repeated use of their campsites. Roux and Theron (1987) regard it an indisputable fact that vegetation in the Karoo biome has changed significantly since colonization and Hoffman and Cowling (1990) suggests that European pastoralism may have been responsible for the expanding of the Karoo over the last 200 year period.

Nomadic hunters and pastoral people used the succulent Karoo during the winter in the form of a transhumance (Penn, 1986 in Milton, *et. al.* 1997) because of the dependence on surface water and in seeking pasture for their domestic herds.

2.2.1 Post-colonial era

After colonisation the first 'trekboere' used the kind of transhumance used by the native people. They kept hundreds of cattle, thousands of sheep, horses and other livestock such as goats on farms of approximately 6 000 ha in area (Shearing and Van Heerden, 1994). Large herds of wild ungulates especially springbok migrated over the Karoo prior to 1850 (Skead, 1980), which would indicate that the region was quite a productive grazing region for game before colonization.

The period between 1850 and 1950 has seen the shift of food dependence by the majority of South Africans from hunting, primitive food gathering and simple pastoralism to technologically advanced intensive agriculture (Downing, 1978). Modern technologies, in particular the sinking of boreholes in the late nineteenth century, enabled farmers to settle in areas that were previously considered economically unproductive for farming purposes (Talbot, 1961; Archer, 2002). From 1912, legislation in the form of the Fencing Act required farmers to fence their properties, and from 1922 an amendment to this act required farmers to make their fences vermin proof (Talbot, 1961). This marked the beginning of rotational grazing systems in the Karoo (Dean *et al.*, 1995). The Drought Investigation Commission of 1923 indicated that the carrying capacity of veld could be increased by the subdivision of the veld into camps. In the end stock numbers were increased with dire consequences (Roux and Opperman, 1986).

According to Nel (1995) the ostrich industry began in 1863 when farmers in the Little Karoo first switched to farming with tame ostriches. This industry grew extremely well, especially with the large demand for ostrich feathers in the early 1900's when this commodity was South Africa's fourth most important export product. During the World Wars the industry collapsed, but it has grown exponentially since the mid 1980's due to the demand of meat and ostrich leather products (Hoffman *et al*., 1999). Even though ostrich farming is now found in almost all the regions of the country, the Little Karoo is still the focal point of the industry.

2.3 The impact of livestock on natural veld

2.3.1 Plant populations and composition

Roux and Theron (1987) regard the introduction of domestic livestock as the main cause of vegetation change in the Karoo biome. These changes in vegetation can be due to the replacement of wild animals, subject to natural controls, by domestic animals not subjected to these controls (Acocks, 1955). Du Toit (1996) found that sheep would very seldom graze less palatable species with stems thicker than 2 mm while palatable species are frequently grazed in excess of 2 mm. During this study it was observed that the stems of palatable species like *Limeum aethiopicum* and *Salsola calluna* were grazed up to 5 mm in thickness. This would indicate that palatable species are very much under pressure from grazing and will be the first species to be removed under heavy stocking rates. In the end entire populations of palatable plants are removed from rangelands.

Allsopp (1999) recorded that a diverse shrubland community can easily be replaced by a single unpalatable species, such as *Galenia africana*, when overgrazed. This particular species is usually a sign of natural or unnatural disturbance, but is not always considered a bad sign as it acts as a pioneer species. Such unpalatable and even poisonous plants have the tendency to increase when veld is continuously overstocked (Vahrmeijer, 1981). Overstocking of domestic animals has reduced the palatable plant populations in some parts of the Succulent Karoo Biome to such an extent that vegetation condition cannot easily be restored by resting (Milton *et al.*, 1997).

2.3.2 Reproduction

The ability of a rangeland to recuperate depends mainly on the level of grazing intensity and the variation in rainfall (Mworia *et al.*, 1997). Grazing and browsing by sheep has been shown to reduce the reproductivity of very palatable species such as *Tripteris sinuata* (Milton, 1992; Todd, 1999). Milton and Dean (1988) has shown that highly palatable species like *Rhigozum obovatum* tends to be much smaller and produces fewer flowers and fruit in grazing land than in road reserves where it has not been grazed at all. Overstocking with sheep can also reduce the ability of palatable species, like *Pentzia incana*, to increase through vegetative reproduction (Milton and Dean, 1995). Therefore, in heavily grazed veld, it is inevitable that palatable plants will produce less seed than unpalatable plants (Milton and Dean, 1990; Fuls, 1992a), which in turn will lead to a change in species composition in the long-term (Milton, 1995).

Milton (1995) suggests that seedling survival in the Succulent Karoo is strongly influenced by spring rainfall and competition from neighbouring plants. Herbivory, therefore, would rather have an influence on the growth of seedlings than their survival.

2.3.3 Cover

The impact of grazing by domestic animals is aggravated in cases of overstocking because the rate of removal of vegetation exceeds the rate of recovery (Roux and Theron, 1987). According to the 'grazing optimization hypothesis' of McNaughton (1979) the stimulation of production occurs at moderate grazing intensities, reaching a maximum and reverting to depression of production at higher grazing intensities. Moderate reduction of leaf area will therefore either have no effect or will stimulate plant growth. Once grazing has reduced leaf area beyond a certain level, plants are not able to replace leaves at the rate they are being removed (Noy-Meir, 1975). Under frequent intensive grazing this could result in the death of plants (Noy-Meir, 1993). Experiments by Mworia *et al.* (1997) on semi-arid rangelands in Kenya has shown that herbaceous biomass in moderately and heavily grazed plots did not recover after two years of resting. They ascribed this to intensive defoliation and the effects of soil compaction caused by animal trampling and disturbance.

2.3.4 Decline in the carrying capacity

It is widely accepted that the long-term productivity of virtually the entire Karoo region has been substantially reduced due to overgrazing (Pelser and Kherehloa, 2000; Hoffman and Ashwell, 2001). There is substantial evidence in literature of a decline in the carrying capacity of our natural rangelands. De Klerk (1986) states that the decline in livestock numbers, despite improved agricultural practices, is an indication of the reduction in the carrying capacity of the natural veld. The overall decline of livestock numbers for the period 1930 to 1975 possibly reflects a decline in the carrying capacity, but it can also be due to changes in consumer demand, economic conditions or convenience to the farmer (Downing, 1978). Milton and Dean (1995) consider possible motivations for the overexploitation of the natural vegetation as the optimistic overestimation of carrying capacity and market forces. In the past the state provided interest-free loans for land acquisition and subsidies for supplementary feeds, boreholes, fencing, labour and stock (De Klerk, 1986; Milton and Dean, 1995). Ironically, these financial aid scheme discriminated against conservation farmers and worked to the advantage of those farmers who overstocked (Du Toit *et al.*, 1991)

The Little Karoo has been the heart of the ostrich industry in South Africa. Since 1896 and in recent years ostrich farming has been blamed for the severe degradation of vegetation and soils in the region (Van Eeden, 1996). Hoffman (1996) states that the impact of ostriches on lowland vegetation has been severe, mainly because of the artificially high numbers sustained by summer feeding. The habitat and food preferences of ostriches bring them into direct competition with mammalian herbivores and will therefore compete with sheep and goats for low-growing forbs and grasses in open habitats (Milton *et al.*, 1994a).

2.4 The impact of livestock on soil

2.4.1 Physical properties

Soil erosion and desertification is one of the biggest environmental and agricultural problems in South Africa (Roux and Opperman, 1986). Animals treading on rangelands cause soil compaction and trampling of vegetation. Hoof pressures were calculated at 192 kPa for cows (Jersey); 83 kPa for sheep (Merino-crossbred) and 60 kPa for goats (Angora) by Willat and Pullar (1983). The calculated hoof pressure is an under estimation of the actual pressure livestock exerts while walking or running. Despite the higher hoof pressure, cattle farming have a less severe effect than sheep on plant cover, provided overstocking does not take place (Roux and Opperman, 1986). Trampling by grazing animals compacts soil aggregates into a comparatively impermeable surface (Belnap, 2001b). The hoof actions by sheep especially on heavier and brackish soils cause severe compaction (Roux and Opperman, 1986). Soil compaction on heavily grazed areas significantly reduces the infiltration rates, saturated hydraulic conductivities and water-stable aggregates of soil (Seitlheko *et al.,* 1993). This was also confirmed through simulated trampling experiments by Ahmed *et al*. (1987). In the southern Karoo Dean (1992) found that grazed shrublands and sheep footpaths remarkably decreased the absorption ability of the soil.

In arid or semi-arid areas high wind speeds and high temperatures, dry plants and draw salt to the soil surface (Snyman and Van Rensburg, 1986). This eventually leads to soil crusting which seals the surface of the soil. In a study by Mills and Fey (2003) results show that soils from goat-transformed sites show greater tendency to crust than soil from intact sites, which is positively related to soil carbon status and soil texture. A physical soil crust can reduce water infiltration and plant establishment (Sumner and Steward, 1992 in Belnap, 2001b).

2.4.2 Soil chemistry

Livestock, if managed ineffectively, can degrade the condition of veld by reducing the cover of vegetation, which in turn will tend to reduce soil organic matter (Du Preez and Snyman, 1993). Patches of vegetation are usually hotspots of soil organic matter and nutrients, especially in semi-arid regions as it return organic matter to the soil, protects the soil from raindrop impact and cools the soils surface through shading (Schlesinger *et al*., 1990).

The removal of vegetation by livestock results in a net depletion of nutrients (Allsopp, 1999). Removal of vegetation tends to deplete soil organic matter because aggregate stability is often a function of soil organic matter (Oades, 1993). The effect of vegetation removal on soil carbon content is most evident in semi-arid areas. In succulent thicket, farming with goats resulted in 34% reduction in soil carbon (a mean loss of 27 t C ha $^{-1}$) to a depth of only 10 cm (Mills, 2003). Ungulates also affect the nitrogen cycle by depositing nitrogen to the upper levels of the soil in urine and faeces. The distribution of nitrogen within rangelands are therefore increased in habitats and patches preferred by herbivores (Hobbs, 1992).

Veld recovery may become extremely difficult if soil quality deteriorates to the extent that plant growth and germination are adversely affected which can lead to a shift in the ecosystem state (Du Preez and Snyman, 1993).

2.4.3 Biological soil crust

Studies worldwide have shown that a biological soil crust reduces soil erosion by wind (Belnap, 2001b) especially in coarse soils that are more erodible than silt soils. Biological soil crusts results from an intimate association between soil particles and cyanobacteria, algae, microfungi, micorrhiza, lichens and bryophytes which live within, or immediately on top of the upper most millimeters of the soil (Belnap *et al.*, 2001). Large filamentous cyanobacteria provide the matrix in which other components of the biological crust are embedded (Belnap, 2001a). Biological soil crusts dominated by cyanobacteria is found on the drier parts of the Little Karoo (Vogel, 1955 in Ullmann and Büdel, 2001). These types of soil crusts occur between quartz rocks and on calcareous soils without pebbles.

In an experiment on the effects of clipping and soil compaction on growth, morphology and mycorrhizal colonization, Wallace (1987) showed that a combination of both these factors significantly reduced plant growth and biomass.

2.4.4 Soil erosion

Under dry conditions such as the Little Karoo, topsoil with a fine texture (<10% sand) and with low vegetation cover is extremely vulnerable to wind erosion, especially when critical wind speed exceeds 20 km/h (Van Oudtshoorn, 1999; Todd *et al.*, 2004). The degree of land slope also affect the amount of surface runoff and soil erosion rates. Mwendera *et al.* (1997) showed in experiments in Ethiopian pastures that the effect of slope on erosion was more pronounced on heavily than moderately grazed plots. Snyman and Van Rensburg (1986) found that slope had no significant influence on the amount of runoff and soil loss. They did, however, agree that unprotected soil surfaces that are subjected to rapid runoff of rainwater accelerate the erosion process.

2.5 Spatial heterogeneity in grazing impact

2.5.1 Piosphere

Every living organism is dependent on water and especially in semi-arid and arid areas where farming units prevent the migration of livestock to areas with more abundant water, the utilisation of underground water is essential for economically viable farm units. The introduction of boreholes made it possible for farmers to utilize the inhospitable semi-arid and arid areas for agricultural purposes, but in many cases spelled negative consequences for the ecology of natural rangelands. Dean and Macdonald (1994) suggest that introduction of boreholes in semi-arid areas of South Africa caused irreversible vegetation degradation that is not necessarily limited to the immediate vicinity of the water-point. These distinct zones of bare soil and ephemeral plants that are found around water-holes are called piospheres (Andrew, 1988; Lange, 1969). Grazing animals usually forage outwards from a watering point, to which they are obliged to return frequently for drinking. These typical radial track patterns that result from hoof actions that cut through soil has been studied and documented by Lange (1969). Simulation models by Jeltsch *et al.* (1997) has shown that animal activities in the area around artificial water-holes often cause vegetation changes and degradation in the rangeland that is unlikely to recover in the short term. However, Hannan *et al.* (1991) suggest that vegetation changes around a water-point are restricted to a limited radius around that point.

Fusco *et al.* (1995) showed that even under conservative continuous cattle grazing in the Chihuahuan desert, biomass was reduced up to a distance of 1 000 m from a water-point. They also found that poisonous plants and annual forbs would dominate the area under 500 m from the water-point. Tolsma *et al.* (1987) states that changes in soil composition around artificial water-points in Botswana can be ascribed to the transport of nutrients via dung towards the borehole and the trampling effect. Because of the higher animal activity around waterholes, it can lead to greater vegetation degradation, a decrease in ecosystem stability and a loss of biodiversity (Owen-Smith, 1996). Collinson (1993) in Van Rooyen *et al.* (1994) therefore recommends for large areas not divided by fences, that artificial water-points should be uniformly spaced not closer than 30 km apart in order to reduce degradation of natural veld. At farm level Teague and Dowhower (2003) recommend that all forage/grazing should be within 0.8 km from water.

Where supplementary feeding is needed, a feeding point can have the same effect on the surrounding vegetation as that of a water-point because animals tend to move towards that point on a daily basis.

2.5.2 Patch formation

The vegetation of arid and semi-arid environments can be described as patchy with open areas of bare soil in-between the patches. One of the major causes of patchiness in arid environments is spatial variation in rainfall (Van Rooyen *et al.*, 1994). Patchiness within rangelands affects the behaviour of grazing animals because both wild and domestic herbivores forage more intensively in some patches than others (Fuls, 1992a). There is substantial empirical evidence that herbivores have accurate spatial memory that allows them to select and return to these preferred patches (Bailey *et al.*, 1996). Ring *et al.* (1985) has shown in a study with steers that they only grazed certain patches repeatedly throughout the grazing season. This results in intensive trampling and dung and urine deposits within the preferred patches. It also changes vegetation composition, reduces cover, compacts the soil and increases the alkalinity and salinity of the soil (Milton and Dean, 1995). Patch-selective grazing and patch overgrazing are regarded as main causes for continued retrogression of semi-arid and arid rangelands worldwide (Fuls, 1992b). Teague and Dowhower (2003) suggests the following recommendations to reduce the effects of selective foraging within patches: light to moderate stocking, provision of water-points so all grazing is preferably within 0.8 km from water, separation of vegetation types, the spreading of grazing pressure with supplements and the use of multiple species for grazing.

2.5.3 Pans

Pans are small internally drained topographic depressions found in arid regions. Vegetation in pans remains greener for longer after periods of rain (Milton, 1990). Van Rooyen *et al.* (1994) has shown that pans near artificial water-points are more favoured by grazers than those far from it. Springbok use pans more frequently because of their social behaviour and because of the availability of preferred forage plant species (Milton *et al.*, 1992). Although the accumulation of animals is normally advantageous to pan ecosystems, pans probably have the same negative effect on surrounding rangelands as water- or feeding points.

2.6 Conceptual models of change in veld

Roux and Vorster (1983) proposed five overlapping, but recognizable, phases of a hypothetical model in veld degradation for the Karoo region. This model was based on Clementsian successional theory, which is based on predictable changes of vegetation over time (Bosch, 1999). Non-equilibrium models provide an alternative to the succession theory for conceptualizing changes in arid rangelands (Ellis and Swift, 1988). These models recognise that in arid areas the variation in vegetation cover and composition in response to prolonged drought or major rainfall events may exceed or mask changes caused by herbivory.

According to Milton and Hoffman (1994) the succession model fails to explain how unpalatable perennials can replace palatable perennials. The state-and-transition model, for range management by Westoby *et al*. (1989), is rapidly replacing the classical rangeland succession model as the preferred means for describing rangeland vegetation dynamics. A state-and-transition model consists of a collection of discrete vegetation states and transitions that describe the circumstances under which the system in question moves from one vegetation state to another. Transitions between the states can be triggered through natural events, such as droughts and fire, by management actions or by a combination of both (Westoby *et al*., 1989). Milton and Hoffman (1994) proposed a state-and-transition model for the arid succulent and semi-arid grassy Karoo that gives a better understanding of the processes that determine the composition of these vegetation types. Milton *et al.* (1994b) develop the ideas of the state-and-transition model further in a stepwise model of rangeland degradation to show how the potential for recovery appears to be related to the function of the affected component. Their study stresses the need to recognize and treat degradation early because restoration cost increase for every step in the degradation process.

2.7 Conclusion

There is no doubt that the historical change from a communal system to one of private ownership and the replacement of wild animals subjected to natural controls by domestic animals not subjected to these controls (Acocks, 1955), accelerated the degradation of rangelands. The fencing of privately owned land and overstocking of the rangelands can be considered key factors in the historic degradation of the veld. Grazing systems that evolved after the implementation of the Fencing Act in 1912 helped, to a certain extent, to reduce the damage done by domestic livestock on rangelands.

The effect livestock has on vegetation and soil in arid areas is well understood and well documented in literature. Why certain areas degraded faster than others, especially in the Little Karoo, is still uncertain. The negative effect of trampling by livestock is also well documented and trampling indices are available for most of the domestic livestock species, but not available for ostriches and game. Ostrich farming have been blamed for most of the degradation in the Little Karoo without taking into account the historical background of the farm units. This has still to be proven through detailed scientific studies.

Education of farmers on rangeland management and economics has a major role to play in their decision-making process when managing their rangelands. Extension officers have a major role to play in this regard to reduce or prevent future rangeland degradation. Bembridge (1986) emphasized the need for educational programmes on veld assessment and the formulation of veld management programmes in the 1980s. I am convinced that there is still room for improvement in this regard.

2.8 References

Acocks, J. P. H. 1955. Agriculture in relation to a changing vegetation. *South African Journal of Science,* **52**:101-108.

Archer, S. 2002. Technology and ecology in the Karoo: a century of windmills, wire and changing farming practice. Pages 112-138 in Dovers, S., Edgecombe, R. and Guest, B. (eds.). *South Africa's Environmental History – cases and comparisons*. Ohio University Press, Claremont.

Ahmed, H., Abdel-Magid, M. J., Trlica, M. J. and Hart, R. H. 1987. Soil and vegetation responses to simulated trampling. *Journal of Range Management,* **40**:303-306.

Allsopp, N. 1999. The effects of grazing and cultivation on soil patterns and processes in the Paulshoek area of Namaqualand. *Plant Ecology,* **142**:179-187.

Andrew, M. H. 1988. Grazing impact in relation to livestock watering points. *Trends in Ecological Evolution,* **3**:336-339.

Bailey, D. W., Gross, J. E., Laca, E. A., Rittenhouse, L. R., Coughenour, M. B., Swift, D. M. and Sims, P. L. 1996. Mechanisms that result in large herbivore grazing distribution patterns – Invited Synthesis Paper. *Journal of Range Management*, **49**:386-400.

Belnap, J. 2001a. Comparative Structure of Physical and Biological Soil Crusts. Pages 177-192 in Belnap, J. and Lange, O. L. (eds.). *Biological Soil Crusts: Structure, Function and Management*. Springer-Verslag, Berlin.

Belnap, J. 2001b. Biological Soil Crust and Wind Erosion. Pages 339-348 in Belnap, J. and Lange, O. L. (eds.). *Biological Soil Crusts: Structure, Function and Management*. Springer-Verslag, Berlin.

Belnap, J., Büdel, B. and Lange, O. L. 2001. Biological Soil Crusts: Characteristics and Distribution. Pages 3-30 in Belnap, J. and Lange, O. L. (eds.). *Biological Soil Crusts: Structure, Function and Management*. Springer-Verslag, Berlin.

Bembridge, T. J. 1986. ‘n Uitdaging vir landbouvoorligting. *Journal of the Grassland Society*, **3**:159-163.

Bosch, O. J. B. 1999. The Karoo biome. Pages 36-43 in Tainton, N. (ed.). *Veld Management in South Africa.* University of Natal Press, Pietermaritzburg.

Cowling, R. M. and Hilton-Taylor, C. 1999. Plant biogeography, endemism and diversity. Pages 42-56 in Dean, W. R. J. and Milton, S. J. (eds.). *The Karoo – ecological patterns and processes*. Cambridge University Press, Cambridge.

Dean, W. R. J. 1992. Effects of animal activity on the absorption rate of soils in the southern Karoo, South Africa. *Journal of the Grassland Society of southern Africa*, **9**:178-180.

Dean, W. R. J. and Macdonald, I. A. W. 1994. Historical changes in stocking rates of domestic livestock as a measure of semi-arid and arid rangeland degradation in the Cape Province, South Africa. *Journal of Arid Environments*, **26**:281-298.

Dean, W. R. J., Hoffman, M. T., Meadows, M. E. and Milton, S. J. 1995. Desertification in the semi-arid Karoo, South Africa: review and reassessment. *Journal of Arid Environments,* **30**:247-264.

De Klerk, C. H. 1986. *‘n Ondersoek na faktore wat in die weg staan van aanvaarding van aanbevole veldbeheerpraktyke.* Departement van Landbou en Watervoorsiening, Pretoria.

Downing, B. H. 1978. Environmental consequences of agricultural expansion in South Africa since 1850. *South African Journal of Science,* **74**:420-422.

Du Preez, C. C. and Snyman, H. A. 1993. Organic matter content of a soil in a semi-arid climate with three long-standing veld conditions. *African Journal of Range and Forage Science,* **10**:108-110.

Du Toit, P. C. V. 1996. Karoobush defoliation in the arid Karoo. *Journal of Range Management*, **49**:105-111.

Du Toit, P. F., Aucamp, A. J. and Bruwer, J. J. 1991. The national grazing strategy of the Republic of South Africa: objectives, achievements and future challenges. *Journal of the Grassland Society of southern Africa*, **8**:126-130.

Ellis, J. E. and Swift, D. M. 1988. Stability of African pastoral systems: alternate paradigms and implications of development. *Journal of Range Management*, **41**:450-459.

Fuls, E. R. 1992a. Ecosystem modification created by patch-overgrazing in semi-arid grassland. *Journal of Arid Environments*, **23**:59-69.

Fuls, E. R. 1992b. Semi-arid and arid rangelands: a resource under siege due to patch-selective grazing. *Journal of Arid Environments*, **22**:191-193.

Fusco, M., Holechek, J., Tembo, A., Daniel, A. and Cardenas, M. 1995. Grazing influences on watering point vegetation in the Chichuahuan desert. *Journal of Range Management*, **48**:32-38.

Hannan, N. P., Prrevost, Y., Diouf, A. and Diallo, O. 1991. Assessment of desertification around deep wells in the Sahel using satellite imagery. *Journal of Applied Ecology*, **28**:173-186.

Hobbs, N. T. 1992. Modification of ecosystems by ungulates – invited paper. *Journal of Wildlife Management*, **60**:695-713.

Hoffman, T. 1996. Little Succulent Karoo. Page 61 in Low, A. B. and Rebelo, A. G. (eds.). *Vegetation of South Africa, Lesotho and Swaziland.* Department of Environmental Affairs and Tourism, Pretoria.

Hoffman, M. T. 1997. Human impacts on vegetation. Pages 507-531 in Cowling, R. M., Richardson, D. M. and Pierce, S. M. (eds.). *Vegetation of Southern Africa*. Cambridge University Press, Cambridge.

Hoffman, M. T. and Ashwell, A. 2001. *Nature Divided – land degradation in South Africa*. University of Cape Town Press, Cape Town.

Hoffman, M. T. and Cowling, R. M. 1990. Vegetation change in the semi-arid eastern Karoo over the last 200 years: an expanding Karoo – fact or fiction? *South African Journal of Science*, **86**:286-294.

Hoffman, M. T., Cousins, B., Meyer, T., Petersen, A. and Hendricks, H. 1999. Historical and contemporary land use and desertification. Pages 257-273 in Dean, W. R. J. and Milton, S. J. (eds.). *The Karoo: Ecological patterns and processes.* Cambridge University Press, Cambridge.

Jeltsch, F., Milton, S. J., Dean, W. R. J. and Van Rooyen, N. 1997. Simulated pattern formation around artificial waterholes in the semi-arid Kalahari. *Journal of Vegetation Science,* **8**:177-188.

Lange, R. T. 1969. The Piosphere: sheep track and dung patterns. *Journal of Range Management,* **22**:396-400.

Ledger, J. 1997. Wildlife Conservation: its past, present and future. Pages 81-95 in Mills, G. and Hes, L. (eds.). *The Complete Book of Mammals*. Struik, Winchester.

McNaughton, S. J. 1979. Grazing as an optimization process: grass-ungulate relationships in the Serengeti. *American Naturalist,* **113**:691-703.

Mills, A. J. 2003. Reciprocal relationships between vegetation structure and soil properties in selected biomes of South Africa. Ph.D-thesis, University of Stellenbosch, Stellenbosch.

Mills, A. J. and Fey, M. V. 2003. Declining soil quality in South Africa: effects of land-use on soil organic matter and surface crusting. *South African Journal of Science,* **99**:429-436.

Milton, S. J. 1990. Lifestyles of plants in four habitats in an arid Karoo shrubland. *South African Journal of Ecology,* **1**:63-72.

Milton, S. J. 1992. The effects of rainfall, competition and grazing on flowering *Osteospermum sinuatum* (Asteraceae) in arid Karoo rangeland. *Journal of the Grassland Society of southern Africa,* **9**:158-64.

Milton, S. J. 1995. Spatial and temporal patterns in the emergence and survival of seedlings in the arid Karoo shrubland. *Journal of Applied Ecology,* **32**:145-156.

Milton S. J. and Dean, W. R. J. 1988. Flower and fruit production of *Rhigozum obovatum* (Bignoniaceae) in road reserves and grazing land. *South African Journal of Science,* **84**:798-799.

Milton S. J. and Dean, W. R. J. 1990. Seed production in rangelands of the southern Karoo. *South African Journal of Science,* **86**:231-233.

Milton, S. J. and Dean, W. R. J. 1995. South Africa's arid and semi-arid rangelands: why are they changing and can they be restored? *Environmental Monitoring and Assessment,* **37**:245-264.

Milton, S. J. and Hoffman, M. T. 1994. The application of state-and-transition models to rangeland research and management in arid succulent and semi-arid grassy Karoo, South Africa. *African Journal of Range and Forage Science,* **11**:18-26.

Milton, S. J., Dean, W. R. J. and Marincowitz, C. P. 1992. Preferential utilisation of pans by springbok (*Antidorcas marsupialis*). *Journal of the Grassland Society of southern Africa,* **9**:114-117.

Milton, S. J., Dean, W. R. J. and Siegfried, W. R. 1994a. Food selection by ostriches in southern Africa. *Journal of Wildlife Management*, **58**:234-248.

Milton, S. J., Dean, W. R. J., Du Plessis M. A. and Siegfried, W. R. 1994b. A conceptual model of arid rangeland degradation. *Bioscience*, **44**:70-76.

Milton, S. J., Yeaton, R. A., Dean, W. R. J. and Vlok, J. H. J. 1997. Succulent Karoo. Pages 131-166 in Cowling, R. M., Richardson, D. M. and Pierce, S. M. (eds). *Vegetation of southern Africa.* Cambridge University Press, Cambridge.

Mwendera, E. J., Mohamed Saleem, M. A. and Dibabe, A. 1997. The effect of livestock grazing on surface runoff and soil erosion from sloping pasture lands in the Ethiopian highlands. *Australian Journal of Experimental Agriculture*, **37**:421-430.

Mworia, J. K., Mnene, W.N., Musembi, D. K. and Reid, R. S. 1997. Resilience of soils and vegetation subjected to different grazing intensities in a semi-arid rangeland of Kenya. *African Journal of Range and Forage Science*, **14**:26-31.

Myers, N., Mittermeier, R. A., Mittermeier, C. G., da Fonseca, G. A. B. and Kent, J. 2000. Biodiversity hotspots for conservation priorities. *Nature*, **403**:853-858.

Nel, C. J. 1995. *Riglyne vir suksesvolle volstruisboerdery*. Klein-Karoo Landbou-ontwikkelingsentrum, Oudtshoorn.

Noy-Meir, I. 1975. Stability of grazing systems: an application of predator-prey graphs. *Journal of Ecology*, **63**:459-481.

Noy-Meir, I. 1993. Compensation growth of grazed plants and its relevance to the use of rangelands. *Ecological Applications*, **3**:32-34.

Oades, J. M. 1993. The role of biology in the formation, stabilization and degradation of soil structure. *Geoderma*, **56**:377-400.

Owen-Smith, N. 1996. Ecological guidelines for waterpoints in extensive protected areas. *South African Journal of Wildlife*, **26**:107-112.

Pelser, A. J. and Kherehloa, T. 2000. Some causes and strategies pertaining to land degradation in southern Africa. *South African Journal of Agricultural Extension*, **29**:24-46.

Pollock, N. C. 1974. *Animals, Environment and Man in Africa*. Lexington Books, Farnborough.

Ring, C. B., Nicholson, R. A. and Launchbaugh, J. L. 1985. Vegetation traits of patch-grazed rangeland in West-central Kansas. *Journal of Range Management*, **38**:51-54.

Roux, P. W. and Opperman, D. P. J. 1986. Soil Erosion. Pages 92-111 in Cowling, R. M., Roux, P. W. and Pieterse, A. J. H. (eds.). *The Karoo Biome: a preliminary synthesis. Part 1 – physical environment*. South African National Scientific Programmes Report No 124.

Roux, P. W. and Theron, G. K. 1987. Vegetation change in the Karoo biome. Pages 50-69 in Cowling, R. M. and Roux, P. W. (eds.). *The Karoo Biome: a preliminary synthesis. Part 2 – vegetation and history*. South African National Scientific Programmes Report No 142.

Roux, P. W. and Vorster, M. 1983. Vegetation changes in the Karoo. *Proceedings of the Grassland Society of Southern Africa,* **18**:25-29.

Sampson, S. G. 1986. Veld damage in the Karoo caused by its pre-Trekboer inhabitants: preliminary observations in the Seacow Valley. *The Naturalist*, **30**:37-42.

Schlesinger, W. H., Reynolds, J. F., Cunningham, G. L., Huenneke, L. F., Jarrel, W. M., Virginia, R. A. and Whitford, W. G. 1990. Biological feedbacks in global desertification. *Science,* **247**:1043-1048.

Seitlheko, E. M., Allen, B. L. and Webster, D. B. 1993. Effects of three grazing intensities on selected soil properties in semi-arid Texas. *African Journal of Range and Forage Science,* **10**:82-85.

Shearing, D. and Van Heerden, K. 1994. *Karoo: Velblomgids van Suid-Afrika 6*. Botaniese vereniging van Suid-Afrika, Kirstenbosch, Claremont.

Skead, C. J. 1980. *Historical manual incidence in the Cape Province*. Vol. 1. Department of Nature and Environmental Conservation. Provincial Administration of the Cape of Good Hope, Cape Town.

Smith, A. B. 1999. Hunters and herders in the karoo landscape. Pages 243-256 in Dean, W. R. J. and Milton, S. J. (eds.). *The Karoo: Ecological patterns and processes*. Cambridge University Press, Cambridge.

Snyman, H. A. and Van Rensburg, W. L. J. 1986. Effect of slope and plant cover on runoff, soil loss and water use efficiency of natural veld. *Journal of the Grassland Society of southern Africa,* **3**:153–58.

State of the Environment Overview Report. 2004. Department of Environmental Affairs and Development Planning, Report No. 329585/1.

Talbot, W. J. 1961. Land utilisation in the arid regions of southern Africa. Part 1: South Africa. Pages 299-338 in Stamp, L. D. (ed.). A *History of Land Use in Arid Regions. Arid Zone research,* Vol. 17, UNESCO, Paris.

Teague, W. R. and Dowhower, S. L. 2003. Patch dynamics under rotational and continuous grazing management in large, heterogeneous paddocks. *Journal of Arid Environments*, **53**:211-229.

Todd, S. W. 1999. Patterns of seed production and shrub association in two palatable Karoo shrub species under contrasting land use intensities. *African Journal of Range and Forage Science*, **17**:22-26.

Todd, R. W., Guo, W., Stewart, B. A. and Robinson, C. 2004. Vegetation, phosphorous and dust gradients downwind from a cattle feedyard. *Journal of Range Management*, **57**:291-299.

Tolsma, D. J., Ernst, W. H. O. and Verwey, R. A. 1987. Nutrients in soil and vegetation around artificial waterpoints in eastern Botswana. *Journal of Applied Ecology*, **24**:991-1000.

Ullmann, I. and Büdel, B. 2001. Biological Soil Crusts of Africa. Pages 107-118 in Belnap, J. and Lange, O. L. (eds.). *Biological Soil Crusts: Structure, Function and Management*, Springer-Verslag, Berlin.

UNCCD. 1995. United Nations Convention to Combat Desertification in Those Countries Experiencing Serious Drought and/or Desertification Particularly in Africa. *United Nations Environment Programme*. Geneva.

Vahrmeijer, J. 1981. *Gifplante van Suider-Afrika wat veeverliese veroorsaak.* Tafelberg Uitgewers Beperk, Kaapstad.

Van Eeden, F. 1996. Waak teen veldagteruitgang. *Landbouweekblad*, April, 19. pp. 36-38.

Van Oudtshoorn, F. 1999. *Gids tot grasse van Suider-Afrika.* Briza Publications, Pretoria.

Van Rooyen, N., Bredenkamp, G. J., Theron, G. K., Bothma, J. du P. and Le Riche, E. A. N. 1994. Vegetation gradients around artificial waterpoints in the Kalahari Gemsbok National Park. *Journal of Arid Environments*, **26**:349-361.

Wallace, L. L. 1987. Effects of clipping and soil compaction on growth, morphology and mycorrhizal colonization of *Schizchyriom scoparium*, a C_4 bunchgrass. *Oecologia*, **72**:423-428.

Westoby, M., Walker, B. H. and Noy-Meir, I. 1989. Opportunistic management for rangelands not at equilibrium. *Journal of Range Management*, **42**:266-274.

Willatt, S. T. and Pullar, D. M. 1983. Changes in soil physical properties under grazed pastures. *Australian Journal of Soil Research*, **22**:343-348.

CHAPTER 3 STUDY AREA

3.1 Introduction

Geographically the Little Karoo region is a narrow tableland, which lies roughly between 33° 15´ S and 34° 00´ S and between 20° 30´ E and 23° 40´ E. The region is separated from the Coastal Belt by the Langeberg and Outeniqua mountains, which forms its southern boundary and is separated from the Great Karoo by the Swartberg mountain range, which forms its northern boundary. The first agricultural development south of the Swartberg mountain range dates back to the early 1600's when the first white farmers bartered for livestock with the indigenous Inqua Khoi clans of the Attaqua region (Anonymous, 1999). By 1730 the first European farmers had dispossessed these Khoi clans of their land and started off as stock farmers, later introducing crop farming with small grain, tobacco and dry fruit (Anonymous, 1999).

Ostrich production is now the primary agricultural activity in the region. Parallel with the ostrich production development, lucerne (*Medicago sativa*) became the most important agricultural crop within the region as it serves as primary fodder for ostriches during the dry summer months. Lucerne is therefore the foundation on which not only the ostrich, but also the dairy industry in the region, is built (Talbot, 1961; Anonymous, 1999). The most important production areas for lucerne are next to the Stompdrift, Kammanassie and Gamka irrigation schemes and several tributaries in the Oudtshoorn region and irrigation areas in the vicinity of the Groot, Touw and Brand River in the Ladismith district (Anonymous, 1999). Even though ostrich farming is the main source of agricultural income for the region, it is in many instances supplemented by small and large stock farming, and game farming is becoming increasingly popular.

The region is under the jurisdiction of the Eden District Municipality, which controls the local Kannaland and Oudtshoorn Municipality. The Kannaland municipality controls the towns of Ladismith, Calitzdorp, Zoar and Van Wyksdorp while Oudtshoorn Municipality controls Oudtshoorn, De Rust and Dysselsdorp. Uniondale falls directly under the Eden District Municipality. Agricultural extension offices in the towns of Ladismith and Oudtshoorn serve the area. In the latter town an experimental farm provide services and research mainly on ostrich feeding, lucerne, new agricultural crops and irrigation. The Little Karoo is divided into the Kango, Touw-Ladismith, Olifants River-Gamka, Kammanassie, Bo-Langkloof and Uniondale agricultural regions as can be seen in Figure 3.1

3.2 Topography and soils

The region consists of valleys, up to 50 km wide and 200 km in length between 400 and 600 m above sea level (Watkeys, 1999). These typical valleys are characteristic of the Touw-Ladismith and Olifants River-Gamka regions with hills in between varying in slope from 6 to 18 percent. In the regions that border the mountain ranges the topography varies from 650 to 900 m above sea level in the Kammanassie, Bo-Langkloof and Kango regions, to as high as 1 200 m in the Uniondale region (Anonymous, 1999).

A mosaic of various rock strata, including the Kango group (conglomerates, shale and limestone), Bokkeveld Group (shale, siltstone and sandstone), Witteberg Group (quartzite and shale) and Uitenhage Group (conglomerate, siltstone, mudstone, calcrete), is found on the low-lying areas of the Little Karoo, while in the higher reaches the geology is dominated by the Table Mountain Group (Van Wyk and Smith, 2001). The soils of the Succulent Karoo Biome does not differ much from the Nama Karoo Biome as both have characteristically weakly developed, lime-rich soils on rock (National Botanical Institute, 2004) and according to Watkeys (1999) red, high-base status apedal to weakly structured shallow soils (with depths less than 300 mm), which is derived from pedologically young landscapes, dominate this topographically variable region.

3.3 Rainfall

The distinctive climatic characteristics of the Succulent Karoo make it different from all other deserts in the world (Desmet and Cowling, 1999), but like all other semi-arid and arid regions, the Karoo ecosystems are also characterised by variable low and unpredictable rainfall (Noy-Meir, 1973; Hoffman and Cowling, 1987). With the exception of the Kango, Bo-Langkloof and Kammanasie agricultural region, the Little Karoo region is an arid to semi-arid area. With both the seasonal rainfall and the amount of rainfall fluctuating, sporadic droughts within the region are common. Cyclonic winter rain mainly falls from May to September in

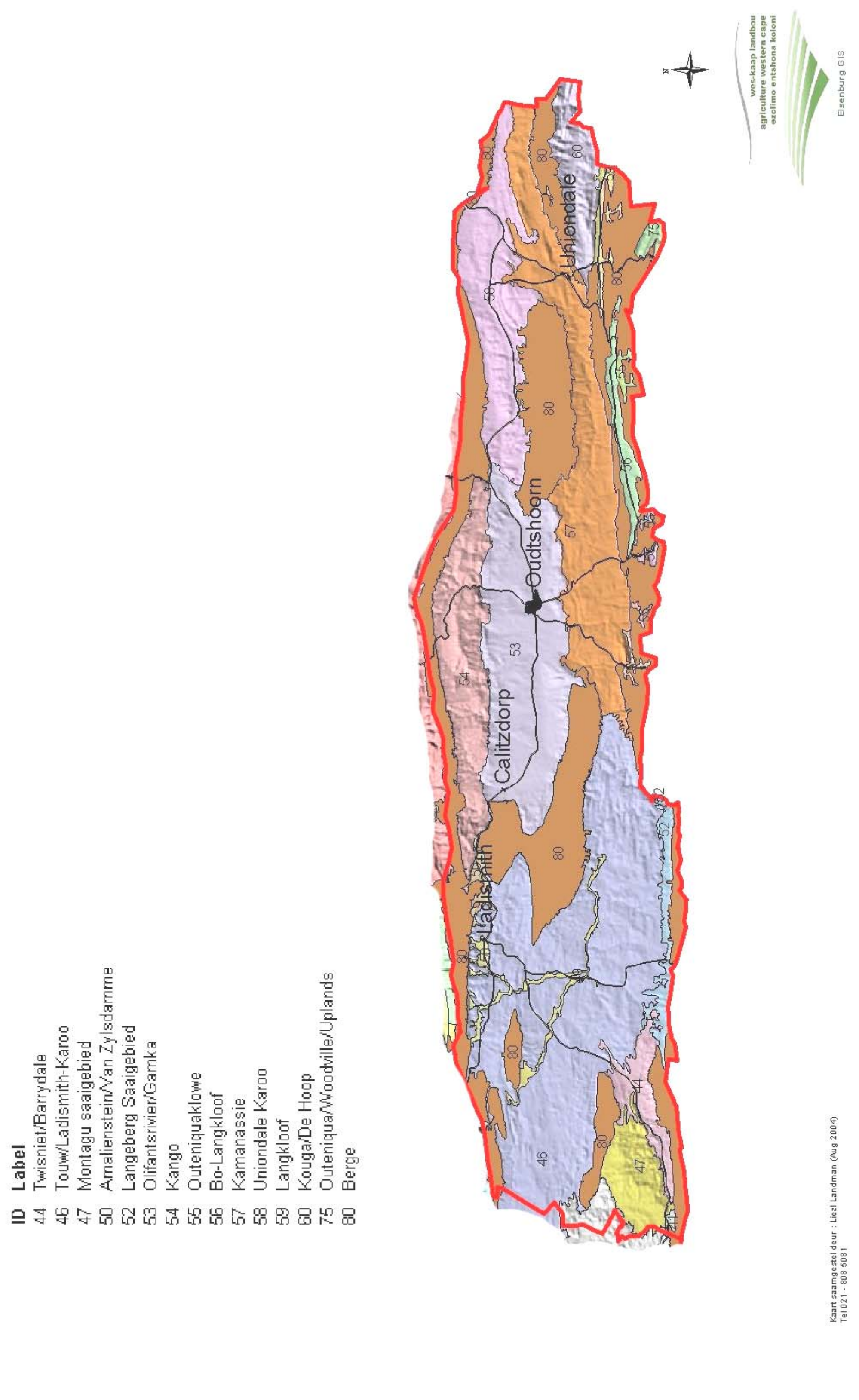


Figure 3.1 Agricultural regions of the Little Karoo

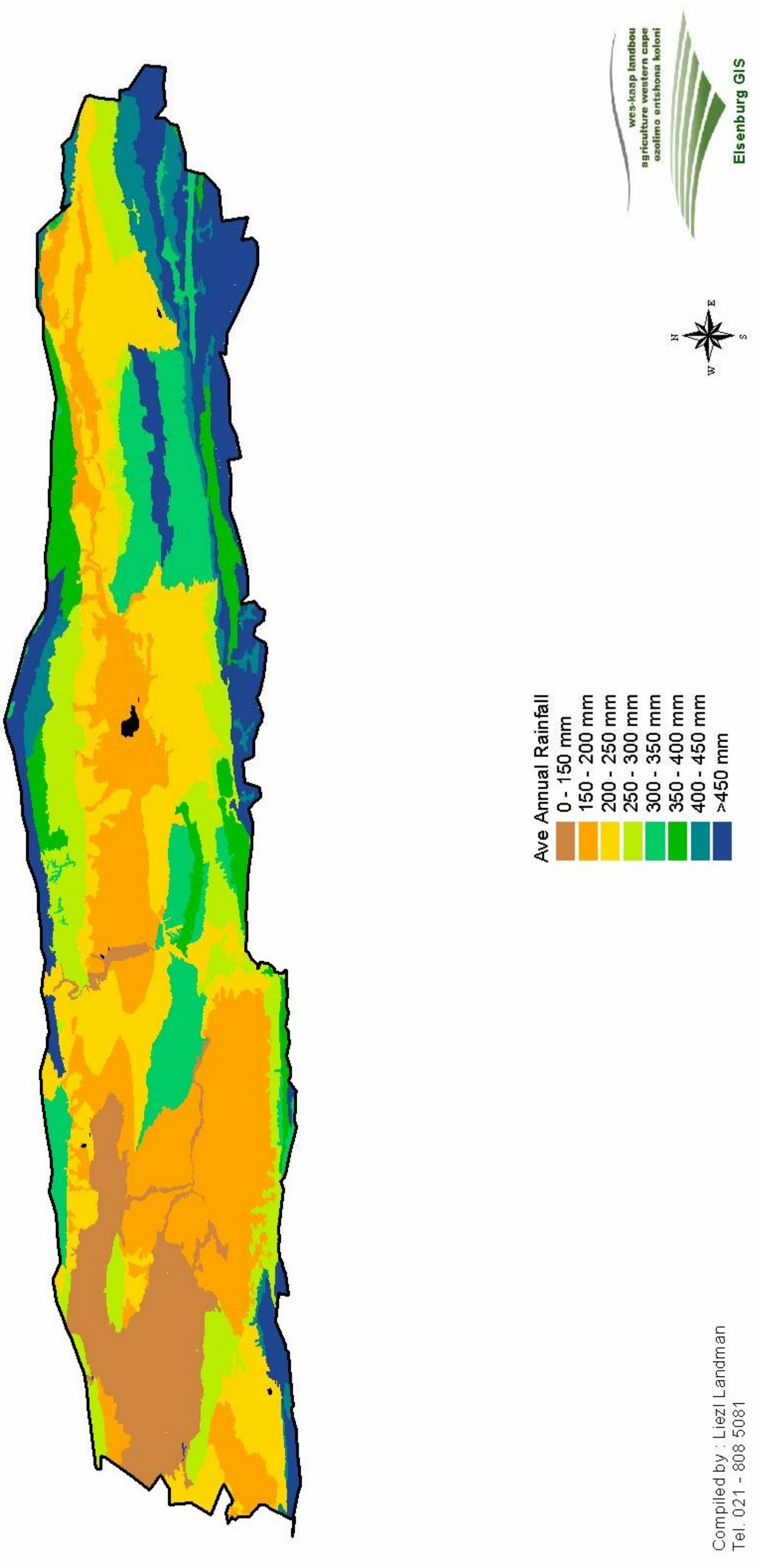


Figure 3.2 Mean annual precipitation in the Little Karoo

the western side of the region while the eastern side receives predominantly summer rainfall from early November (Van Wyk and Smith, 2001). The annual rainfall varies from as low as 125 – 300 mm to as high as 400 mm according to Van Wyk and Smith (2001), but can be higher than 500 mm closer to the northern and southern boundaries. Both the seasonal rainfall and the amount of rainfall fluctuate tremendously within the region as can be seen in Figure 3.2 and as suggested by Venter *et al.* (1986) it tends to decrease from east to west. The rain-shadow effects of the mountain ranges forming the southerly boundaries, which diminish the ability of cold fronts to bring more rain from the south, mainly cause the predominant arid conditions within the region.

In the Touw-Ladismith region the mean annual precipitation (MAP) is the lowest within the Little Karoo region, between 150 and 200 mm and is spread throughout the year. In the Olifants River-Gamka region the MAP fluctuates from 177.8 mm in Calitzdorp to 237.3 mm near Oudtshoorn and 240.7 mm at Rooirivier. Within the Kango region the MAP increases northwards towards the Swartberg mountain range and varies from 381.2 mm at Kruisrivier, 416.0 mm at Matjiesrivier and 579.1 mm at Rust-en-Vrede. The Bo-Langkloof region has the highest MAP of about 513 mm of which 53% falls in winter. Rainfall decreases fast in a northern direction and the MAP is only 323 mm at Ezeljacht. Within the Uniondale region the climate is reasonably homogenous and the MAP fluctuates from 209 mm at Barandas to 240 mm at Toorwater and Rooirivier (Anonymous, 1999). Rainfall data for the Kammanassie region is incomplete.

3.4 Vegetation

The geographical and rainfall variability makes the Little Karoo a unique landscape in South Africa because four of the seven biomes as described by Low and Rebelo (1996) fall within its boundaries (Figure 3.3). The Fynbos, Succulent Karoo, Thicket and Forest biomes and seven vegetation types are found in this region, making it an area that is rich in botanical biodiversity. The Fynbos and Succulent Karoo biomes are two of the world’s twenty-five recognised biodiversity hotspots of the world (Myers *et al.*, 2000). Small patches of Afromontane forest, a component of the Forest biome, are found in the eastern part of the region.

In the Fynbos biome the four vegetation types that are present are Mountain Fynbos, Grassy Fynbos, Central Mountain Renosterveld and South and South–west Coast Renosterveld. Mountain Fynbos is confined to the sandstones of the Cape Supergroup (Rebelo, 1996c) in the areas of high altitudes in the Swartberg and Outeniqua mountain ranges, Rooiberg, Gamkaberg and Anysberg. Grassy Fynbos, is found east of Uniondale on sandy soils derived from Cape Supergroup sandstones, the Witteberg Group and Enon conglomerates (Rebelo, 1996d).

Central Mountain Renosterveld is found on the fringes of the Little Karoo basin on the Bokkeveld and Witteberg Group with *Acacia karroo* (soetdoring), *Aloe ferox* (alwyn), *Euclea undulata* (ghwarrie) and *Rhus* spp. being the dominant species (Rebelo, 1996a). This vegetation type is primarily used for grazing by cattle farmers. The South and South–west Coast Renosterveld is found on clay soils derived from the Bokkeveld and Kango Group shale with *Dicerothamnus* (*Elytropappus) rhinocerotis* (renosterbos), *Hermannia flammea, Helichrysum anomalum, Indigofera denudata, Relhania genistifolia* and *R. cuneata* the dominant species (Rebelo, 1996b). Like the Central Mountain Renosterveld, this vegetation type is also used for grazing by cattle farmers. The well-developed grass component, including *Brachiaria serrata*, *Pentaschistis pallida*, *Sporobolus africanus* and *Themeda triandra* (rooigras), forms the bulk of the diet of large-stock. In the Kango region, camps within this vegetation type are very often not used for grazing and are mostly dominated by unpalatable *Dicerothamnus* (*Elytropappus) rhinocerotis* and *Dodonaea viscosa* (ysterhout) which eventually reduce the under story vegetation component and diversity (personal observation).

Spekboom Succulent Thicket vegetation is dominated by *Portulacaria afra* (spekboom). Other species that are common include *Aloe* spp., *Crassula* spp., *Euclea undulata, Grewia robusta*, *Pappea capensis, Rhigozum obovatum, Rhus* spp. and *Schotia afra* (Lubke, 1996). *Portulacaria afra*, is fairly palatable on the warmer northern slopes (Joubert *et al.*, 1969) is readily ingested and is under pressure from goats, which can easily reach higher altitudes.

Succulent Karoo vegetation is dominated by chamaephytes (shrubs less than 1 meter) with roughly 60% perennial species of which more than 60% have succulent leaves (Orshan *et al.*, 1984 quoted by Midgley and Van der Heyden, 1999). Succulent karoo vegetation is renowned for its botanical diversity and has been well documented (Hilton-Taylor, 1987; Cowling *et al.*, 1989; Milton *et al.*, 1997; Van Wyk and Smith, 2001) and recognised as a biodiversity hotspot, which are areas that have high levels of endemism and diversity, but also experience a high rate of loss of habitat (Myers *et al*., 2000). Within the Central Little Karoo alone there are more than 1 325 species, which include 182 endemics of especially Mesembryanthemacea,

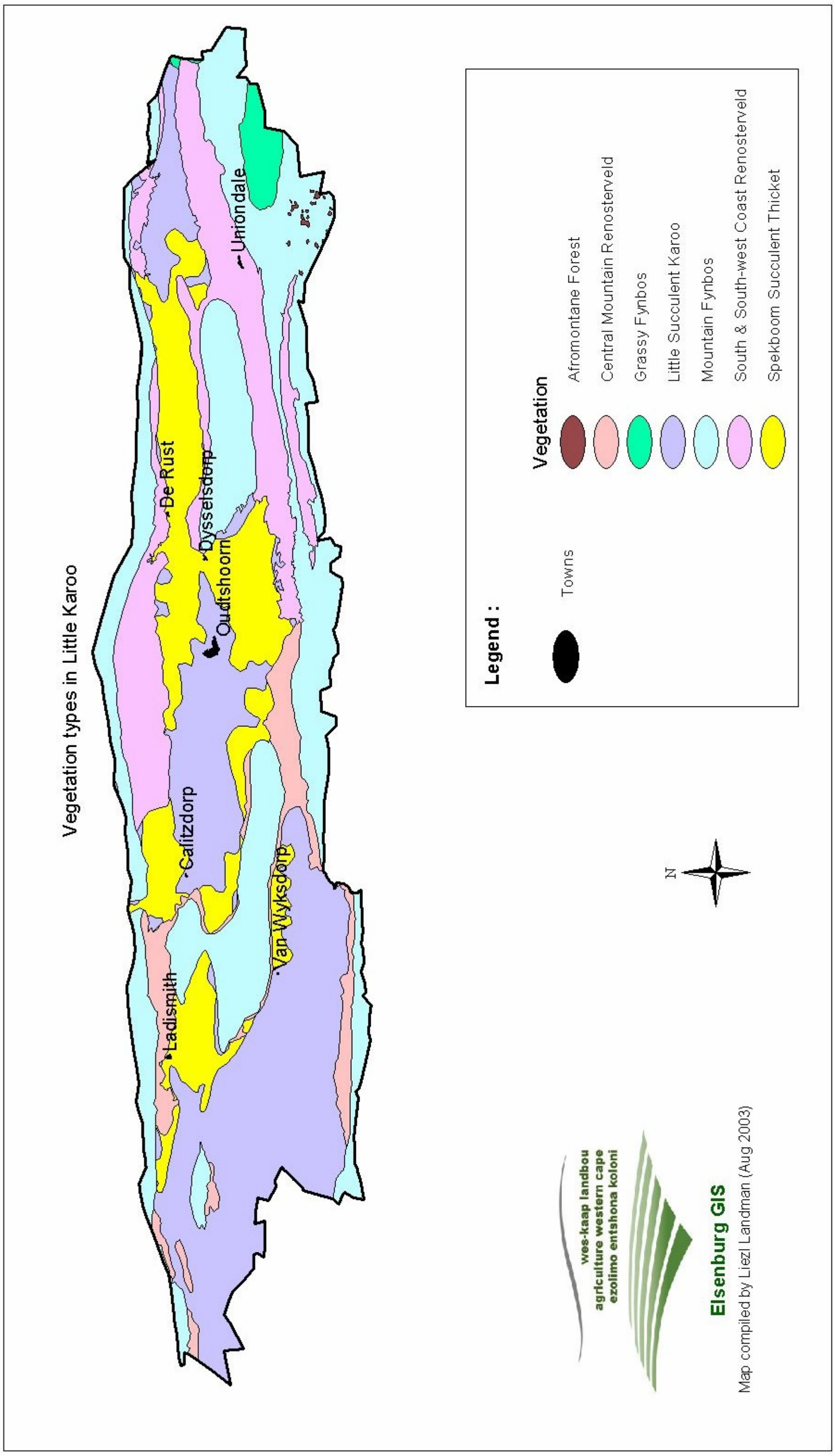


Figure 3.3 Vegetation types in the Little Karoo (Low and Rebelo, 1996)

bulbs and other succulents with extremely small ranges of less than 50 km^2 (Anonymous, 2003). Succulents such as *Drosanthemum*, *Mesembryanthemum*, *Psilocaulon*, *Ruschia* and *Spalmanthus* species dominate the vegetation of the Little Succulent Karoo (Anonymous, 1999) and non-succulent shrubs such as *Hirpicium integrifolium*, *Pteronia pallens* and trees such as *Euclea undulata* (ghwarri), *Pappea capensis* and *Schotia afra* (Karoo Boerbean) are common (Hoffman, 1996). Joubert *et al.* (1969) documented the presence of palatable karoo shrubs such as *Eriocephalus glabrescens*, *Pentzia incana*, and *Felicia muricata* along fenced-in railway lines in the 1960's which would suggest that these plants, which are today mostly absent in grazed veld, must have been more common in the past.

In the Succulent Karoo, the activities of termites (*Microhodotermes viator*) and mole-rats, that accumulate soil and nutrients over their nests, result in mima-like mounds called *heuweltjies* (little hills) (Owen-Smith and Danckwerts, 1997; Ellis, 2004). The activities of termites make the soil on *heuweltjies* finer, moister and more alkaline and less stony (Midgley and Musil, 1990; Ellis, 2004) and therefore plant communities on the *heuweltjies* are very different from the surrounding vegetation. Free-range ostriches prefer these *heuweltjies* as nesting sites (Milton and Dean, 1990).

Recently a fine scale vegetation map (1:50 000) was compiled which can be used at different hierarchical levels: aquatic-terrestrial map, biome map showing four different biomes, habitat map indicating 55 different habitat types and vegetation unit map indicating 369 different vegetation units (Vlok *et al*, 2005). This map is a vast improvement to its forerunners and an excellent tool in planning for conservation and management in this region.

3.5 Agricultural regions

This section describes the extent of the various agricultural regions in the Little Karoo, the agricultural activities in these regions and the agricultural carrying capacity of the regions for livestock. Agricultural carrying capacity is defined here as the potential of an area to support livestock over an extended number of years without deterioration of the overall ecosystem (Danckwerts, 1981). This variable is expressed as Large Stock Units per hectare (LSU/ha) where LSU is regarded as an animal with a mass of 450 kg, which gains 0.5 kg per day on forage with a digestible energy percentage of 55% (Meissner, 1982). Reference is also made to the grazing capacity of each region. Grazing capacity is defined by (Booysen, 1967) as the productivity of the browseable or grazeable portion of a homogeneous unit of vegetation expressed as the area of land needed to maintain a single animal unit over an extended number of years without deterioration of the overall ecosystem. The correct stocking rate for different forms of livestock should be calculated using the large animal unit conversion table published in Meissner *et al.* (1983) or the Government Gazette (1985).

3.5.1 Touw-Ladismith

This region of about 495 659 ha stretches from the Touw River in the west, past Van Wyksdorp to the eastern boundary of the Ladismith district (Figure 3.1). This extensive small stock-farming region is mainly used to raise Dorper sheep, while a few farmers keep Merino sheep, Boer goats and ostriches (Anonymous, 1999). The estimated grazing capacity for the region is 54 ha/LSU (hectares per large stock unit) (Figure 3.4).

3.5.2 Olifants Rivier-Gamka

The area of about 148 300 ha stretches from Rooirivier in the east to Calitzdorp in the west (Figure 3.1) and roughly 24 000 ha is used for irrigation (Anonymous, 1999). The natural veld constitutes more or less 124 000 ha of the total area with a very low estimated grazing capacity of 60 ha/LSU for the Little Succulent Karoo component and 48 ha/LSU for the Spekboom Succulent Karoo component (Figure 3.4). Despite the low grazing capacity the Olifants River-Gamka region is the most important ostrich-producing region in the country with approximately 70% of all ostrich products originating here (Anonymous, 1999). The dry climate and soil in this region is suitable for the production of lucerne, which serves as the main food source for ostriches.

3.5.3 Kango

This agricultural region lies directly south of the Swartberg mountain range and stretches from Matjiesgoedvlei in the west towards Kleinkruis in the east (Figure 3.1). The region is about 111 600 ha in size of which about 8 000 ha (7.2%) is considered to be dry land and 2 000 ha (1.8%) irrigation land (Anonymous, 1999). The region is characterised by mixed farming with lucerne as the most important crop that is under irrigation, and is primarily used as feed for large stock, ostriches and to a lesser extent small stock. The main vegetation type is South and South-west coast Renosterveld (Figure 3.3), with a very low grazing capacity of 72 ha/LSU (Figure 3.4). The rugged terrain, make the veld in this region unsuitable for stock farming. On some farms suitable land is planted with fruit trees or vineyards, or is utilised for vegetable or vegetable seed production (Anonymous, 1999).

3.5.4 Kammanassie

This region of about 291 000 ha is bordered by the Olifants River-Gamka, Bo-Langkloof and Uniondale agricultural regions (Figure 3.1). The natural veld of about 258 200 ha is a mixture of mostly South and South-west Coast Renosterveld that is the dominant vegetation type, with smaller pockets of Spekboom Succulent Thicket (Figure 3.3). The Kammanassie region is mainly a crop and livestock production region where large areas are planted with lucerne and limited amounts of fruit and vegetables are produced. Because of the low grazing capacity of Renosterveld (72ha/LSU, Figure 3.4), various livestock breeds, such as Dorper and Merino sheep, Angora and Boer goats, to a great extent depend on planted fodder crops. Cattle are the only livestock that utilize the palatable grasses found in Renosterveld (Anonymous, 1999).

3.5.5 Uniondale

The Uniondale region of about 78 200 ha (Anonymous, 1999) is the furthest east in the region and lies south of the Swartberg Mountain range (Figure 3.1). The vegetation is a mixture of South and South-west Coast Renosterveld, Little Succulent Karoo and Spekboom Succulent Thicket (Figure 3.3). In the Renosterveld ('sour veld') large areas of dense stands of fairly unplatable *Pteronia incana* (kraakbos) can be observed around Uniondale. The grazing capacity here is estimated at 72 ha/LSU but as grazing conditions improve in the northern part of this region it is estimated at 42 ha/LSU (Figure 3.4). This area is used extensively for small stock production and breeds such as Dorper and Merino sheep and Angora and Boer goats are raised with great success (Anonymous, 1999).

3.5.6 Bo-Langkloof

This is a relatively small region of 17 600 ha north of the Outeniqua mountains (Figure 3.1) of which 12 000 ha (68%) are non-irrigated fields (dry lands) and about 1 000 ha of arable land is under irrigation. The natural veld of less than 5 000 ha, comprises South and South-west Coast Renosterveld and Fynbos (Figure 3.3). It has a very low estimated grazing capacity of 72 ha/LSU is rarely utilized for grazing (Figure 3.4). Small stock, mostly wool sheep and dual-purpose breeds are confined to old fields and pastures. This region is mostly renowned for its crop and fruit production (Anonymous, 1999).

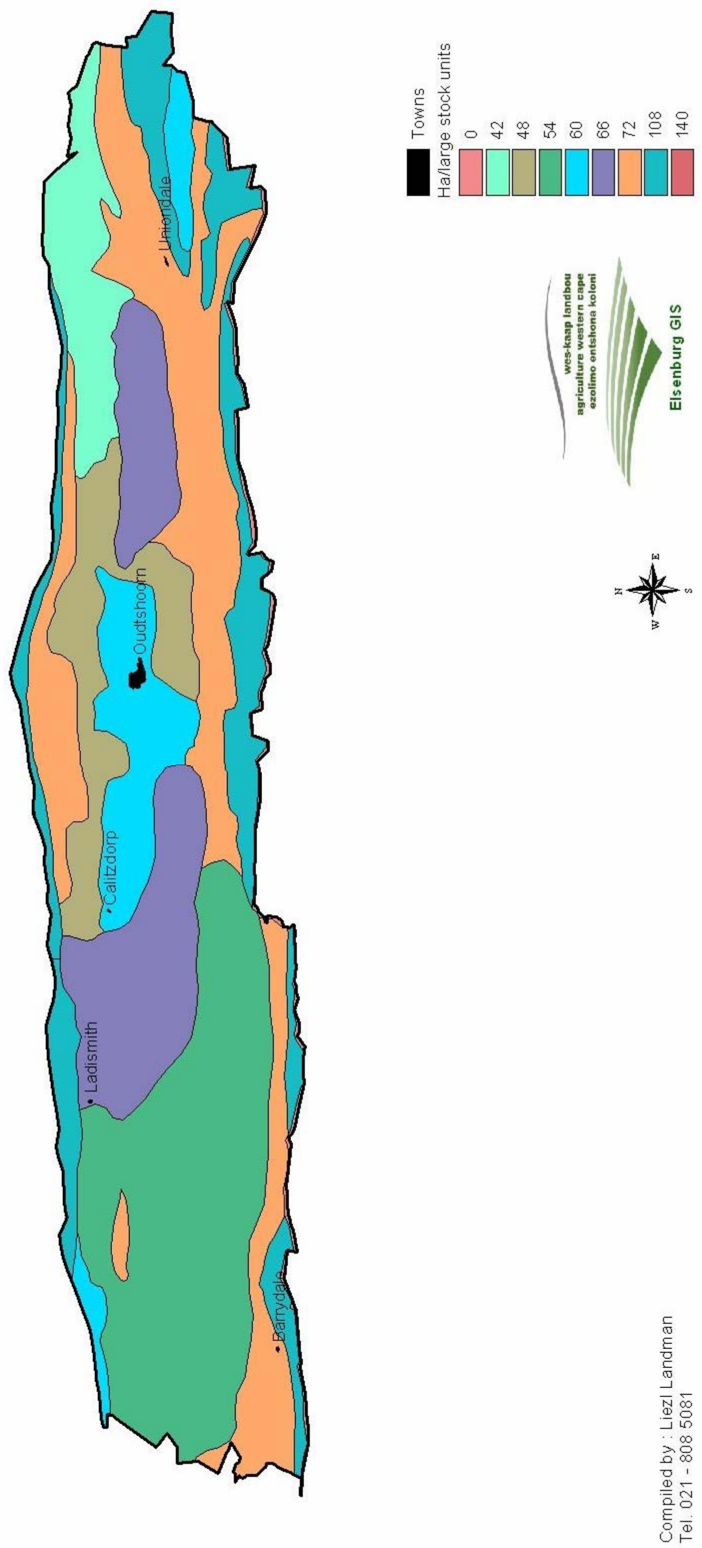


Figure 3.4 Estimated grazing capacities of the Little Karoo.

3.6 Socio-economics

The understanding of the socio-economic context in a hotspot is important for identifying the root causes of biodiversity loss and to develop effective conservation strategies (Conservation International, 2004). In the Little Karoo the economy is largely dependent on agriculture, therefore the sustainable utilisation of the natural resources is of utmost importance. The after-effects of discrepancies caused by the Apartheid regime can still be seen throughout the region of the Little Karoo where the 'Coloured' population, which constitutes roughly 80% of the Little Karoo population, still suffers economically. In the Kannaland region tourism and agriculture are the main sources of income, especially commercial fruit, small stock, ostriches and lucerne farming (Anonymous, 2002a). The economy of the Oudtshoorn Municipal region depends almost entirely on the ostrich industry (Anonymous, 2002b).

Within the Eden District Municipal area the agricultural sector provides 10.1% employment (Anonymous, 2002c), but the percentage is likely to be much higher within the Little Karoo region itself. Unemployment is a major concern, especially in the Kannaland region with employment ranging from as low as 28% in Zoar to 55.9% in Van Wyksdorp. In the major towns of Ladismith and Calitzdorp employment is respectively 47.5% and 37.8%. Despite the low percentage of employment more than 75% of people living or working on farms in and around these towns survive on earnings of less than R 1 500 per month (Anonymous, 2002a). Increased mechanization of agriculture and the increasing conversion of commercial farms to game farms could possibly lead to more unemployment in the near future.

Up to the present day the majority of agricultural land is still in the hands of White commercial farmers. The Land Redistribution for Agricultural Development (LRAD) programme which broader goal is to give Black farmers access to land for subsistence or productive purposes is one way of alleviating the poverty within the region. The process is however very slow with only 1 723 ha transferred to 370 people in the Little Karoo region (LRAD Department of Agriculture: Western Cape, 2004).

3.7 References

Anonymous. 1999. Klein Karoo Streeksinligtingsdokument. Oudtshoorn Proefplaas, Oudtshoorn.

Anonymous. 2002a. Kannaland Municipality Integrated Development Plan. Kannaland Municipality, May 2002.

Anonymous. 2002b. Oudsthoorn Local Municipality Integrated Development Plan. Oudtshoorn Municipality, 2002/3.

Anonymous. 2002c. Garden Route Klein Karoo Integrated Development Plan. Eden District Municipality, Ref 01809, April 2002.

Anonymous. 2003. The Succulent Karoo Hotspot: Namibia and South Africa, Final Version February 12, 2003. Critical Ecosystem Partnership Fund.

Booysen, P. de V. 1967. Grazing and grazing management terminology in southern Africa. *Proceedings of the Grassland Society of southern Africa*, **2**:45-57.

Conservation International 2004. Biodiversity hotspots. http://www.biodiversityhotspots.org/xp/Hotspots/hotspotsScience/monitoringHS.xml. accessed 22/09/2004.

Cowling, R. M., Gibbs Russel, G. E., Hoffman, M. T. and Hilton-Taylor, C. 1989. Patterns of plant species diversity in southern Africa. Pages 19-50 in Huntley, B. J. (ed.). *Biotic diversity in southern Africa. Concepts and conservation.* Oxford University Press, Cape Town.

Danckwerts, J. E. 1981. A technique to assess the grazing capacity of sweetveld with particular reference to the false thornveld area of the Ciskei. M.Sc.-thesis, University of Natal, Pietermaritzburg.

Desmet, P. G. and Cowling R. M. 1999. The climate of the karoo – a functional approach. Pages 3-16 in Dean W. R. J. and Milton, S. J. (eds.). *The Karoo: Ecological patterns and processes*. Cambridge University Press. Cambridge.

Ellis, F. 2004. Soil variation on and between heuweltjies in arid and semi-arid regions of South Africa. Arid Zone Ecological Forum 2004, 30 August – 02 September 2004, Victoria West, p. 15.

Government Gazette 1985. Conservation of Agricultural Resources Act, 1983 (Act 43 of 1983). Regulation Amendment, No. R. 2687. 6 December 1985.

Hilton-Taylor, C. 1987. Phytogeography and origins of the Karoo flora. Pages 70-95 in Cowling, R. M. and Roux, P. W. (eds.). *The karoo biome: a preliminary synthesis. Part 2 – vegetation and history*. South African National Scientific Programmes Report No. 142, Pretoria.

Hoffman, M. T. 1996. Little Succulent Karoo. Page 61 in Low, A. B. and Rebelo, A. G. (eds.). *Vegetation of South Africa, Lesotho and Swaziland*. Department of Environmental Affairs and Tourism, Pretoria.

Hoffman, M. T. and Cowling, R. M. 1987. Plant physiology, phenology and demography. Pages 1-34 in Cowling, R. M. and Roux, P. W. (eds.). *The karoo biome: a preliminary synthesis. Part 2 – vegetation and history*. South African National Scientific Programmes Report No. 142, Pretoria.

Joubert, J. G. V., Stindt, H. W. and Perold, I. S. 1969. *The nutritive value of natural pastures in the districts of Calitzdorp, George, Knysna, Mossel Bay, Oudtshoorn and Uniondale in the Winter Rainfall Area of the Republic of South Africa.* Technical Communication No. 82. Department of Agricultural Services, Government Printers, Pretoria.

Low, A. B. and Rebelo, A. G. 1996. *Vegetation of South Africa, Lesotho and Swaziland*. Department of Environmental Affairs and Tourism, Pretoria.

LRAD Department of Agriculture: Western Cape. 2004. Farmer Support and Development. Updated database June 2004.

Lubke, R. 1996. Spekboom Succulent Thicket. Page 18 in Low, A. B. and Rebelo, A. G. (eds.). *Vegetation of South Africa, Lesotho and Swaziland*. Department of Environmental Affairs and Tourism, Pretoria.

Meissner, H. H. 1982. Beef cattle C.3 – Classification of farm and game animals to predict carrying capacity. *Farming in South Africa*, pp. 1-3.

Meissner, H. H., Hofmeyr, H. S., van Rensburg, W. J. J. and Pienaar, J. P. 1983. *Classification of livestock for realistic prediction of substitution values in terms of a biologically defined Large Stock Unit*. Technical Communication no. 175, Government Printer, Pretoria.

Midgley, G. F. and Musil, C. F. 1990. Substrate effects of zoogenic soil mounds on vegetation composition in the Worcester-Robertson valley, Cape Province. *South African Journal of Botany*, **56**:158-166.

Midgley, G. F. and Van der Heyden, F. 1999. Form and function in perennial plants. Pages 91-106 in Dean, W. R. J. and Milton, S. J. (eds.). *The Karoo: Ecological patterns and processes*. Cambridge University Press, Cambridge.

Milton, S. J. and Dean, W. R. J. 1990. Mima-like mounds in the Southern and Western Cape - are the origin so mysterious? *South African Journal of Science*, **86**:207-208.

Milton, S. J., Yeaton, R. A., Dean, W. R. J. and Vlok, J. H. J. 1997. Succulent Karoo. Pages 131-166 in Cowling, R. M., Richardson, D. M. and Pierce, S. M. (eds.). *Vegetation of southern Africa.* Cambridge University Press, Cambridge.

Myers, N., Mittermeier, R. A., Mittermeier, C. G., da Fonseca, G. A. B. and Kent, J. 2000. Biodiversity hotspots for conservation priorities. *Nature*, **403**:853-858.

National Botanical Institute 2004. Succulent Karoo Biome. http://www.plantzafrica.com/vegetation/succkaroo.htm, accessed 03/08/2004.

Noy-Meir, I. 1973. Desert ecosystems: environments and producers. *Annual Review of Ecology and Systematics*, **4**:25-551.

Owen-Smith, N. and Danckwerts, J. E. 1997. Herbivory. Pages 397-420 in Cowling, R. M., Richardson, D. M. and Pierce, S. M. (eds.). *Vegetation of southern Africa.* Cambridge University Press, Cambridge.

Rebelo, A. 1996a. Central Mountain Renosterveld. Page 65 in Low, A. B. and Rebelo, A. G. (eds.). *Vegetation of South Africa, Lesotho and Swaziland*. Department of Environmental Affairs and Tourism, Pretoria.

Rebelo, A. 1996b. South and South–west Coast Renosterveld. Page 66 in Low, A. B. and Rebelo, A. G. (eds.). *Vegetation of South Africa, Lesotho and Swaziland*. Department of Environmental Affairs and Tourism, Pretoria.

Rebelo, A. 1996c. Mountain Fynbos. Page 71 in Low, A. B. and Rebelo, A. G. (eds.). *Vegetation of South Africa, Lesotho and Swaziland*. Department of Environmental Affairs and Tourism, Pretoria.

Rebelo, A. 1996d. Grassy Fynbos. Page 72 in Low, A. B. and Rebelo, A. G. (eds.). *Vegetation of South Africa, Lesotho and Swaziland*. Department of Environmental Affairs and Tourism, Pretoria.

Talbot, W. J. 1961. Land utilisation in the arid regions of southern Africa. Part 1: South Africa. Pages 299-338 in Stamp, L. D. (ed.). *A History of Land Use in Arid Regions. Arid Zone research*, Vol. 17. UNESCO, Paris.

Van Wyk, A. E. and Smith, G. F. 2001. *Regions of Floristic Endemism in South Africa. A Review with emphasis on succulents*. Umdaus Press, Pretoria.

Venter, J. M., Mocke, C. and De Jager, J. M. 1986. Climate. Pages 30-52 in Cowling, R. M., Roux, P. W. and Pieterse, A. J. H. (eds.). *The karoo biome: a preliminary synthesis. Part 1*. South African National Scientific Programmes Report 124, Pretoria.

Vlok, J. H. J., Cowling, R. M. and Wolf, T. 2005. A vegetation map for the Little Karoo. Unpublished maps and report for a SKEP project. Supported by CEPF grant No. 1064410304.

Watkeys, M. K. 1999. Soils of the arid south-western zone of Africa. Pages 17-25 in Dean W. R. J. and Milton, S. J. (eds.). *The Karoo: Ecological patterns and processes*. Cambridge University Press. Cambridge.

CHAPTER 4 VELD MANAGEMENT PRACTICES IN THE LITTLE KAROO

4.1 Introduction

4.1.1 The problem

The sinking of boreholes in the late nineteenth century enabled White commercial stock farmers to expand into arid areas that were previously considered economically unproductive for farming purposes (Talbot, 1961; Archer, 2002). A system, that allowed farmers to fence off farms into camps, was later employed to replace the traditional '*kraal system*'. In patchy systems like the Little Karoo different management strategies such as fencing, placement of watering points or salt licks, and breed selection, are used for increased uniform grazing by livestock. By applying recommended veld management systems, the production of palatable plant material for grazing animals on natural veld can be improved considerably (Stindt and Joubert, 1979). These veld management practices are employed by farmers to get maximum productivity from their farming units, but these practices must be employed without causing long-term damage to the rangeland. Degradation of our rangeland is however a reality and all investigations since 1923, that were directly or indirectly related to droughts, have reported that veld degradation was not primarily caused by drought, but mainly by overstocking and wrong agricultural veld practices (Anonymous, 1923; De Klerk, 1986). The advent of the rotational grazing systems in 1912 in the Karoo (Dean *et al.*, 1995) was a direct result of legislation in the form of the Fencing Act, which required farmers to fence their farm properties (Talbot, 1961). The Drought Investigation Commission of 1923 has indicated that the subdivision of farms into camps could increase the carrying capacity of the veld considerably (Roux and Opperman, 1986). Natural veld utilized for grazing is normally divided into camps to allow rotational grazing of the veld by livestock. It should supply the feeding needs of the grazing animal and the rest periods should be adequate for the growth requirements of the veld (Donaldson and Vorster, 1989). Recommended veld management practices considered in this study are grazing rotation, stocking rate control, moderate veld utilisation, separation of ecotopes, veld rehabilitation, controlling declared weeds and alien vegetation and regular assessment of veld condition. However they are not uniformly applied.

4.1.2 Recommended management practices and their acceptance

Personal knowledge as well as knowledge of the farming community's values are important because these factors greatly affect their perception, which will in the end influence their decision-making on management practices (Koch, 1985; De Klerk, 1986; Heitschmidt *et al.*, 2004). Bembridge (1975 as cited in De Klerk, 1986) has for example shown that there is a negative relationship between age and the acceptance of practices. In the same way one could expect that education levels of farmers will also play an important role in this regard. King and Bembridge (1988) have shown that improved levels of farmer education can accelerate the adoption of proven and recommended farming practices. The *Kommisie van Ondersoek na Landbou* (1970) has made it clear that South African farmers should qualify themselves adequately by means of formal educational programmes in farming practices before taking on farming as a profession.

The farm size, camp size, and position and number of watering points all have an influence on the strategy a farmer will follow in managing livestock on his farm. In general, livestock are reluctant to travel long distances to water (Valentine, 1974 as cited in Bailey, 2004), therefore the number and distribution of watering places is very important in managing the movement, distribution and concentration of grazing animals (Vallentine, 1989). Livestock are then managed within a specific grazing system. According to Vallentine (2001) grazing management is the manipulation of animal grazing to achieve desired results based on animals, plants, land, or economic responses, but the ultimate goal is to supply the quantity and quality of forage needed by the grazing animal for it to achieve the production function intended. Various grazing systems, which can be divided into the four categories of continuous grazing systems, resting or group camp systems, short duration grazing systems and veld reclamation systems, are employed by farmers to achieve the above-mentioned goal (McCabe, 1987). With the continuous grazing system stock is kept continuously in one camp, therefore stocking density must be low, but this system can lead to selective grazing. The resting systems or group camp systems of two, three and five camps was developed and recommended by the Department of Agriculture since 1923 to allow adequate periods of rest for the veld. The short duration grazing system was developed on the principles of Savory (1978) and recommended in South Africa to forestall veld degradation (Mentis, 1991). The key feature is that livestock is rotated through at least eight camps for a very short period of time (Holechek *et al*., 1989). The veld reclamation system, also known as the non-selective grazing or the Acocks system, is used to stop erosion by running as many different species of stock in limited size camps for a maximum of two weeks at a high stocking density. The system allows for a long period of recuperation (McCabe, 1987). Each grazing system has its pros and cons and there is still considerable ongoing debate, especially around rotational grazing systems (Roberts, 1969; Hoffman, 1988; Westoby *et al.*, 1989; O' Reagain and Turner, 1993; Illius and O'Connor, 1999; Hoffman, 2003).

The farmer's decision on the stocking rate is also a very important consideration when managing. Various studies have shown that long-term overstocking can lead to overexploitation of palatable plants that results in changes in plant species composition (Roux and Theron, 1987; Milton and Dean, 1990; Fuls, 1992; Milton, 1995; Milton and Dean, 1995; Milton *et al.*, 1997; Allsopp, 1999; Pelser and Kherehloa, 2000; Mellado *et al.*, 2003; Simons and Allsopp, 2003). 'Stocking rate' is defined by Booysen (1967) as *the area of land in a system of management, which the operator has allotted to each animal unit in the system and is expressed per length of the grazeable period of the year.* The stocking rate affects the rate of defoliation, hoof action, rate of accumulation of organic material and utilisation of specific components in the veld (McCabe, 1987; Morris *et al.*, 1999). Therefore a long term stocking rate that is higher than the estimated grazing capacity can have a detrimental effect on the veld condition. 'Grazing capacity' is defined by Booysen (1967) as *the productivity of the grazeable/browseable portion of a homogeneous unit of vegetation expressed as the area of land required to maintain a single animal unit over an extended number of years without deterioration to vegetation or soil.* Under Regulation 10 and 11 of the Conservation of Agricultural Resources Act (CARA) of 1983 (Act 43 of 1983), the grazing capacity, expressed as number of hectares per large stock unit, may not be exceeded, during a period of 12 months.

The veld condition of a rangeland determines to a great extent the profitability per hectare of natural veld (Danckwerts and King, 1984). The concept 'veld condition' is defined by Trollope *et al.* (1990) as *the state of health of the veld in terms of its ecological status, resistance to soil erosion and its potential for producing forage for sustained optimum livestock production.* The quality and productivity of the natural veld is of utmost importance to livestock farmers and frequent assessment of the veld condition can ensure sustainable productivity of the veld and help the landowner to make appropriate management decisions (Milton and Dean, 1996).

Grazing animals are usually very selective and in heterogeneous vegetation and patchy areas, these animals tend to congregate on certain areas and avoid other areas (Hugo, 1966; Vorster, 1999; Vallentine, 2001). Fencing is a direct method of altering the grazing patterns of livestock by which sensitive areas with similar forage and topography are managed differently (Bailey, 2004). According to Donaldson and Vorster (1989) the separation of 'vegetation types' by fencing can play a major role in reducing veld degradation in South Africa. 'Vegetation types' from an agricultural perspective are not necessarily related to the ecological vegetation types as classified by Acocks (1975) or Low and Rebelo (1996), but more related to landscape form or uniformity of vegetation. Vorster (1999) refers more correctly to 'vegetation types' in this regard as ecotopes. In an agricultural sense, a 'vegetation type' or ecotope represents the smallest practical unit of subdivision of veld in farm planning (Donaldson and Vorster, 1989). Traditionally riparian zones, plains and mountainous areas are fenced separately because of the differences in palatability within these landscapes. Riparian zones are, for example, favoured by grazing animals because of its high palatability, quality and variety of forage (Vallentine, 2001).

Unacceptable farming practices, especially overstocking which results in overgrazing can lead to considerable changes in plant composition and soil loss through excessive grazing, browsing and trampling. In many instances the soil and vegetation composition have been altered almost permanently and simply resting from livestock cannot restore the landscape to its original state (Milton *et al.*, 1997; Simons and Allsopp, 2003). The only way to make the rangeland productive again is through various rehabilitation techniques. Rehabilitation indicates *a holistic approach to a degree that the ecosystem is restored to an optimum usable condition within economic boundaries* (Van Wyk, 1994 as cited in Van den Berg, 2002). Scheepers and Kellner (1995 as cited in Snyman, 1998) estimates that 66% of the rangelands in South Africa is in a moderate to serious phase of degradation. According to Roux and Opperman (1986) soil erosion in the Karoo varies from moderate to extreme and the symptoms ranges from very obvious gullies (also referred to as 'dongas') to inconspicuous sheet erosion. In the Little Karoo, especially in the Little Succulent Karoo and Spekboom Succulent Thicket vegetation types, sheet and gulley erosion are common (Anonymous, 1999) because of high run-off.

The utilisation of South Africa's natural agricultural resources is controlled primarily by the National Department of Agriculture. In the interest of 'best agricultural practices' in the sustainable land use, legislation was developed to maintain the land's production potential, prevent erosion, protect the natural vegetation and to prevent the invasion of alien plants. The majority of this legislation applicable to landowners is found in the Conservation of Agricultural Resources Act of 1983 (CARA) (Act 43 of 1983). In addition to this recent legislation such as the National Environmental Management Act 107 of 1998 (NEMA), the National Veld and Forest Fire Act 101 of 1998 and the National Water Act 36 of 1998 were developed. Specific guidelines on veld management practices specifically for ostrich farmers were recently revised by the Ostrich Business Chamber, farmer unions, the Department of Agriculture and the Western Cape Nature Conservation Board (Anonymous, 2003). This pamphlet contains simplified guidelines based on CARA and NEMA to which ostrich farmers should adhere, in order to reduce the alleged detrimental effect high ostriches numbers have on the natural veld (Van Eeden, 1996; Hoffman, 1996).

Even though legislation is in place to regulate veld management practices, the ways in which farmers manage their farming units remains a personal issue. Studies by Düvel (1975) and De Klerk (1986) have recognized that personal and environmental factors do have an influence on the acceptance of practices by managers.

4.1.3 Objectives

The objective of this chapter is to provide background information on the demography of the Little Karoo farming community (age structure, farming experience and education level), sizes of farms and camps, types of farming enterprises and on adoption of recommended veld management practices in the region. Information on the farming community and their management practices and motives can be used in developing future agricultural policies or improve training, management and service provision within the region.

4.2 Method

Background on farming practices adopted by farmers in the Little Karoo was determined by using a questionnaire, which was completed by means of a personal interview on the respondent's property.

4.2.1 Questionnaire design

A questionnaire used by De Klerk (1986) to determine which factors inhibit the acceptance of recommended veld management practices by farmers, was the template for setting up the questionnaire (Appendix 1) for this study. The questions were grouped into the following categories: (a) demography of farmers, (b) ostrich farming, (c) perceptions and knowledge of farmers on farming practices, (d) grazing rotation, (e) stocking rate, (f) veld utilisation and veld assessment, (g) separation of ecotopes, (h) veld rehabilitation, (h) control of alien vegetation and (i) farmers' knowledge on legislation. The questionnaire makes provision for open-ended and closed questions. Some of the closed questions were multiple response questions where respondents could make more than one choice, which were in no specific order of importance. The open-end questions were added to the questionnaire to encourage free and spontaneous answers (Oppenheim, 2003). Respondents were therefore not limited to choices predetermined by the designer of the questionnaire when answering such questions. In some instances closed questions were combined with open-ended questions. The questionnaire was set up in Afrikaans because it is the language used by the majority of farmers in the Little Karoo region. After the concept questionnaire was circulated to specialists for comments and recommendation, it was reproduced for the pilot study.

4.2.2 Sample size

Farmer unions of the Kango, Olifants River-Gamka, Touw-Ladismith, Kammanassie and Uniondale agricultural regions were requested to identify landowners within their region whose farms comprise more than 40% of natural veld. The Bo-Langkloof region was not considered because it is primarily a crop and fruit-producing region. In total three hundred and three such landowners were identified of which 100 was selected randomly from the compiled list. A stratified random sample design (Steyn *et al*., 1994) was used to draw samples from each agricultural region in proportion to the number of landowners in each region. Thirty-three percent of the appropriate landowners in the region were sampled. As a result the following samples were drawn for each region: Kango (6), Olifants River-Gamka (58), Touw-Ladismith (12), Kammanassie (11) and Uniondale (13). A reserve list of twenty five percent of this sample size was created for each agricultural region Kango (2), Olifants River-Gamka (15), Touw-Ladismith (3), Kammanassie (3) and Uniondale (3) as insurance in case some of the landowners in the sample would decline to participate as respondents in the study.

4.2.3 Pilot study

A pilot study as suggested by Oppenheim (2003) was done late in 2002 with three landowners from the Olifants River-Gamka and one from in the Touw-Ladismith region to test-run the questionnaire to get an estimate of time needed to complete it. On average the time required for each questionnaire was about 55 minutes. Questions that were found to be confusing to the respondent were identified and revised and thereafter reproduced for the final interviews.

4.2.4 Media

In 2002 the Ostrich Business Chamber took the initiative to issue a press release, which was published in the local newspaper *Hoorn* (18 July 2002) to inform landowners in the Little Karoo about the proposed study.

4.2.5 Cover letter

A cover letter was mailed one month before the start of the fieldwork to all the landowners in the sample. The cover letter explained why and how the farmer was chosen, the purpose of the study, why the study is important and how long it would take to complete the questionnaire, as suggested by Thomas (1999). It also assured the landowners about the confidentiality of the questionnaire and that the respondent would not be disclosed under any circumstances.

4.2.6 Telephonic appointments

Telephone calls to respondents were made between 19h00 and 21h00 during weekdays, because this appears to be the time slot most convenient for farmers. Landowners in the sample were contacted two weeks in advance to confirm whether they had received the cover letter and an appointment was made. In general landowners preferred to be reminded again a day or two before the appointment date due to the unpredictability of their work situation.

The fieldwork was done according to agricultural region and landowners in the sample that lived close to each other had to be identified in order to arrange appointments on the same day. A maximum of three interviews could be completed in one day depending on the availability of respondents, weather conditions, road conditions, available daylight and the distance between farms, but on average mostly two could be completed per day.

4.2.7 Statistical analysis

Data was captured in Microsoft® Excel spreadsheet format in order to generate descriptive statistics. Non-parametric statistics were used because data tended to be qualitative and non-normally distributed. Chi-square analysis in the statistical package SPSS (SPSS, 2002) was used to test the hypothesis of no association of columns and rows in tabular data. Microsoft® Excel was also used to put data into frequency tables and graphs.

4.3 Results

4.3.1 Demography of farming community

<u>Farmer age, farming knowledge and farming experience</u>

The majority of respondents fall in the category 41 to 50 years of age (36%) and 73% of them are older than 40 years as can be seen in Figure 4.1.

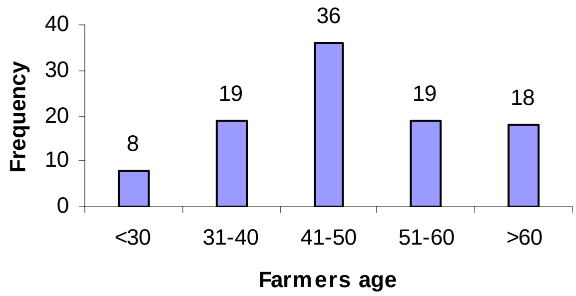


Figure 4.1 The age classes of respondents (N = 100).

Fifty five percent of respondents are between 30 and 50 years of age with only 8% younger than 30 years. More than 50% of respondents have more than 20 years of farming experience as illustrated by Figure 4.2. Most farmers in this region tend to stay on the same farm and as shown by Figure 4.3, more than 70% of farmers stayed on the same farm for the last decade.

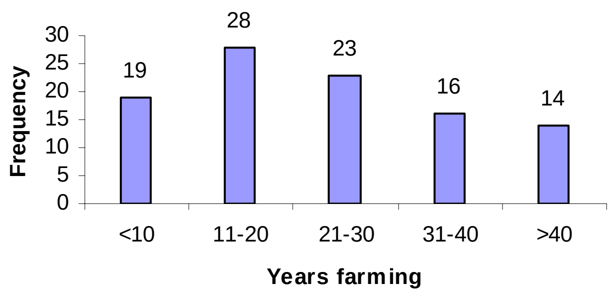


Figure 4.2 Respondents’ farming experience.

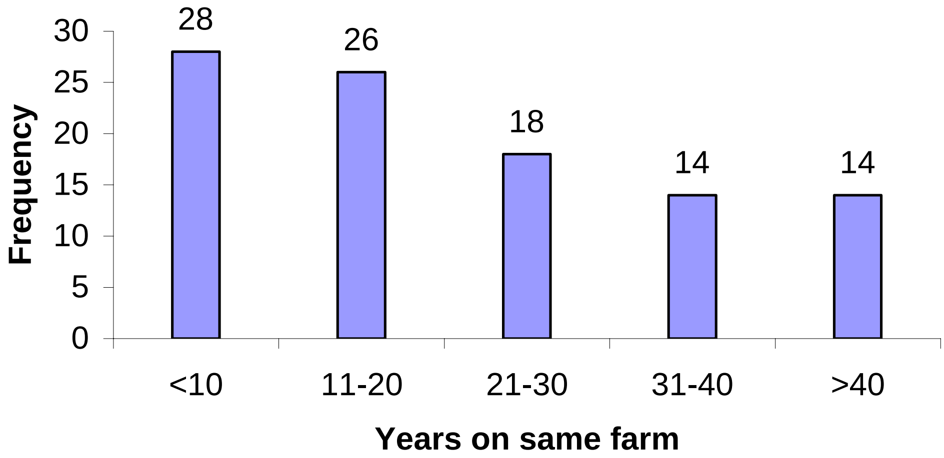


Figure 4.3 Respondents' occupation of the same farm.

<u>Educational level and perceived knowledge of farming practices</u>

Figure 4.4 shows that fifty percent of farmers have some form of post-matric qualification while 49% have received schooling of some sort. Only one percent of the respondents did not receive any schooling.

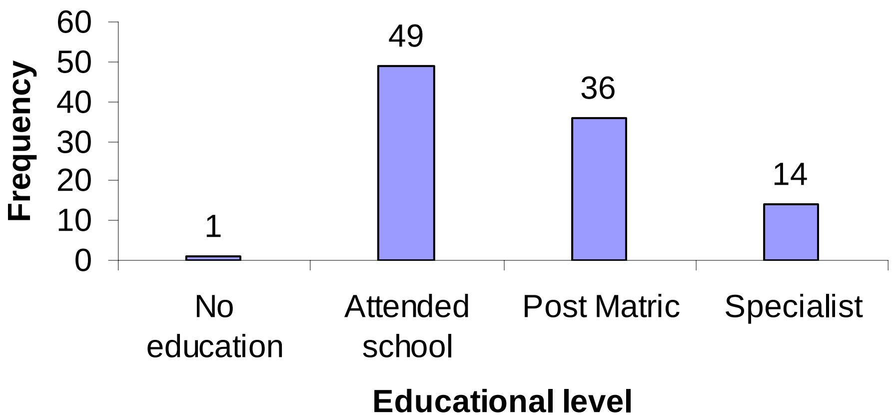


Figure 4.4 Educational level of Little Karoo farmers.

In general the majority of Little Karoo farmers believe that they have a good to excellent knowledge of farming practices as can be seen in Figure 4.5. More than 60% of respondents believe that they have a good to excellent knowledge of farming practices and a very small percentage (<15%) feel that their knowledge on this matter is poor to very poor.

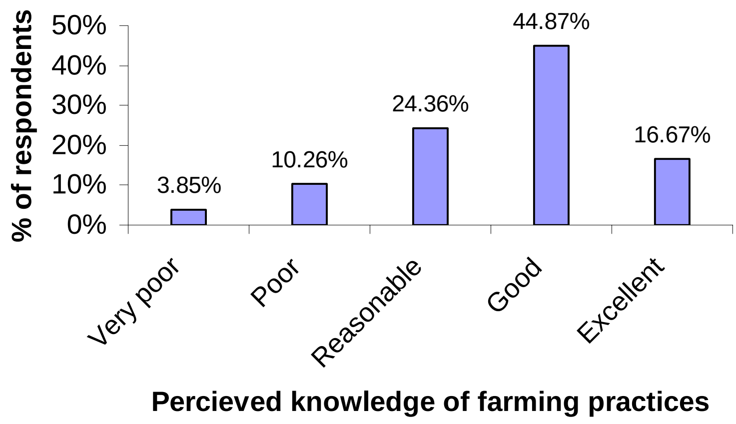


Figure 4.5 The knowledge of respondents' farming practices as perceived by themselves.

4.3.2 Farm and camp size and watering points

Farm size and division

Farms in the Little Karoo region are relatively small for a semi-arid agricultural region as can be seen in Table 4.1 which shows that more than 60% of farms are smaller than 2 000 ha.

Table 4.1 The number and percentage of farms in different farm size categories

	Respondents	
Farm size (ha)	**N**	**%**
< 500	23	23.23%
501 – 1 000	16	16.16%
1 001 – 2 000	22	22.22%
2 001 – 3 000	10	10.10%
3 001 – 4 000	7	7.07%
4 001 – 5 000	6	6.06%
>5 000	15	15.15%
Total	99	100.00%

More than 90% of the farm area in the sample is considered to be natural veld and only 4.54 % of the agricultural land is utilized for planting of artificial crops (Table 4.2). The low rainfall and availability of surface water is probably the main reason for this low figure and lucerne is one of the very few crops that can be successfully cultivated.

Despite the low percentage of agricultural land that is utilized for artificial forage crops, respondents feel that they have enough reserve feed or camps available for drought periods. Figure 4.6 shows that slightly less than 80% of respondents feel very confident (good =

44.87% and excellent = 34.67%) that they have adequate reserve feed available for dry seasons.

Table 4.2 A summary of farm utilisation

Farm division	Ha	% of farm
Total Farm area	281 447.0	
Used for veld	257 431.0	91.47%
Used for crops	12 779.5	4.54%
Other use	9 641.5	3.43%
Old fields	1 665.0	0.59%
Total*	281 517.0	100.03%

*Total farm area and final total does not add up because in many cases respondents gave an estimate of farm size.

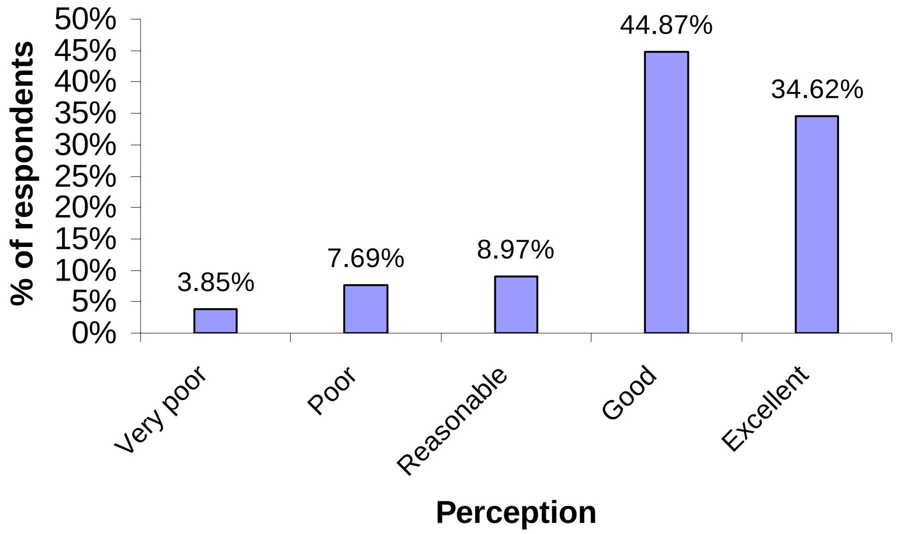


Figure 4.6 The perception of respondents on the reserve feed available during dry seasons.

<u>Camp size and watering points</u>

Table 4.3 shows that smaller farms have very small, and very few camps, while larger farms tend to have larger and more camps. In the Little Karoo the average number of camps are eight per farm and the average camp size is 319.23 ha. However, more than 60% of farms are less than 2 000 ha with an average of only four camps with an average size of 230.5 ha.

Table 4.3 A summary of the farm size classes with the average number and size of veld camps in the Little Karoo

Farm size classes	N	Average camps	Average camp size (in Ha)	SD in camp size
< 500	23	3.13	105.83	4.17
501 – 1 000	16	3.44	243.44	2.34
1 001 – 2 000	21	5.38	357.19	3.14
2 001 – 3 000	9	6.89	370.56	3.22
3 001 – 4 000	7	11.71	301.43	3.45
4 001 – 5 000	6	17.17	323.33	9.62
>5 000	15	16.93	650.00	8.97

*Three farms excluded because of inadequate data

Most camps in the Little Karoo (76.63%) are supplied with permanent watering points and on average there are two watering points per camp in the region. Each watering point provides on average water to 182.66 ha of natural veld. The distribution of watering points in the Little Karoo region is displayed in Table 4.4, which shows that most watering points are placed central (N = 36, 42.86%) within the camp. About 37% (N = 31) of the respondents have watering points placed in random positions.

Table 4.4 The distribution of water-points for all animal types in the Little Karoo region

	Respondents	
Position of watering points	N	%
Central	36	42.86%
In corner	5	5.95%
Next to fence line	12	14.29%
Random	31	36.90%
Total	84	100.00%

The perception of farmers on the quality and quantity of camps on their farms is displayed in Figure 4.7.

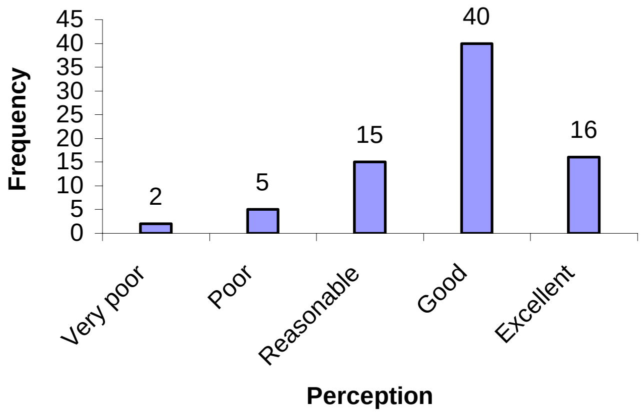


Figure 4.7 The farmers' perception on quality and quantity of camps on their farms.

4.3.3 Types of farming enterprises and income

<u>Animal breeds /types</u>

The Little Karoo is well known for its ostrich production, but a variety of animal breeds can be found in this region as displayed in Table 4.5. This variation in animal breeds could be explained by the heterogeneity of vegetation types and topography of the region. Ostriches are by far the most popular animals that are bred by respondents (N = 82), followed by sheep (N = 59), cattle (N = 58) and to a lesser extent goats (N = 28). Dorper (N = 44) and Bonsmaras (N = 13) are respectively the most common small and large stock breeds and there is also a high frequency of crossbred cattle in the region. Boer (N = 15) and Angora goat (N = 7) are the most common goat breeds. Boer goats are found across the whole region, while Angora farming is mostly found in the Uniondale agricultural region. Very few respondents (N = 14) have game on their farms and it is mostly kept for its aesthetic or recreational value. Very few farmers farm actively with game on a large scale and of the three that were visited, none has been in operation for more than 10 years and income from game farming was never more than 1% of the farmers' total income. Game species that are found on farms in the region are springbok, ostrich, koedoe, eland, zebra, black wildebeest, red hartebeest and giraffe.

Table 4.5 A summary of sheep, cattle and goat breeds and game farming in the Little Karoo

Goat

	Frequency	Percent
Boer goat	15	53.6
Angora	7	25.0
Other	1	3.6
Boer goat / Angora Combination	5	17.9
Total	28	100.0

Sheep

	Frequency	Percent
Dorper	44	74.6
Merino	5	8.5
Damaras	1	1.7
Ille de France	3	5.1
Other	4	6.8
Dorper/Damaras Combination	2	3.4
Total	59	100.0

Cattle

	Frequency	Percent
Bonsmaras	13	22.4
Afrikaner	4	6.9
Nguni	4	6.9
Fries	2	3.4
Jersey	2	3.4
Brahman	2	3.4
Hereford	7	12.1
Holstein	1	1.7
Crossbred	12	20.7
Santa Gertrudes	2	3.4
Angus	2	3.4
Simmentaler	1	1.7
Combination	6	10.3
Total	58	100.0

	Frequency	Percent
Game	14	100.0
Ostriches	82	100.0

Income from livestock or ostrich production

The same categories used by De Klerk (1986) were used to classify farmers according to the percentage income from livestock or ostrich production.

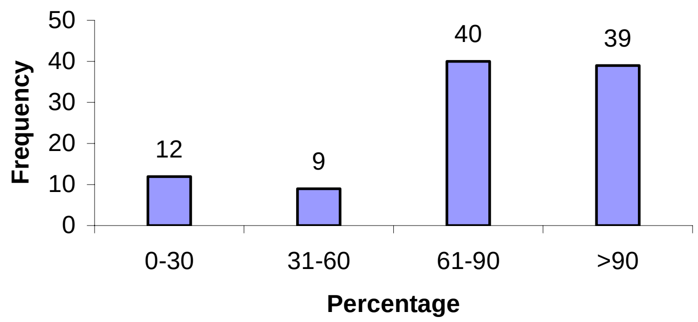


Figure 4.8 The percentage income of farmers from livestock and / or ostrich production.

Slightly less than 80% of farmers in Little Karoo have an income of more than 60 % from livestock production of which a large percentage (39%) receive an income of more than 90% directly from livestock production (Figure 4.8). One could therefore conclude that most farmers in the region are dependent on their natural veld for animal production.

The factors that farmers consider to be important contributors towards a higher income from livestock and ostrich production are displayed in Figure 4.9. The majority of respondents felt that better prices (N = 47) were the most important factor that could increase their income from livestock or ostrich farming. More land (N = 32), planting of drought resisting fodder (N = 28), better genetic selection (N = 27) and higher stocking numbers (N = 25) were also considered as important factors that could increase their income. Not one respondent thought that the lowering of stock numbers could increase income.

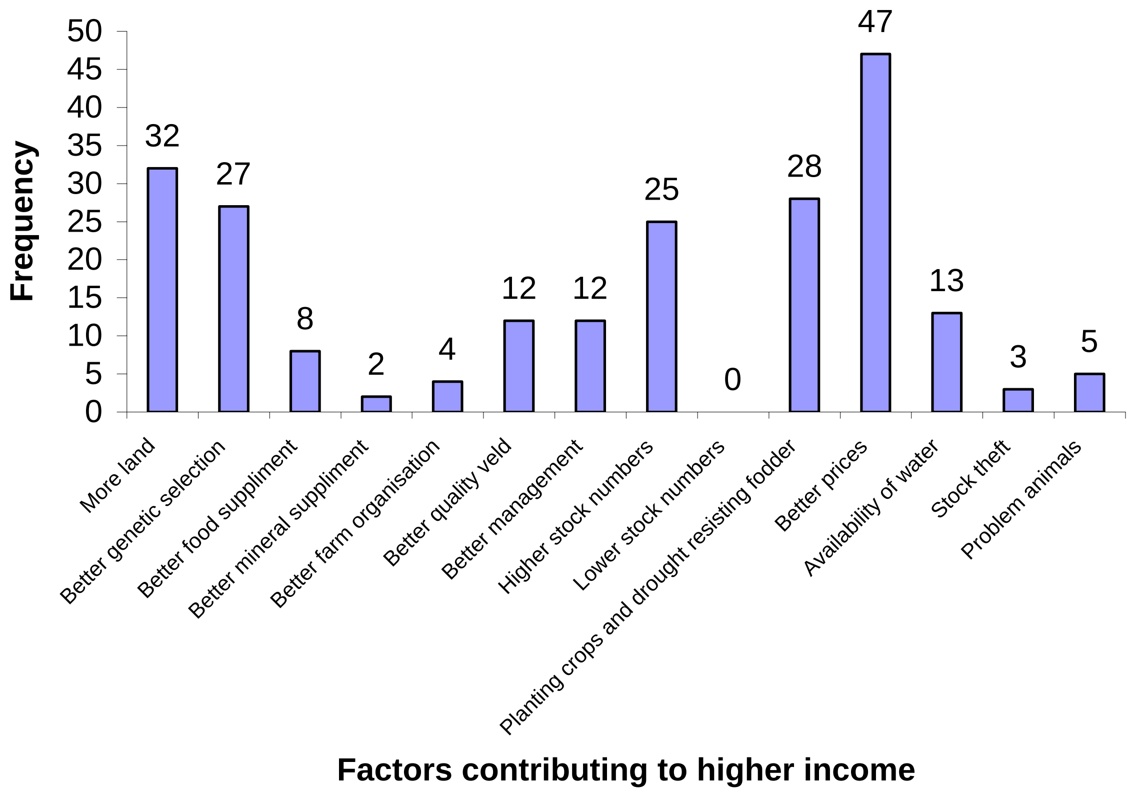


Figure 4.9 Factors that are considered by Little Karoo farmers, which could contribute to a higher income from livestock and / or ostrich production.

4.3.4 Ostrich farming

Very few farmers (N = 14, 17.07%) farm exclusively with ostriches. Ostrich farming is mostly supplemented with small or large livestock or as a combination. These combinations are displayed in Table 4.6. The combination of farming with ostriches and cattle (N = 19) and ostrich / cattle / sheep (N = 23) have the highest frequency.

Most ostrich farmers sell mature birds directly to the co-operation (N = 58) where 98% of the birds are processed. A few farmers indicated that they only market feathers (N = 3), skin (N = 3) and meat (N = 5) and fifty-eight respondents raise ostrich chicks that are later sold to farmers that specialize in slaughter birds.

Table 4.6 The combinations of farming with ostriches and livestock

Combinations of animal type	N	%
Ostrich only	14	17.07%
Ostrich and cattle	19	23.17%
Ostrich and sheep	7	8.54%
Ostrich and goat	1	1.22%
Ostrich, cattle and sheep	23	28.05%
Ostrich, cattle and goat	3	3.66%
Ostrich, sheep and goat	9	10.98%
Ostrich, cattle, sheep and goat	6	7.32%
Total	82	100.00%

Ostrich farmers make use of a variety of camps in which ostriches are kept for feeding or breeding. The frequency of the type of camps used for raising ostriches is displayed in Figure 4.10. Ostriches mostly occupy lucerne pastures (N = 76) and feeding camps (N = 64). Feeding camps are camps of up to 10 ha which are used primarily for feeding ostriches that will be slaughtered for meat, skin and feather products at a stocking density of 70 to 100 birds per ha (Anonymous, 2003). Breeding birds are often kept in these camps after the breeding season for up to four months (Nel, 1995). For breeding purposes ostriches are kept on either natural veld camps or in small breeding camps.

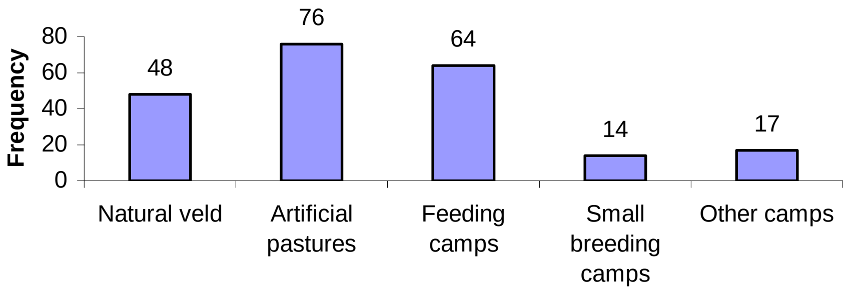


Figure 4.10 Frequency of camp types where ostriches are kept on farms.

Free-range ostrich farming on natural veld

Natural veld camps are used by 63.16% (N = 48) of ostrich farmers to breed birds in breeding flocks, therefore if one would consider the fact that natural veld constitutes more than 90% of the farm's surface it can be assumed that the largest portion of such farms are used for breeding birds. The breeding season for ostriches is normally from May / June until the end of January (Nel , 1995).

More than two thirds of respondents (N = 32) keep breeding birds for seven to nine months in veld camps, 6.25% (N = 3) for less than seven months and 27.08% (N = 13) for periods of more than ten months up to a year. Ostrich farmers making use of free-range ostrich production prefer using camps with the least slope. Because of the high topographical variation in the region (Watkeys, 1999), large flat areas that are ideal for ostrich camps are not readily available and only 12.5% (N = 6) of free-range ostrich farmers indicated that their camps are mostly flat. More than 80% of them (N = 40) described the topography of their camps as rolling and less than five percent (N = 2) indicated that their veld camps were mainly on steep slopes.

Small breeding camps

Only 18.42% (N = 14) of ostrich farmers keep breeding pairs or trios (one male with two females) in small breeding camps. These breeding camps are usually about 0.25 ha which can produce and take care of a maximum of 25 chicks (Nel, 1995). Very often ostrich farmers will consider camps as large as 5 hectares as small breeding camps where up to 18 ostriches are kept.

Income from ostrich farming

Ostrich farmers were grouped according to their income from ostrich production. ‘Strictly ostrich farmers’ are considered to have an income of >66.6% (N = 48, 58.54%) from ostriches, ‘mostly ostrich farmers’ receive 33 to 66% (N = 21, 25.61%) and ‘part-time ostrich farmers’ <33% (N = 13, 15.85%) of their income from ostrich farming. Figure 4.11 shows that farming with ostriches on natural veld is the most lucrative form of ostrich production. Results from a Chi-square analysis to ascertain whether type of ostrich farming (small breeding camps or veld) has any correlation with the percentage of income from ostrich farming indicated that there is a difference between these groups with a Pearson Chi-Square value of 13.63 that is statistically significant ($p < 0.05$). Further examination of the Chi-Square scores indicates that those farmers who receive less than 33% of their income from ostriches are most likely to have breeding birds in small breeding camps and least likely to have breeding birds in the veld while those farmers who receive more than 66% of their income from ostriches are least likely to have breeding birds in small breeding camps and most likely to have breeding birds in the veld.

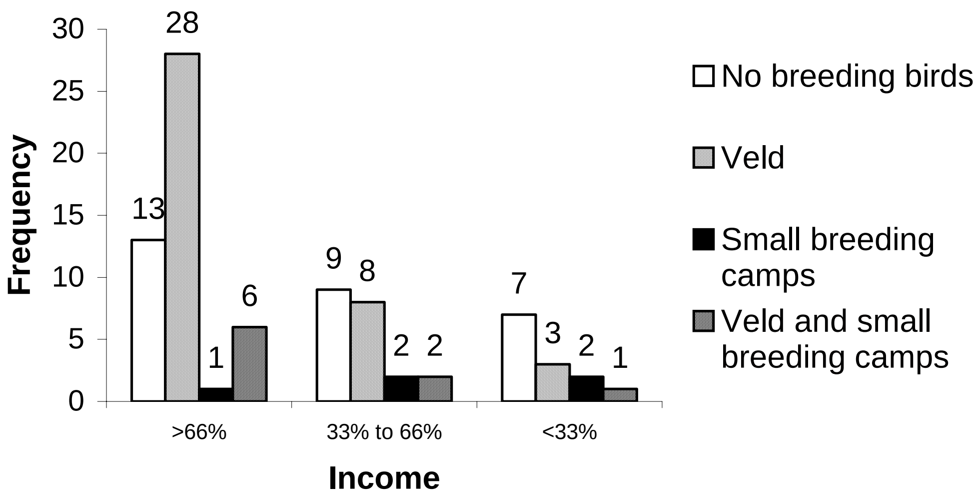


Figure 4.11 The contribution of ostrich farming to total income of ostrich farmers with the frequencies of farmers with no breeding birds and with breeding birds in veld, small breeding camps and a combination of veld and small breeding camps.

4.3.5 Grazing rotation

In general the majority of respondents are satisfied with the grazing rotation that they practice on their farms with more than 50% describing it as good and 18.42% as excellent (Figure 4.12). Less than 10% describe the grazing rotation on their farms as poor and 3.95% as very poor. The grazing systems that are used by ostrich farmers and for all animals are displayed in Table 4.7. In general the three camp systems is most widely used by 32.05% of farmers in the Little Karoo. More than 40% of ostrich farmers claim to use a three camp system where a flock utilizes one camp for one breeding season and thereafter the camp is rested for two seasons. The short duration grazing system is used exclusively by farmers of mammalian livestock that make up 11.54% of all farmers in the region. 'No fixed system' is used by slightly less than 20% of Little Karoo farmers. In this 'system' the farmer employs no method recommended by the Department of Agriculture. It would seem that such farmers rather consider environmental factors like frequency of rainfall and current productivity of the veld when deciding on the amount of time for resting veld and when animals are moved in and out of camps.

It is clear from Figure 4.13 that farmers are more likely to chose the most practical grazing system (N = 54) that suite their needs on their specific farm. It seems that the information on grazing systems from extension officers (N = 11) or neighbouring farmers (N = 4) are less important when deciding on a particular system. Four respondents indicated that their choice of grazing system was made with the intention of improving veld quality.

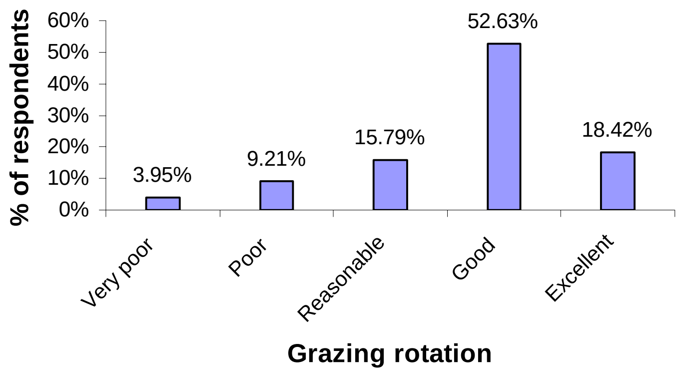


Figure 4.12 The perception of farmers on the successful practice of grazing rotation on their farms.

Table 4.7 The frequency of grazing systems used by ostrich farmers and for all farmers in the Little Karoo

Grazing system		**Ostriches**	**Mammalian livestock**	**All animals**
Group Camp systems				
4 - 5 Camp	N	1	3	4
	%	2.08%	10.00%	5.13%
Three camp	N	21	4	25
	%	43.75%	13.33%	32.05%
Two camp	N	5	0	5
	%	10.42%	0.00%	5.13%
Other systems				
No fixed system	N	7	7	14
	%	14.58%	23.33%	19.23%
Short duration grazing	N	0	9	9
	%	0.00%	30.00%	11.54%
Continuous	N	8	1	9
	%	16.67%	3.33%	11.54%
Other	N	6	6	12
	%	12.50%	20.00%	15.38%
Total		**48**	**30**	**78**

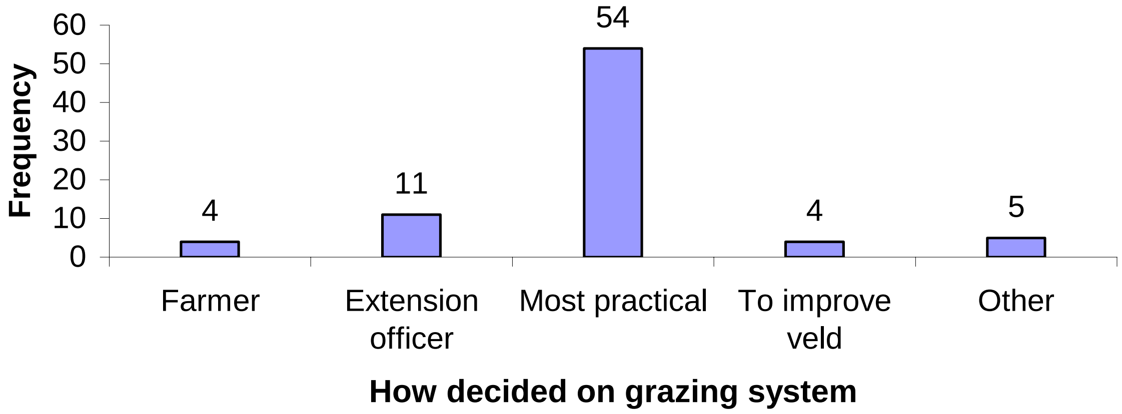


Figure 4.13 Factors influencing farmers' decision-making on their choice of grazing system.

4.3.6 Stocking rate

Stocking rate on the veld is referred to in terms of hectares per large stock unit per time unit (year) and likewise, the grazing capacity is referred to in the same terms (Du Toit, 2003). According to Galt *et al.* (2000), authors generally agree that in semi-arid areas a 25% harvest coefficient (percentage of forage produced that is assigned to grazing animals for consumption) is accepted to avoid land degradation and chronic forage deficits. They conclude that this percentage should be considered when grazing capacity and stocking rate is assigned. The estimated grazing capacity for South Africa's rangeland has been mapped by the Department of Agriculture (see Chapter 3 for the Little Karoo estimated grazing capacity).

From the data displayed in Figure 4.14 it seems that the majority of respondents are satisfied with the stocking rate of animals in their farms. More than 19% believe that their stocking rate is excellent i.e. well below the estimated grazing capacity of the Department of Agriculture for the region. About 35% of them indicated that their stocking rate is good, i.e. under stocked relative to the estimated grazing capacity. More than 16% indicated that their stocking rate is poor, which means that they stock above the estimated grazing capacity and 7.79% of respondent feel that they heavily overstock their veld.

The extent to which respondents agree or disagree with the accuracy of the estimated grazing capacity of the Department of Agriculture is displayed in Table 4.8.

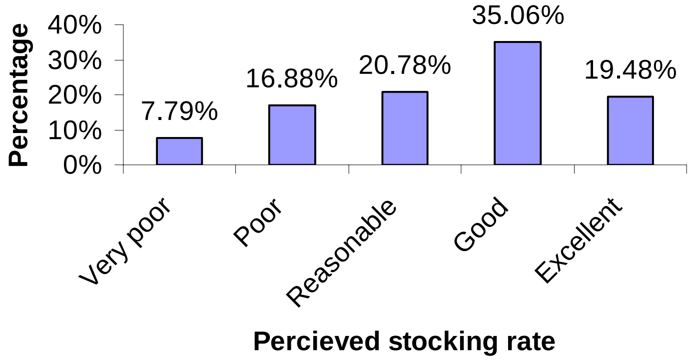


Figure 4.14 Farmers' perception of their own farm's stocking rate.

Table 4.8 The measure of farmers' agreement on the accuracy of the estimated grazing capacity of the Department of Agriculture

	Own farm		District	
	N	**%**	**N**	**%**
Totally disagree	7	8.97%	10	12.82%
Do not agree	12	15.38%	9	11.54%
Agree to certain extent	14	17.95%	11	14.10%
Agree	19	24.36%	24	30.77%
Totally agree	12	15.38%	11	14.10%
Do not know / Unsure	14	17.95%	13	16.67%
Total	78	100.00%	78	100.00%

The perception of respondents on the over or under estimation of their own veld's grazing capacity in relation to that estimated by the Department of Agriculture for ostrich, sheep, cattle and goat is displayed in Figure 4.15. The respondents estimation of his farm's grazing capacity is expressed as percentage under estimate or as the percentage over estimate in categories: 0 to 33%, 33 to 66% and >66% over estimated. It seems clear that ostrich farmers do not feel that their own farm's grazing capacity is lower than the estimated grazing capacity of the Department. Only about 10% under-estimated their grazing capacity when compared to the Department's estimated grazing capacity and 90% have over estimated. The majority of ostrich farmers have over estimated their farm's grazing capacity from 34% up to >66% when compared to the estimated grazing capacity of the Department. More or less a third of sheep, goat and cattle farmers under estimated the grazing capacity of their farms and therefore feel that their veld has a lower carrying capacity as indicated by the estimated grazing capacity of the Department. A larger percentage of ostrich farmers (37.5%) than livestock farmers (18.25% on average) were unsure on how their farms' grazing capacity compares to the estimated grazing capacity of the Department.

Chi-square analysis was conducted to ascertain whether type of animal farming has any association with percentage agreement with Government estimated grazing capacity. The results show that there is a significant association with a Pearson Chi-Square value of 34.00 that is statistically significant ($p < 0.001$). Further examination of the Chi-Square scores indicates that those farmers who farm with ostriches are most likely to over estimate their grazing capacity by more than 66% and least likely to under estimate or over estimate their grazing capacity by up to 33%. Those farmers who farm with sheep are least likely to over estimate their grazing capacity by more than 66% while those farmers who farm with goats are most likely to over estimate their grazing capacity by up to 33%.

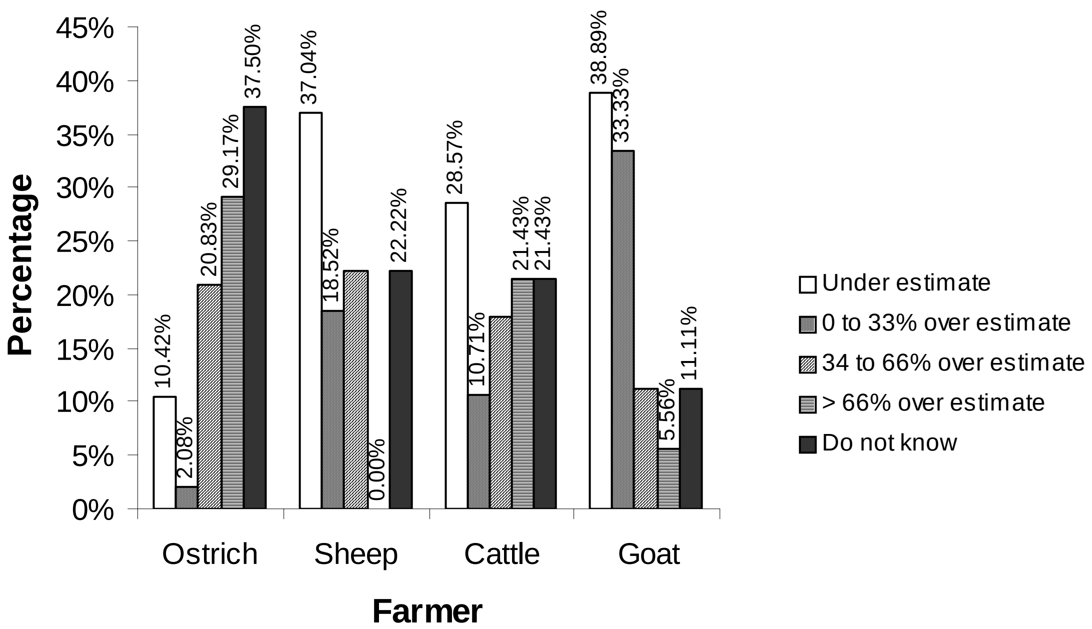


Figure 4.15 The perception of farmers on the over or under estimation of their own veld's grazing capacity in relation to that recommended by the Department of Agriculture.

4.3.7 Veld utilisation, grazing records and assessment of veld condition

According to De Klerk (1986) 'veld utilisation' implies keeping the correct livestock on a specific vegetation type, the number of animals kept, the correct number of camps and the correct period of grazing and resting of veld. However, in this section the respondents were questioned on their perception on veld utilisation, the keeping of grazing records, veld condition and veld assessment, and factors influencing decision making regarding veld management. The respondents' perception on how they utilize their natural veld is displayed in Figure 4.16

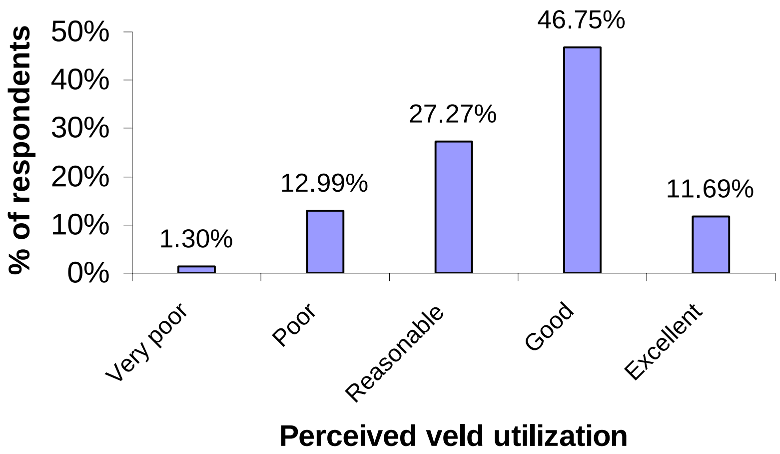


Figure 4.16 The perception of respondents on the utilisation of their natural veld.

<u>Keeping of grazing records</u>

Only seven (9.09%) respondents indicated that they keep complete grazing records, 14 (18.18%) only partial records and the majority (N = 56, 72.72%) do not keep any grazing records.

<u>Veld condition and veld assessment</u>

The frequency of assessing veld by respondents is displayed in Figure 4.17. Most respondents (N = 32) suggested that they assess their veld condition on a continuous basis whenever they are in the veld, and 19 suggested at least once every season. This frequent assessment would indicate that respondents should have a good knowledge of the veld condition and would pick up trends of deterioration or improvement in it.

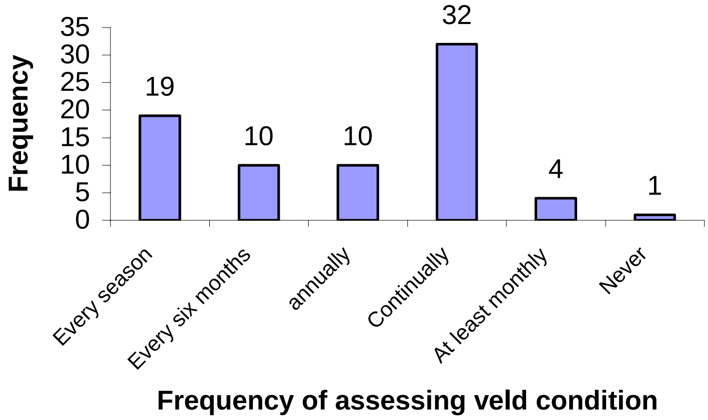


Figure 4.17 The frequency at which respondents assess their own farms' veld condition.

A multiple response question was used to establish which factors farmers consider as the three most important in assessing veld condition. Figure 4.18 shows that vegetation cover (N = 56) was the most important factor and second to that 'good species' (N = 31). The 'good species' referred to here are palatable plants that primarily provide the bulk of the livestock diet. Very few considered factors such as soil condition (N = 14), grazing intensity (N = 16), establishment of seedlings of palatable plants (N = 16) and disturbance indicators (N = 14), such as alien invaders or the high frequency of '*opslag*'(ephemerals) and mat-forming plants (e.g. succulents like *Malephora* spp.).

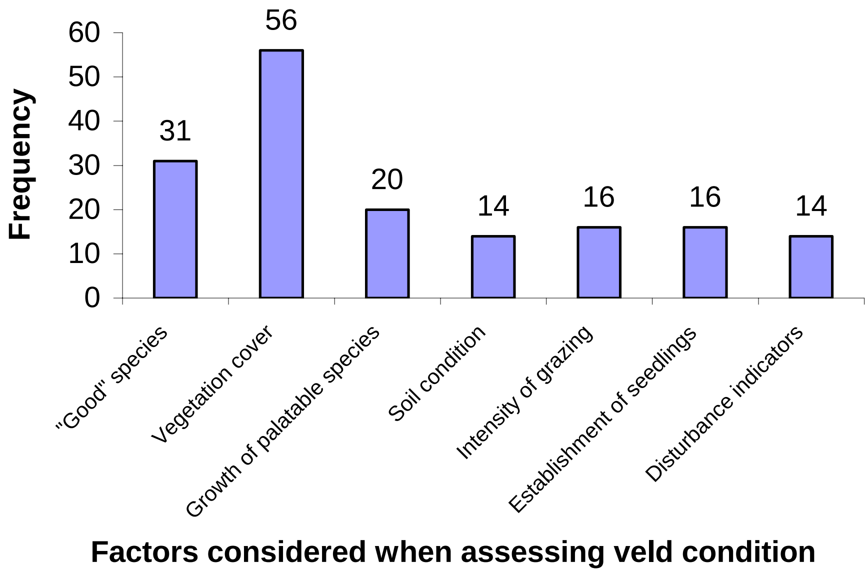


Figure 4.18 The factors farmers take into consideration when assessing the condition of natural veld on their farms.

When questioned on the improvement or deterioration of veld condition on their farms, most respondents indicated that there was much improvement (N = 9) or an improvement (N = 48) in the veld condition over the past decade (Figure 4.19). Only three respondents indicated that the condition of their veld had deteriorated while 15 felt that it did not change much during this period of time.

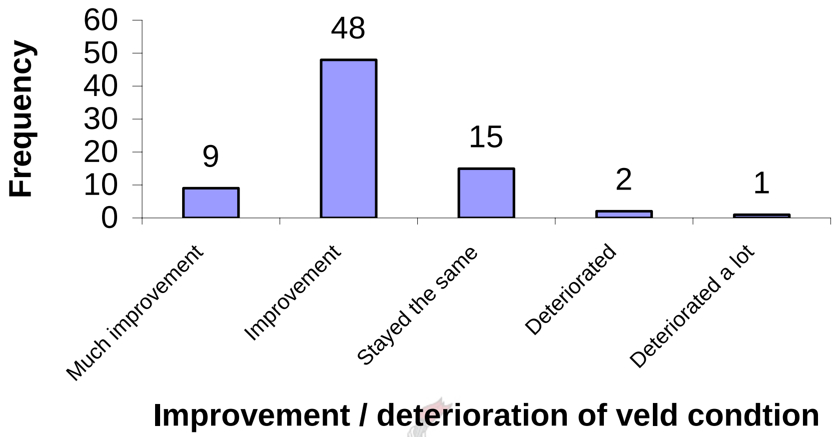


Figure 4.19 The perception of respondents on the improvement or deterioration in the veld condition over the past decade.

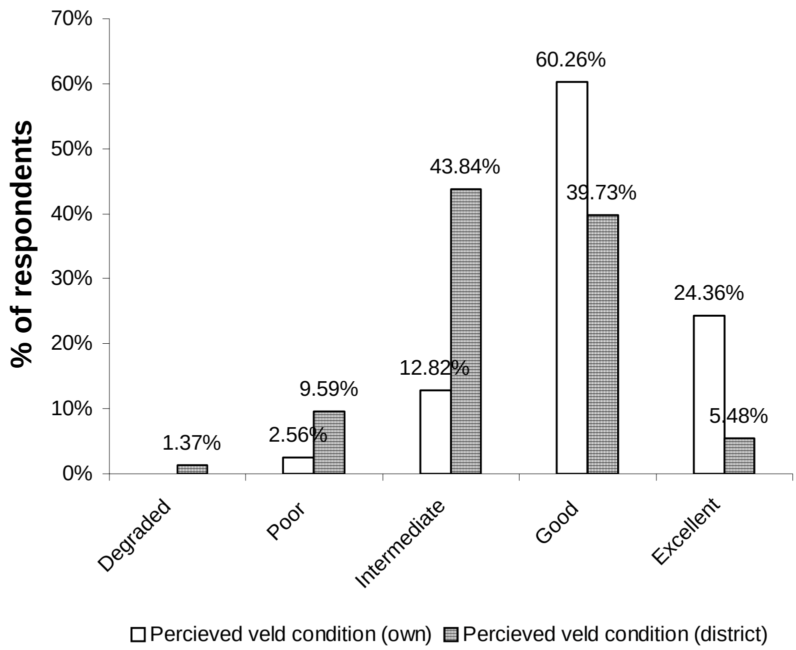


Figure 4.20 The perception of farmers on the veld condition of their own veld compared to that of the district.

The respondents' perception of the veld condition of their own and the districts veld is displayed in Figure 4.20. Respondents are overall more optimistic about the condition of their own veld than that of the district. More than 80% of respondents believe that their veld is in a good to excellent condition and less than 3% believe that their veld condition is poor. More than 45% of respondents believe that the veld condition in the district is in good to excellent condition and about 10% feels that it is in a poor to degraded condition.

A Chi-square analysis showed that a significant relationship exists between perceptions of own veld and perceptions of the districts' veld ($p < 0.01$). Further analysis indicate that those respondents who thought that their own veld was good also thought that the district's veld was good but not excellent. Those respondents who thought that their own veld was intermediate thought that the district's veld was poor. Finally those who thought that their veld was excellent also thought that the districts veld was excellent. What is evident is that only one respondent thought that the districts veld condition was better than his.

<u>Factors influencing decision-making regarding grazing management</u>

In managing a veld camp the farmer needs to make decisions on grazing period and resting period that will be allocated to each camp within a camp system to keep the production of palatable species at an optimum. Results from a multiple response question (Figure 4.21) indicates that the choice of a fixed (rotational) system (N = 24) in the case of ostrich farming and to a lesser extent a fixed system (longer than 14 days) for small and livestock farming (N = 10), are the most important driving forces in deciding the grazing and resting period of veld camps in a grazing system. Respondents also tend to look at the condition of indicator species (palatable species) (N = 22), condition of stock (N = 15) and grazing intensity (N = 13) on palatable plants.

From a multiple response question only ten respondents indicated that they do not experience any difficulty in managing their veld. The factors that most respondents considered to be hindering better veld management are displayed in Figure 4.22. Factors with the highest frequency are problem animals (N = 32), droughts (N = 31), the availability of water (N = 27), stock theft (N = 26), high cost (N = 21) and the lack of camps (N = 19).

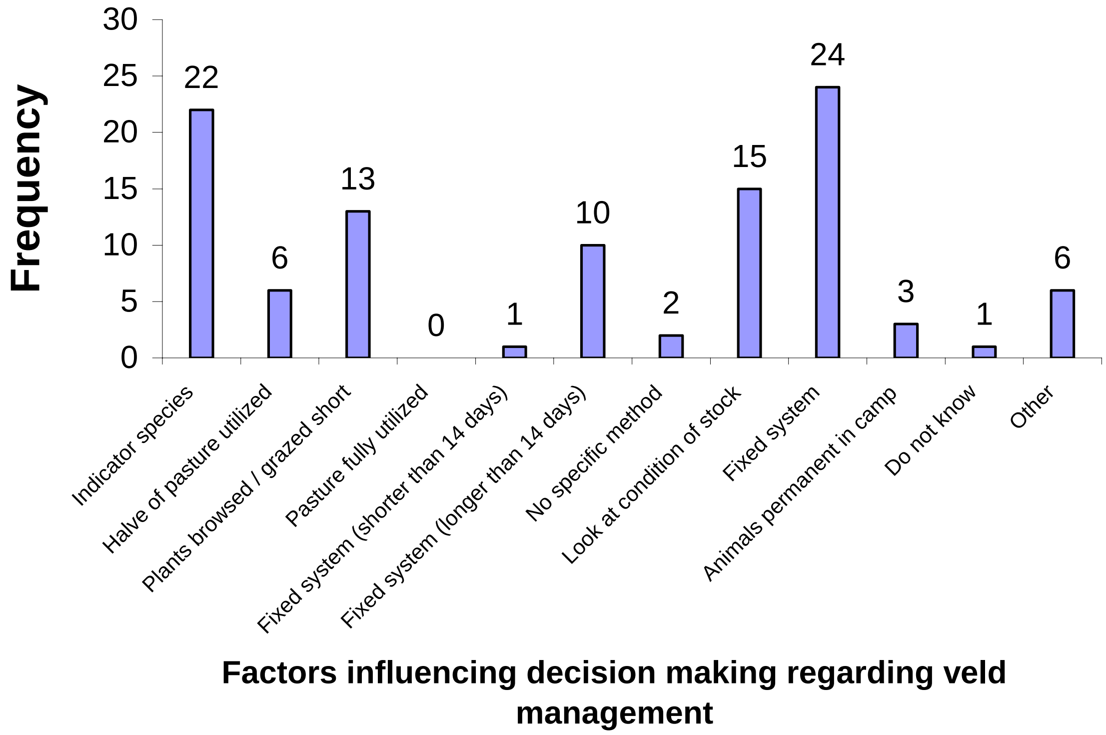


Figure 4.21 The factors that respondents consider to have the greatest effect on veld management.

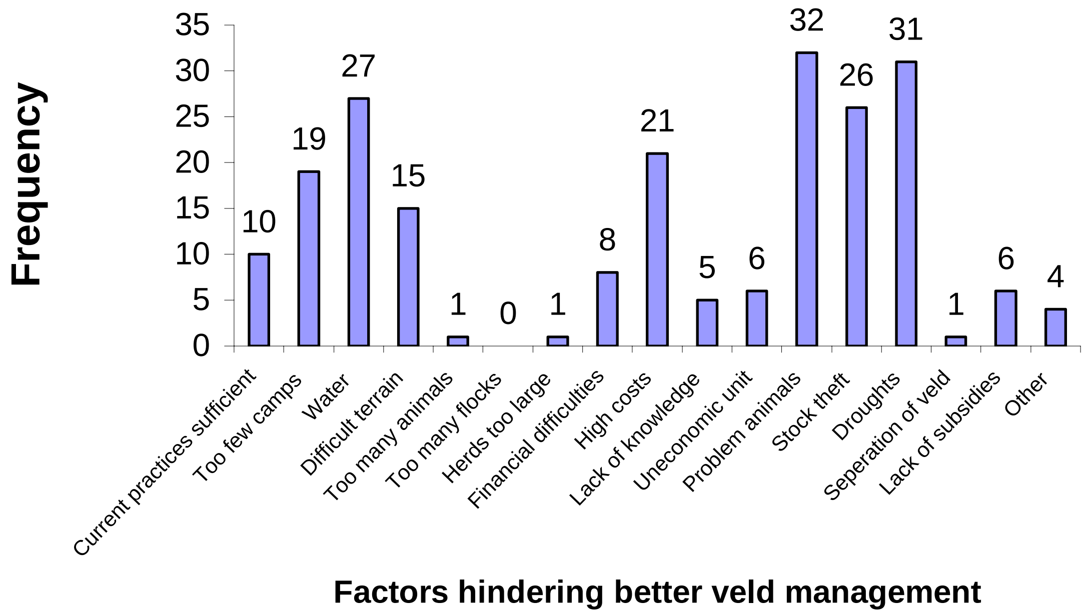


Figure 4.22 The factors that respondents consider to be hindering better veld management on their farms.

4.3.8 Separation of 'vegetation types'

The opinion of respondents on the separation of the 'vegetation types' on their farms is displayed in Figure 4.23. In general respondents are optimistic about the separation of their farms' 'vegetation types' and slightly less than 50% of them consider it as good to excellent. Less than 20% consider separation of veld on their farms as poor and less than 13% as very poor.

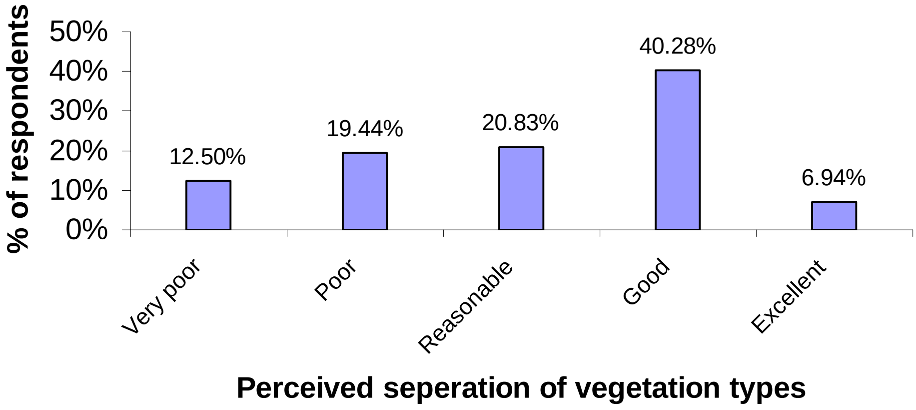


Figure 4.23 The perception of respondents on the degree to which the ecotopes or 'vegetation types' are camped off on their farms.

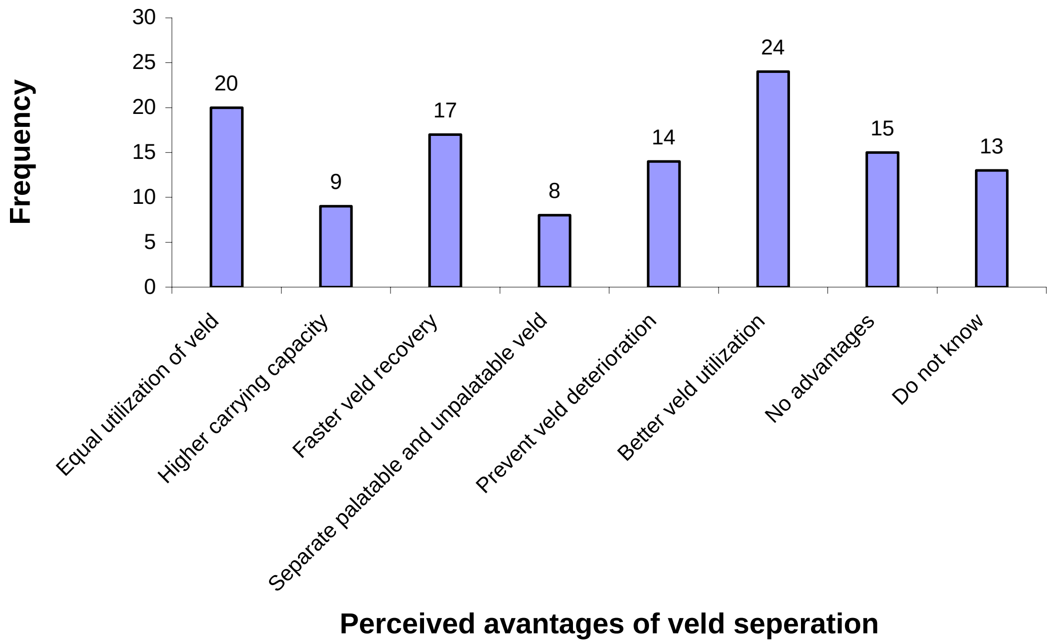


Figure 4.24 The factors respondents perceived to be advantageous in camping off of ecotopes on their farms.

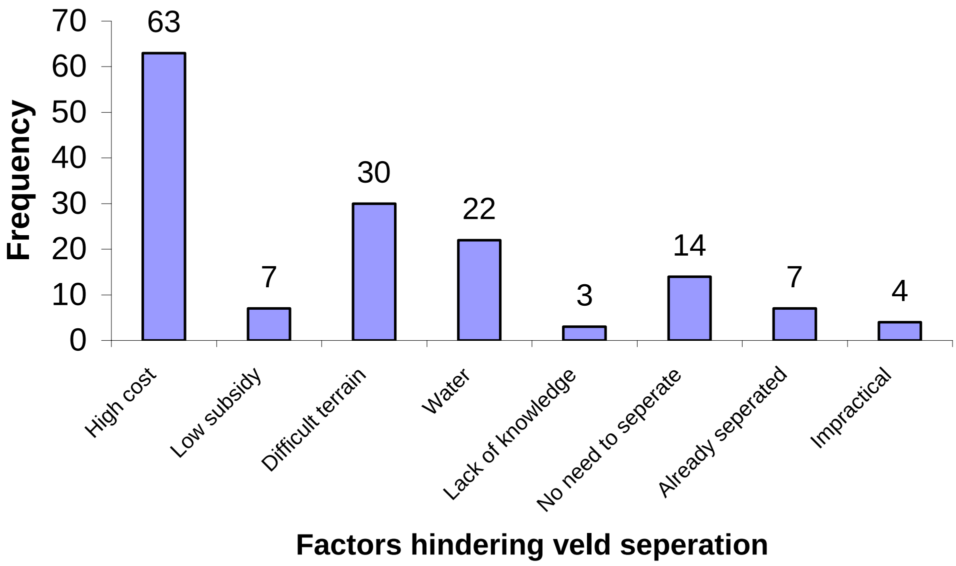


Figure 4.25 Factors that respondents consider to be hindering better ecotope or veld separation on their farms.

Most respondents consider better veld utilisation (N = 24), even utilisation of veld (N = 20) and faster veld recovery (N = 17) as the most important advantages in separating vegetation types (Figure 4.24). A fairly high frequency did not consider the separation of veld to be advantageous as a farming practice (N = 15) while other indicated that they do not know (N = 13). Factors that inhibit the camping of ecotopes are displayed in Figure 4.25. The high cost of fencing material (N = 63) is certainly the most important major factor followed by the difficult terrain (N = 30) in the region and the lack of water and difficulty in setting up watering points (N = 22). Despite the positive perception regarding the separation of 'vegetation types' as displayed in Figure 4.23, very few (N = 7) indicated that the ecotopes on their farms are already separated.

4.3.9 Veld rehabilitation

More than half (54%, N = 42) of the respondents indicated that they try to rehabilitate trampled areas, 15% (N = 12) only occasionally and 31% (N = 24) do not rehabilitate veld at all. The various reasons for not rehabilitating natural veld are given in Figure 4.26. Most respondents that do not rehabilitate claim that they do not have any degraded areas on their farm (N = 7). The high cost (N = 5) and the perception that veld rehabilitates by itself (N = 4), were the most common reasons given for not rehabilitating degraded areas.

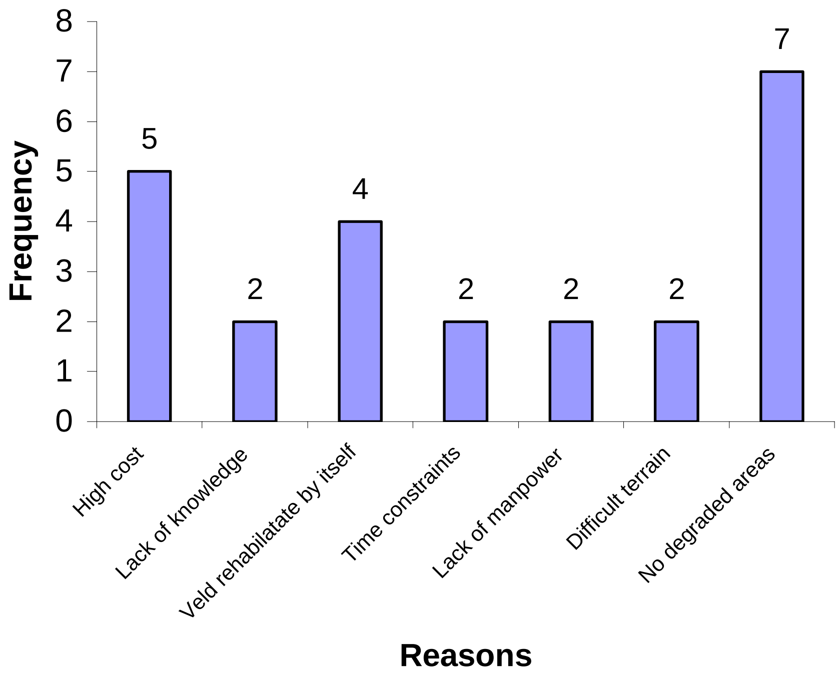


Figure 4.26 Reasons for not rehabilitating veld.

Table 4.9 Methods of rehabilitating natural veld

Rehabilitation method	**Frequency**
Plant saltbush	13
Mechanical treatment only	10
Pack stones	10
Brush packing only	9
Other	9
Mechanical treatment / Brush packing	7
Sowing indigenous seeds only	5
Indigenous seeding / Brush packing	3
Indigenous seeding / Mechanical treatment	1
Indigenous seeding / Mechanical / Brush packing	1

Respondents that indicated that they do rehabilitate veld, make use of techniques as displayed in Table 4.9. The rehabilitation methods with the highest frequencies are planting of saltbush (*Atriplex nummularia*) (N = 13), the use of mechanical treatment only (N = 10) and packing of stones (N = 10).

However, mechanical treatment of soil alone is not as effective and should be combined with the sowing in of indigenous seeds and brush packing (Visser *et al.*, 2004).

4.3.10 Alien weeds and invader plants

Alien vegetation are widely distributed within the Little Karoo and 82% of respondents claim that they do have problems with these invasive alien plants, while 18% of respondents claim that they do not have any on their farm. The most common invasive alien plants reported by respondents in the Little Karoo are displayed in Table 4.10.

Table 4.10 Alien weeds and invasive plants in the Little Karoo region

Alien weeds and invaders	Number of respondents
Xanthium spinosum (boetebos)	74
Xanthium strumarium (kankerbos)	18
Nerium oleander (selonsroos)	10
Acacia karroo (soetdoring)	8
Prosopis glandulosa (mesquite)	8
Acacia mearnsii (black wattle)	7
Hakea spp (hakeaboom)	7
Opuntia sp (turksvy)	7
Datura stramonium (olieboom)	6
Nicotiana glauca (wild tobacco)	5
Solanum elaeagnifolium (satansbos)	3
Other	11

Most of the plants listed in Table 4.10 prefer growing alongside or near to waterways. Even though *Acacia karroo* is an indigenous tree, it is listed in the Conservation of Agricultural Resource Act (1983) because of its encroaching ability and is considered as a problem plant by a few respondents (N = 8).

In terms of the amendments of the Conservation of Agricultural Resource Act (1983), landowners are under legal obligation to control the spread of these plants. Eighty percent of respondents that have invasive alien species on their farms indicated that they try to control the spread of these plants while 4% of them stated that they managed to stop the spread of these plants on their farms. Sixteen percent of respondents said that they do not control invasive alien species, 14% indicate that they do not have any invasive alien species on their farms. The other 2% are those that do have problems with invasive alien species but do not bother to control their spread.

Figure 4.27 illustrates the methods and combination of methods used by respondents in the Little Karoo to control invasive alien species. The mechanical method (N = 56) is by far the most common way of clearing invader plants and the majority of respondents indicated that they make use of labourers, using a spade (N = 58). A small proportion makes use of axe (N = 11), chain saw (N = 5) or uprooting plants by hand (N = 5). Only 25 respondents make use of herbicide to control alien vegetation of which the majority (N = 17) do so in combination with mechanical control. Most of them applied herbicide on leaves by means of a knap sack (N = 23) and two of them applied it on stems after invader trees have been cut down. Only two respondents made use of biological control in combination with mechanical and chemical control.

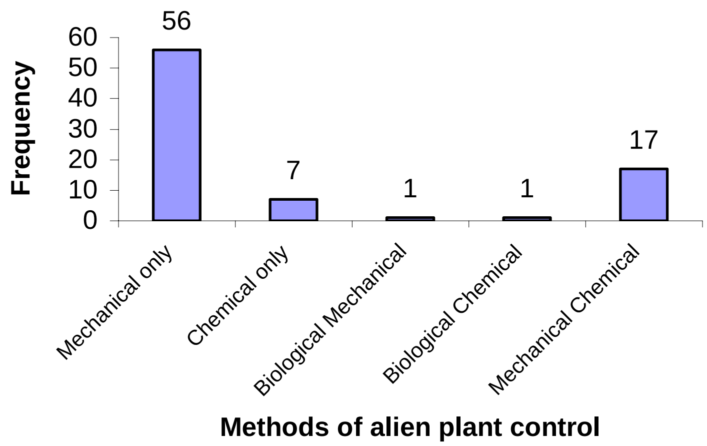


Figure 4.27 The method or combination of methods used to control invasive alien plants in the Little Karoo.

4.3.11 Legislation

Land owners should be aware and understand the implications of the legislation on natural agricultural resources that could influence the way they manage the natural veld on their farming units. It must be kept in mind that the questionnaire only tested whether the respondents were aware of the different Acts. Table 4.11 shows the farmers' awareness of the various acts and regulations that is associated with the conservation of natural agricultural resources. Overall the frequencies for all regulations and acts were fairly high with the knowledge on the National Water Act scoring the highest frequency. Very few farmers (N = 39) seem to be familiar with the National Environmental Management Act of 1998.

Table 4.11 Farmers' knowledge on legislation applicable to natural land use

Legislation	**N**
CARA 1983 Regulation 9 Protection of veld against degradation	68
CARA 1983 Regulation 10 and 11 Grazing capacity	88
CARA 1983 Regulation 12 Veld fires	79
CARA 1983 Regulation 13 and14 Rehabilitation of veld	62
CARA 1983 Regulation 15 and 16 Invasive weeds and alien vegetation	90
National Environmental Management Act, 107 of 1998	39
National Veld and Forest Fire Act 101 of 1998	72
National Water Act 36 of 1998	92

4.4 Discussion

4.4.1 Demography of farming community

The age distribution of farmers is quite similar to the finding by De Klerk (1986) of stock farmers in different regions of South Africa. Most of the farmers have more than 20 years of farming experience and the majority have been occupants of their farm for the past decade. Given the farmers age distribution, farming experience and lengthy occupation of farms, one could therefore assume that most farmers should have a fairly good understanding of the farming conditions in the Little Karoo. The educational level of farmers for the region is reasonably high compared to the studies done by De Klerk (1986) and King and Bembridge (1988). The effect, whether positive or negative, that age and educational level have on farmers decision-making is however still a debatable issue. The majority of farmers in the Little Karoo tend to believe that they have a good to excellent knowledge of veld management practices.

4.4.2 Farm and camp size and watering points

The size and number of camps on a farm usually relates to the land available and the type of animal that is produced on it. De Klerk's (1986) survey showed that only 45% of farms in South Africa were smaller than 2 000 ha and less than nine percent of farms in the whole of the Karoo region fell into this category. However, more than 60% of farms in the sample are less than 2 000 ha in size and therefore farms in the Little Karoo region are relatively smaller compared to those throughout the country and the Greater Karoo region. Small farming units are one of the major factors that contribute to inadequate farming facilities and the implementation of healthy veld management practices (Anonymous, 1999). Small farming units results in fewer and smaller camps which is illustrated by the fact that the mean camp size on farms smaller than 2 000 ha is only 245 ha and the mean number of camps only four per farm. The region therefore has very few camps per farm when compared to the situation in the Greater Karoo region where De Klerk (1986) found that more than 85% of livestock farms have more than ten camps. According to Tainton *et al.* (1999) livestock farmers in South Africa seldom have more than two or three camps per group of animals despite the fact that South African pasture advisors has seen four to five camps as the economic limit while in the past others such as Acocks (1968) and Savory (1978) recommended multi-camp systems with much higher camp numbers. Earlier surveys from the Department of Agriculture indicated that there are on average only five camps per three herds. Despite the very low percentage of less than 5% of the farm that is utilized for producing crops, farmers in general feel that they have adequate reserve feed for times of drought. This is in contrast to what is found by the Department of Agriculture that there is in fact a general lack of drought resisting fodder plantations (or crops) in the region, which results in farmers being reliant on natural veld for additional feed during droughts (Anonymous, 1999).

Despite the relative small number and size of camps, respondents tend to feel very positive about the number and quality of camps on their farms. More than 90% of respondents indicated that their feeling on the number and quality of their camps ranges from reasonable to excellent.

The number and placement of watering points for livestock is an important consideration to reduce the impact of hoofs and toes on the degradation of vegetation in veld camps. The data indicates that theoretically watering points should provide water to livestock up to a radius of 0.76 km, which seems to be adequate when compared with the recommendation of Teague and Dowhower (2003) that forage should not be more than 0.8 km from water. According to Vallentine (2001), the location of a water-point in the centre of a camp is optimum, but factors such as the limitation of available water, and terrain factors may have an influence on the positioning of such points in the Little Karoo.

4.4.3 Type of farming enterprises and income

The production of ostriches is the most important agricultural activity within the region with more that 80% of the respondents in the sample that keep ostriches. Only 17.07% of farmers in the sample receive all their income from ostrich farming. Livestock farming in the Little

Karoo, which is renowned for its ostrich production, is however very diverse with various breeds of goat, sheep and cattle that are kept to supplement the income from ostriches in the region. The majority of farmers receive an income of more than 60% from livestock production which seem to indicate that the Little Karoo is still very much dependent on its natural resources for animal production. Game farming is becoming increasingly popular in the Little Karoo for gaining income from tourism. Very few respondents (N = 14) have game on their farms and as noted by Colvin (1982) it is mostly kept for its aesthetic or recreational value.

It seems to be the perception of farmers that they get maximum production from their land and only an external factor, such as better prices can improve their income. Other factors that seem important in increasing income are obtaining more land, increasing the grazing capacity of their land unit by planting more crops and drought resistant fodder, or by increasing their stock numbers. Producing better breeds by genetic selection seems to be the only other factor within their power that could increase income. It would also seem that farmers in general feel that they do not need to improve on water provision, farm management and organization, veld condition or food and mineral supplement. It also seem that stock theft and problem animals do not have a major influence on the farmers' income. No respondent indicated that a reduction of livestock numbers could improve income as suggested by Danckwerts and King (1984). The reason for this is probably the fact that the success of ostrich farming is not dependent on the condition of the veld because ostriches are given supplement feed.

4.4.4 Ostrich farming

Ostrich farmers that make use of free-range ostrich farming utilize natural veld camps for this purpose. Free-range ostrich farming differs from mammalian livestock farming because ostriches cannot be moved from one camp to another once the breeding season has started. Ostriches prefer camps with the least slope and the low-lying Little Succulent Karoo (LSK) vegetation type, which is mostly found in valleys, is therefore ideal for the following reasons:

- Ostriches prefer plains because of their very active lifestyle and they can run freely in their natural habitat
- The chances of animal loss through ostriches accidentally breaking a leg or damaging themselves is minimized
- LSK has less tall shrubs that could damage the skin which is the most valuable ostrich product to the farmer

- LSK has lots of *'heuweltjies'* with soft soil which provide ideal nesting sites for ostriches
- Easier to collect eggs in camps on plains than in rugged terrain

The use of small breeding camps of smaller than 0.25 ha in size for egg production is at this stage less preferred by farmers mainly because of the high cost of fencing material. Camping off birds in trios (one male with two female) has got the advantage of more control over the genetic selection and should theoretically be less damaging to the landscape as a whole, because less surface area of the farm is exposed to trampling. Results from Chi-square analysis indicates that it is financially more advantageous to farmers to make use of free-range ostrich farming.

4.4.5 Grazing rotation

Little Karoo farmers are in general very satisfied with the grazing rotation systems they use on their farms. More than 70% of farmers feel that their grazing system is good to excellent. Most farmers in the Little Karoo (32.05%) make use of a three camp grazing system and the majority (84%) of them are ostrich farmers with free-range ostriches. Thirty percent of mammalian livestock farmers make use of a short duration grazing system with six or more camps in the system. Conventional rotational system is incompatible with free-range ostrich farming because ostriches are territorial by nature and occupy nesting sites. Moving them from one camp to another every few days will most likely lead to a lower or no production of eggs. Guidelines from the South African Ostrich Business Chamber on the utilisation of natural veld by ostriches (Anonymous, 2003), recommend the use of a three-camp system. Only 43.75% of free-range ostrich farmers make use of this system where camps rest for at least two breeding seasons. With the exception of one other ostrich farmer who makes use of a four-camp system, it would seem that in the majority of cases camps do not rest for at least two breeding seasons. The data also indicate that despite the efforts of the extension officer to promote the use of a three-camps system for ostriches (personal communication Kobus Nel 2003), most farmers tend to choose the 'most practical' grazing system. It would seem as if the limited amount of camps on plains, which are ideal for free-range ostrich farming, could be a limiting factor which forces farmers to choose the 'most practical' grazing system. Few farmers of mammalian livestock make use of short duration grazing systems, which could be indicative of the small farms with relative few camps within the region.

4.4.6 Stocking rate

When looking at estimated grazing capacities as laid down by the Department of Agriculture, it must be kept in mind that the boundaries for such a map are very broad and do not necessarily show the estimated grazing capacity at farm scale. At this scale it also does not make provision for adjustment for factors such as distance from water and slope as recommended by Holechek *et al.* (1989) and Vallentine (2001). In calculating the correct stocking rate, the metabolic mass equivalent of the animals being put onto the veld is of paramount importance and Large stock Units (LSU) conversion should be based on tables published in Meissner *et al.* (1983) or the Government Gazette (1985). Regulation 11 of CARA states clearly that landowners are legally obliged to '*restrict the number of animals, expressed as large stock units, kept on the veld of his farm unit to not more than the ……….. applicable grazing capacity referred to in Regulation 10' ………. providing that that such number may on occasion be exceeded on condition that the average number of animals kept on the veld of the farm unit concerned* <u>*during a period of 12 months shall not exceed such number*</u>*.'* Guidelines from the South African Ostrich Business Chamber (Anonymous, 2003) also determine that ostrich camps should be stocked within the estimated grazing capacity as laid down by the Department of Agriculture for the period from May/June until the end of January. Ostrich farmers utilize one camp per breeding season, mostly in a three camp system where in theory each camp should be allowed to rest for two years in order not to overstock the camp for a three year period (personal communication Kobus Nel, 2003). This strategy where camps are heavily overstocked for up to nine months is in contradiction to Regulation 11 of CARA and potentially damaging to the environment. The perception of farmers' about their stocking rates in the Little Karoo tend to be very optimistic with the majority of them feeling they do not overstock the veld. Less than 25% feel that they do overstock their veld with animals.

It would seem that the majority of respondents agree that the estimated grazing capacity of Government is more or less in line with their perceived grazing capacity of their own veld. Less than a quarter of them feel that the estimated grazing capacity is not accurate for their farm. Chi-square analysis indicates that ostrich farmers are likely to overestimate the grazing capacity on their farms by more than 66% when compared to the estimated grazing capacity whereas farmers who have mammalian stock tend to be more conservative in this regard. This perceived overestimation of the grazing capacity by ostrich farmers may be related to the provision of food supplements.

4.4.7 Veld utilisation, grazing records and assessment of veld condition

South African livestock farmers in general (70.9%) do not tend to keep accurate grazing records (De Klerk, 1986) and those farmers in the Little Karoo is no exception with less than 10% of them keeping accurate records. In the Karoo region, however, De Klerk (1986) found that more than 45% of farmers kept reasonable to good grazing records. Therefore, in the Little Karoo its seems that grazing record is more in agreement with the national norm found by De Klerk (1986). This could be attributed to the fact that ostrich farmers, that are the majority of farmers, make use of less complicated grazing systems than that employed by livestock farmers and can rely on memory for record keeping. The perception of more than 50% of the farmers on how they utilize their natural veld tends to be good to excellent and is very similar to the national norm found by De Klerk (1986).

The majority of farmers tend to continually assess the veld condition of farms. Vegetation cover is considered to be the most important indicator of veld condition; therefore one could assume that trampled bare areas would be the most important factor that indicates veld degradation. The presence of palatable species is considered to be the second most important indicator of good veld condition. This is especially true for mammalian livestock farmers that are dependent on natural veld for feeding where no additional forage is fed to livestock in normal rainfall years. In general the growth of palatable species, soil condition, grazing intensity, the establishment of seedlings and disturbance indicators are overlooked when assessing veld condition. Disturbance indicators (especially short-lived ephemerals) can contribute a great deal towards the percentage vegetation cover, and focusing mainly on cover in assessing veld condition, it could easily give a false perception of the actual veld condition. The focus on vegetation cover to assess veld condition and ignoring the species composition and other environmental factors cannot be considered ‘fair agricultural practice’ or conservation farming and can be detrimental to the rich plant biodiversity in this region. The perceived improvement in veld condition as experienced by the majority of farmers seen over the past decade can be regarded as an improvement in vegetation cover and not necessarily an improvement in the biodiversity of the area. Only a small minority of farmers is under the impression that their veld condition has deteriorated in the past decade. Farmers’ over-optimistic perception on the condition of their veld was quite similar to the results obtained from De Klerk *et al.* (1983), De Klerk (1986) and Düvel and Scholtz (1992). In all of these studies very few farmers considered their veld condition to be poor.

Farmers reported that problem animals, droughts, and the availability of water, stock theft, high cost and the lack of camps influenced the ways in which they managed their veld. It would seem that so-called problem animals, especially the black-backed jackal cause farmers to make decisions that negatively influence veld management, especially during the lambing season. In the Uniondale and the Ladismith-Touw regions black-backed jackal and caracals cause severe losses to farmers. It is also known that jackal will prey on ostrich chicks and destroy eggs. If predation is too high farmers are forced to deviate from their grazing system and move livestock to safer camps. Drought and the lack of water are very obvious factors that will affect veld management in semi-arid areas like the Little Karoo. The difficult terrain also contributes to the difficulty of providing camps with watering points in areas with variable topography. A high frequency of theft of livestock and ostrich eggs is common, especially on farms near towns or next to roads. It seems that organized syndicates, and not petty theft, are the main concern to farmers in this region. It does not seem as if the number of animals and the size of herds or flocks, the poor separation of ecotopes and a lack of knowledge are considered factors that have a negative impact on the farmers' ability to manage the veld.

4.4.8 Separation of 'vegetation types'

De Klerk (1986) has pointed out that there is a significant positive relationship between the measure in which the ecotopes on farms are camped off and the farmers' financial success. The fencing in of plant communities of different animal preference is often impractical, mainly due to their limited size and occurrence in a mosaic pattern (Vallentine, 2001). This seems to be the case in the Little Karoo with its high variability in topography, especially when compared to that of the Greater Karoo. Little Karoo farmers are never the less fairly optimistic about the separation of the ecotypes on their farms. The most important advantages of the separation of ecotopes are recognised as: improved veld utilisation, equal utilisation of veld and faster veld recovery, but the high cost, difficult terrain and water limitations stand in the way of improving this. Despite the positive perception regarding the separation of ecotopes, the number of farms that are well separated is very small.

4.4.9 Veld rehabilitation

According to Regulation 13 of Conservation of Agricultural Resources Act of 1983 (CARA) every land user should '*effectively restore or reclaim the land on his farm unit on which excessive soil loss due to erosion occurs or has occurred.*' Under Regulation 14 of the same

Act the land user *'must effectively restore or reclaim any denuded or disturbed land on his farm unit'*. The planting of exotic fodders, especially *Atriplex nummularia* (Old man saltbush) especially on degraded old fields is the most common rehabilitation method used by Little Karoo farmers. In the 1970's this plant was regarded as an important crop that can play an important role in the conservation and improvement of natural veld (Aucamp, 1973), but today it is considered a Category 2 invader plant in South Africa (Henderson, 2001) and for this reason it cannot be considered in restoring bare patches in natural veld. The packing of stones in eroded areas (N = 10) to minimize erosion and mechanical treatment (N = 10), are second to the planting of saltbush, the most important rehabilitation method used by farmers. Soil treatment is needed to improve the water infiltration and soil water conditions (Joubert and Van Breda, 1976) and mechanical treatment of soil can cost up to R 1 100 per hectare (Beukes and Cowling, 2003). Witbooi (2002) recommended the combination of light cultivation such as tilling with the addition of indigenous seeds as the most cost effective way for restoring old fields. Visser *et al.* (2004) recommended the use of the combination of tilling, seeding and branches application as the most successful, but the combination tilling and seeding was a much cheaper method.

The rehabilitation of degraded and eroded veld in arid and semi-arid areas is a slow and very costly process and according to Esler and Kellner (2001) the cost can run from R150/ha to R1 322/ha. Actual cost for 2004 is estimated between R69/ha for tilling only and up to R13 147/ha for the combination of tilling, seeding and brush packing (personal communication Stefan Theron, 2004). Very few Little Karoo farmers make use of these combinations of restoration methods as recommended by agricultural scientists, probably due to inadequate funding or a lack of knowledge. The recovery rate and success of current rehabilitation methods used by farmers can therefore be questioned. There is a shortage of indigenous seed (Esler and Kellner, 2001) and indigenous forage plant seed sources need to be developed, as Worcester Veld Reserve cannot keep up with supplying indigenous seeds for rehabilitation purposes to the Western Cape (personal communication Hannes Botha, 2004).

4.4.10 Alien weeds and invader plants

Invasive alien plants are fairly wide distributed and present in the Little Karoo and only 14% of respondents indicated that they do not have such problems on their farms. The spread of alien plants, as indicated by respondents confirms the findings of Richardson *et al.* (1997) that

Opuntia sp, *Nerium oleander*, *Nicotiana glauca*, *Prosopis sp.* and *Xanthium* spp. are common alien weeds and invaders in the Karoo region. The declared weed *Xanthium spinosum* (boetebos), a 1.2 m poisonous annual, which spreads into cultivated land, old lands and riverbanks (Henderson, 2001) is by far the most common alien plant that causes problems to respondents. *Xanthium spinosum, X. strumarium, Nerium oleander, Hakea* spp, *Opuntia* spp., *Datura stramonium, Nicotiana glauca* and *Solanum elaeagnifolium* are all listed as Category 1 plants in the Conservation of Agricultural Resource Act (1983), which means that it is prohibited and must be controlled by the landowner. *Prosopis glandulosa* and *Acacia mearnsii*, both small to large invader trees, are listed as Category 2 plants which have some commercial value, but can only be planted by landowners in demarcated areas. *Alhagi maurorum* (kameeldoring) is fairly wide distributed in the Olifants River-Gamka region (Anonymous, 1999), and *Arundo donax* (Spanish Reed), which is widely spread especially along the Gouritz River (personal communication Jeff Manuel, 2004) are both Category 1 plants, but does not seem to be problematic to farmers, or it could be an indication that farmers are unaware that these plants are invasive alien plants that must be controlled. The spread of alien trees, such as *Hakea sericea* (Category 1) and *Acacia mearnsii* (Category 2) are limited to the higher rainfall regions such as the Kammanassie and Bo-Langkloof.

Landowners are under legal obligation to control invasive alien vegetation, which occur on a farmer's farming unit. It must also be managed according the amended Regulations 15 and 16 under the CARA legislation. Eighty percent of farmers indicated that they try to control the spread of invasive alien plants, while 16% of them do not attempt any control. Those farmers that do control these plants primarily make use of mechanical control, mostly using manual labour with a spade. Very few apply herbicide or make use of biological control. Only 2% indicated that they do not bother to control invasive alien plants.

4.4.11 Legislation

Overall the frequencies for all regulations and acts were fairly high with the awareness of the National Water Act scoring the highest frequency. The awareness of the newer legislation was reasonably high with the exception of the National Environmental Management Act of 1998 (N = 39), which was not very familiar to them. Section 13 and 14 of CARA, which deal with the rehabilitation of natural veld, were also less familiar to farmers (N = 62). Section 28 of the National Environmental Management Act, 107 of 1998 states the following: *Duty of care and remediation of environmental damage.—(1) Every person who causes, has caused* *or may cause significant pollution or degradation of the environment must take reasonable measures to prevent such pollution or degradation from occurring, continuing or recurring, or, in so far as such harm to the environment is authorised by law or cannot reasonably be avoided or stopped, to minimize and rectify such pollution or degradation of the environment.* Farmers seem to be less familiar with Regulation 9 of the Conservation of Agricultural Resources Act of 1983 (CARA) (N = 68), which deals with the protection of veld against degradation (N = 68). It would therefore seems that many farmers are not aware that they are legally obliged to protect their veld against degradation and rehabilitate degraded areas on their properties. Farmers seem to be well aware of Regulations 15 and 16 of CARA, which deal with combating invasive weeds and alien vegetation and Regulations 10 and 11, which deal with the limitation of the number of animals on natural veld for a period of 12 months.

4.5 Conclusion

The State of the Environment Overview Report (2004) highlights poor veld condition and soil degradation in the Little Karoo, and specifically around the towns of Oudtshoorn and Calitzdorp, which would indicate that the current veld management practices as employed by farmers are not environmentally sound. The relatively small farming units with relatively few veld camps are unusual for agricultural regions that are to a great extent dependent on the natural veld for their income. A diverse number of animal types is farmed in the Little Karoo, but ostrich farming remains the major agricultural activity within the region. Whereas mammalian livestock farming takes place in a variety of vegetation types and landscape units, ostriches are largely confined to the Succulent Karoo on flat to gently sloping topography. Ostriches are generally overstocked in veld, whereas other domestic livestock are kept at densities closer to those recommended by the Department of Agriculture. Less than 50% of free-range ostrich farmers make use of the recommended three-camp system, which allows the camp to rest for at least two breeding seasons, whereas more than 50% of other livestock farmers use rotational grazing systems. Veld camps where ostriches are kept are generally in poorer condition than camps used for other livestock.

There are three major reasons for these differences between ostrich and other livestock in terms of the ways they are managed and their impacts on the veld. Firstly, veld management practices with free-range ostrich farming differ entirely from that of mammalian livestock, and require entirely different management strategies. The territorial behaviour of free-range ostriches makes it impossible to employ a short duration grazing system or a multi-camp system in which ostriches can be moved from one camp to another during the nine month breeding season in order to rest the veld. Secondly, in an area with an extremely low grazing capacity for livestock, it does not seem to be economically viable to stock animals at low densities in small veld camps. The feeding of high numbers of ostriches in natural veld is a viable profitable business under the limiting circumstances ostrich farmers have to deal with in the Little Karoo. The argument of Danckwerts and King (1984) of the lowering of stock numbers to obtain a higher income per hectare is not applicable to ostrich farming because of the fact that ostriches receive supplementary food. Finally, the option of using small breeding camps to minimize the number of ostriches on the veld, has been adopted by only a few farmers.

According to Heitschmidt *et al.* (2004) social values or perceptions, rather than ecological science, drive farmers' decision-making. Economic considerations are the primary reason why ostrich farmers overstock breeding ostriches on natural veld. This situation could be improved by the development, in collaboration with farmers, of cost-effective and sustainable alternative ostrich husbandry systems, together with changes in policy and legislation. Punitive measures are ineffective unless they are implemented and are often considered as 'negative forces' (Düvel and Scholtz, 1986) that lead to resistance by farmers to adoption of sound farming practices. Because of the low levels of compliance with regulations in South Africa (Botha, 2001), incentives such as tax relief or subsidies for restoration, should be considered, as farmers in general will not be persuaded to adopt innovations that are not economically sound. A well-prepared economic message should be developed (King & Bembridge, 1988) together with awareness programmes to farmers on the importance of conserving biodiversity in rangelands in order to find a compromise between economically viable agricultural practices and biodiversity conservation.

4.6 References

Acocks, J. P. H. 1968. Non-selective grazing; how it was developed. *Farmers Weekly*, March 13. pp. 47-49.

Acocks, J. P. H. 1975. *Veld types of South Africa*. 2nd Edition. Memoirs of the Botanical Survey of South Africa, **40**:1-28.

Allsopp, N. 1999. The effects of grazing and cultivation on soil patterns and processes in the Paulshoek area of Namaqualand. *Plant Ecology*, **142**:179-187.

Anonymous. 1923. Drought Investigation Commission, Final Report of the Department of Agriculture and Forestry. Cape Times for Government Printer, Cape Town.

Anonymous. 1999. Klein Karoo Streeksinligtingsdokument. Oudtshoorn Proefplaas, Oudtshoorn.

Anonymous. 2003. Riglyne vir die benutting van natuurlike veld deur volstruisboerdery – 'n gedragskode vir volstruisprodusente (a pamphlet). South African Ostrich Business Chamber, Oudtshoorn.

Archer, S. 2002. Technology and ecology in the Karoo: a century of windmills, wire and changing farming practice. Pages 112-138 in Dovers, S., Edgecombe, R. and Guest, B. (eds.). *South Africa's Environmental History – cases and comparisons*. Ohio University Press, Claremont.

Aucamp, J. D. 1973. Benut droogtebestande struike. Anecdote to *Golden Fleece.* January 1973.

Bailey, D. W. 2004. Management strategies for optimal grazing distribution and use of arid rangelands. *Journal of Animal Science*, **82**(E. Suppl.): E147-E153.

Beukes, P. C. and Cowling, R. M. 2003. Evaluation of restoration techniques for the Succulent Karoo. *Restoration Ecology*, **11**:308-316.

Booysen, P. De V. 1967. Grazing and grazing management terminology in southern Africa. *Proceedings of the Grassland Society of Southern Africa*, **2**:45-57.

Botha, M. 2001. Incentives for Conservation on Private land: Options and Opportunities. Summary Report 02/2001. Botanical Society, Cape Conservation Unit, Cape Town.

Colvin, I. S. 1982. *An enquiry into game farming in the Cape Province*. M.Sc thesis, University of Cape Town, Cape Town.

Conservation of Agricultural Resource Act, 1983, (Act 43 of 1983). Government Gazette, No.9238, Pretoria.

Danckwerts, J. E. and King, P. G. 1984. Conservative stocking or maximum profit: a grazing management dilemma? *Journal of the Grassland Society of Southern Africa,* **1**:25-28.

Dean, W. R. J., Hoffman, M. T., Meadows, M. E. and Milton, S. J. 1995. Desertification in the semi-arid Karoo, South Africa: review and reassessment. *Journal of Arid Environments,* **30**:247-264.

De Klerk, C. H. 1986. *‘n Ondersoek na faktore wat in die weg staan van die aanvaarding van aanbevole veldbeheerpraktyke*. Suid-Afrikaanse Instituut vir Landbouvoorligting, Pretoria.

De Klerk, C. H., Düvel, G. H. and Terblanche, E. le F. 1983. *‘n Ondersoek na wolskaapboerdery in die Republiek van Suid-Afrika.* Suid-Afrikaanse Instituut vir Landbouvoorligting, Universiteit van Pretoria, Pretoria.

Donaldson, C. H. and Vorster, M. 1989. *Veldbestuur in die Karoo – ‘n strategie vir die toekoms.* Agriforum 1989, Department of Agriculture and Water Affairs, Pretoria.

Du Toit, P. C. V. 2003. The stocking rate: grazing capacity relation. *Grootfontein Agric,* **6**:29-34.

Düvel, G. H. 1975. The mediating function of perception in innovation decision-making. *Suid-Afrikaanse Tydskrif vir Landbouvoorligting*, **4**:25-36.

Düvel, G. H. and Scholtz, H. P. J. 1986. The non-acceptability of recommended veld management practices. *Suid-Afrikaanse Tydskrif vir Landbouvoorligting*, **15**:1-10.

Düvel, G. H. and Scholtz, H. P. J. 1992. The incompatibility of controlled selective grazing systems with farmers’ needs. *Journal of the Grassland Society of Southern Africa*, **9**:24-29.

Esler, K. J. and Kellner, K. 2001. Resurrecting degraded Karoo veld. *Farmers’ Weekly*, March 9. pp. 24-26.

Fuls, E. R. 1992. Ecosystem modification created by patch-overgrazing in semi-arid grassland. *Journal of Arid Environments*, **23**:59-69.

Galt, D., Molinar, F., Navarro, J., Joseph, J. and Holecheck, J. 2000. Grazing capacity and stocking rate. *Rangelands*, **22**:7-11.

Government Gazette 1985. Conservation of Agricultural Resources Act, 1983 (Act 43 of 1983), Regulation Amendment, No. R. 2687. 6 December 1985.

Heitschmidt, R. K., Vermeire, L. T. and Grings, E. E. 2004. Is rangeland agriculture sustainable? *Journal of Animal Science*, **82**(E. Suppl):E138-E146.

Henderson, L. 2001. *Alien Weeds and Invasive Plants. A complete guide to declared weeds and invaders in South Africa*. Handbook No. 12, Plant Protection Research Institute, Agricultural Research Council, Cape Town.

Hoffman, M. T. 1988. Rationale for Karoo grazing systems: criticisms and research implications. *South African Journal of Science*, **84**:556-559.

Hoffman, M. T. 1996. Little Succulent Karoo. Page 61 in: Low, A. B. and Rebelo, A. G. (eds.). *Vegetation of South Africa, Lesotho and Swaziland.* Department of Environmental Affairs and Tourism, Pretoria.

Hoffman, M. T. 2003. "Nature's method of grazing": Non-selective grazing (NSG) as a means of veld reclamation. *South African Journal of Botany,* **69**:92-98.

Holechek, J. L., Pieper, R. D. and Herbel, C. H. 1989. *Range Management – principles and practices.* Prentice Hall, New Jersey.

Hoorn 18 July 2002. Local News Paper of the Oudtshoorn region.

Hugo, W. J. 1966. *Die Kleinveebedryf in Suid-Afrika*. Departement Landbou-tegniese dienste. Staatsdrukker, Pretoria.

Illius, A. W. and O'Connor, T. 1999. On the relevance of non-equilibrium concepts to arid and semi-arid grazing systems. *Ecological Applications,* **9**:798-813.

Joubert, J. G. V. and van Breda, P. A. B. 1976. Methods of establishing *Osteospermum sinuatum* in the Little Karoo veld. *Proceedings of the Grassland Society of Southern Africa,* **11**:123-124.

King, P. G. and Bembridge, T. J. 1988. An extension approach for the National Grazing Strategy based on farmer characteristics in the Eastern Cape. *Journal of the Grassland Society of Southern Africa*, **5**:8-14.

Koch, B. H. 1985. The role of knowledge in the adoption of agricultural development practices. *South African Journal of Agricultural Extension*, **14**:11-17.

Kommissie van Ondersoek na die Landbou, 1970. Tweede verslag. R. P. 84/1986. Staatsdrukkers, Pretoria.

Low, A. B. and Rebelo, A. G. 1996. *Vegetation of South Africa, Lesotho and Swaziland*. Department of Environmental Affairs and Tourism, Pretoria.

McCabe, K. 1987. Veld management in the Karoo. *The Naturalist,* **31**:8-15.

Meissner, H. H., Hofmeyr, H. S., van Rensburg, W. J. J. and Pienaar, J. P. 1983. *Classification of livestock for realistic prediction of substitution values in terms of a biologically defined Large Stock Unit*. Technical Communication no. 175, Government Printer, Pretoria.

Mellado, M., Valdez, R., Lara, L. M. and Lopez, R. 2003. Stocking rate effect on goats: A research observation. *Journal of Range Management*, **56**:167-173.

Mentis, M. T. 1991. Are multi-paddock grazing systems economically justified? *Journal of the Grassland Society of Southern Africa,* **8**:29-34.

Milton, S. J. 1995. Spatial and temporal patterns in the emergence and survival of seedlings in arid Karoo shrublands. *Journal of Applied Ecology*, **32**:145-156.

Milton S. J. and Dean, W. R. J. 1990. Seed production in rangelands of the southern Karoo. *South African Journal of Science*, **86**:231-233.

Milton, S. J. and Dean, W. R. J. 1995. South Africa's arid and semi-arid rangelands: why are they changing and can they be restored? *Environmental Monitoring and Assessment*, **37**:245-264.

Milton, S. J. and Dean, W. R. J. 1996. *Karoo veld: ecology and management.* Agricultural Research Institute, Pretoria.

Milton, S. J., Yeaton, R. A., Dean, W. R. J. and Vlok, J. H. J. 1997. Succulent Karoo. Pages 131-166 in Cowling, R. M., Richardson, D. M. and Pierce, S. M. (eds.). *Vegetation of southern Africa.* Cambridge University Press, Cambridge.

Morris, C. D., Hardy, M. B. and Bartholomew, P. E. 1999. Stocking rate. Pages 186-193 in Tainton, N. (ed.). *Veld Management in South Africa.* University of Natal Press, Pietermaritzburg.

National Environmental Management Act, No. 107 of 1998 of the Republic of South Africa. Government Gazette, No.19519, Cape Town.

National Veld and Forest Fire Act, No. 101 of 1998 of the Republic of South Africa. Government Gazette, No.19515, Cape Town.

National Water Act (Act 36 of 1998). http://www.dwaf.pwv.gov.za/Documents/Legislature/nw_act/nwa.pdf. Accessed October 2004.

Nel, C. J. 1995. *Volstruisboerderystelsels.* Pages 6-8 in Nel, C. J. (ed.). *Riglyne vir suksesvolle volstruisboerdery*. Klein Karoo Landbou-ontwikkelingsentrum, Oudtshoorn.

Oppenheim, A. N. 2003. *Questionnaire Design, Interviewing and Attitude Measurement.* Continuum, London.

O'Reagain, P. J. and Turner, J. R. 1992. An evaluation of the empirical basis for grazing management recommendations for rangeland in southern Africa. *Journal of the Grassland Society of Southern Africa*, **9**:38-49.

Pelser, A. J. and Kherehloa, T. 2000**.** Some causes and strategies pertaining to land degradation in southern Africa. *South African Journal of Agricultural Extension*, **29**:24-46.

Richardson, D. M., Macdonald, I. A. W., Hoffmann, J. H. and Henderson, L. 1997. Alien plant invasion. Pages 535-567 in Cowling, R. M., Richardson, D. M. and Pierce, S. M. (eds.). *Vegetation of Southern Africa*. Cambridge University Press, Cambridge.

Roberts, B. R. 1969. The multicamp controversy – search for evidence. Conex, Veld management conference proceedings, pp 41-57.

Roux, P. W. and Opperman, D. P. J. 1986. Soil Erosion. Pages 92-111 in Cowling, R. M., Roux, P. W. and Pieterse, A. J. H. (eds.). *The Karoo Biome: a preliminary synthesis. Part 1 – physical environment*. South African National Scientific Programmes Report No 124.

Roux, P. W. and Theron, G. K. 1987. Vegetation change in the Karoo biome. Pages 50-69 in Cowling, R. M. and Roux, P. W. (eds.). *The Karoo Biome: a preliminary synthesis. Part 2 – vegetation and history*. South African National Scientific Programmes Report No 142.

SPSS Inc. 2002. SPSS base 11.0 user's guide package. Prentice-Hall, Upper Saddle River, New Jersey.

Savory, A. 1978. A holistic approach to ranch management using short duration grazing. *Proceedings of the 1st International Rangeland Congress.* Denver, Colorado: 555-557.

Simons, L and Allsopp, N. 2003. Rehabilitation as a means to understanding vegetation change under heavy grazing in the succulent karoo desert, South Africa. *African Journal of Range and Forage Science*, **20**:158.

Snyman, H.A. 1998. Dynamics and sustainable utilisation of rangeland ecosystems in arid and semi-arid climates of southern Africa. *Journal of Arid Environments,* **39**:645-666.

State of the Environment Overview Report. 2004. Department of Environmental Affairs and Development Planning, Report No. 329585/1.

Stindt, H. W. and Joubert, J. G. V. 1979. *The nutritive value of natural pastures in the districts of Ladismith, Riversdale and Heidelberg in the winter rainfall region of the Republic of South Africa.* Technical Communication No 154. Department of Agriculture Technical Services, Pretoria.

Steyn, A. W. G., Smith, C. F., Du Toit, S. H. C. and Strasheim C. 1994. *Moderne Stastitiek vir die Praktyk.* J L Van Schaik Uitgewers, Pretoria.

Tainton, N. M., Aucamp, A. J. and Danckwerts, J. E. 1999. Grazing programmes. Pages 169-179 in Tainton, N. (ed.). *Veld Management in South Africa.* University of Natal Press, Pietermaritzburg.

Talbot, W. J. 1961. Land utilisation in the arid regions of southern Africa. Part 1: South Africa. Pages 299-338 in Stamp, L. D. (ed.). *A History of Land Use in Arid Regions. Arid Zone research*, Vol. 17. UNESCO, Paris.

Teague, W. R. and Dowhower, S. L. 2003. Patch dynamics under rotational and continuous grazing management in large, heterogeneous paddocks. *Journal of Arid Environments*, **53**:211-229.

Thomas, S. J. 1999. *Designing surveys that work. A step-by-step guide*. Corwin Press, Inc. California.

Trollope, W. S. W., Trollope, L. A. and Bosch, O. J. H. 1990. Veld and pasture management terminology in southern Africa. *Journal of the Grassland Society of Southern Africa*, **7**:52-61.

Vallentine, J. F. 1989. *Range Development and Improvements*. 3rd Edition. Brigham Young University Press, Provo.

Vallentine, J. F. 2001. *Grazing Management*. Academic Press, Inc, New York.

Van den Berg, L. 2002. The evaluation of a number of technologies for the restoration of degraded rangelands in selected arid and semi-arid regions in South Africa. M.Sc. Thesis, University of Potchefstroom, Potchefstroom.

Van Eeden, F. 1996. Waak teen veldagteruitgang. *Landbouweekblad*, 19 April 1996. pp. 36-38.

Visser, N., Botha, J. C. and Hardy, M. B. 2004. Re-establishing vegetation on bare patches in the Nama Karoo, South Africa. *Journal of Arid Environments*, **57**:155-177.

Vorster, M. 1999. Karoo and the associated sweet grassveld. Pages 293-311 in Tainton, N. (ed.). *Veld management in South Africa*. University of Natal Press, Pietermaritzburg.

Watkeys, M. K. 1999. Soils of the arid south-western zone of Africa. Pages 17-25 in Dean W. R. J. and Milton, S. J. (eds.). *The Karoo: Ecological patterns and processes*. Cambridge University Press, Cambridge.

Westoby, M., Walker, B. H. and Noy-Meir, I. 1989. Opportunistic management for rangelands not at equilibrium. *Journal of Range Management*, **42**:266-274.

Witbooi, B. M. 2002. Potential of selected Karoo plant species for rehabilitation of old fields. M. Sc. Thesis, University of Stellenbosch, Stellenbosch.

<u>Personal communication</u>

Jeff Manuel, 2004. University of the Western Cape, Bellville.

Hannes Botha, 2004. Department of Agriculture: Western Cape, Worcester Veld Reserve, Worcester.

Kobus Nel, 2003/4. Department of Agriculture: Western Cape, Klein Karoo Agricultural Development Centre, Oudtshoorn.

Stefan Theron, 2004. Department of Agriculture: Western Cape, Beaufort West.

CHAPTER 5 VELD CONDITION OF THE LITTLE KAROO

5.1 Introduction

It is commonly accepted that widespread significant vegetation change, which was primarily caused by overgrazing, resulted in the decline of long-term productivity over virtually the entire Karoo region (Roux and Vorster, 1983; Roux and Theron, 1987; Dean and Macdonald, 1994; Dean *et al.,* 1995; Pelser and Kherehloa, 2000; Hoffman and Ashwell, 2001). The magisterial commercial farming districts of Oudtshoorn and Calitzdorp in the Little Karoo are considered as the most degraded areas in the Western Cape (Hoffman and Ashwell, 2001; State of the Environment Overview Report, 2004). It is generally assumed that poor livestock management (including overstocking, continuous and selective grazing) leads to deterioration in rangeland condition or health (Acocks, 1938; Roberts, 1970; Roux and Vorster, 1983; Hobbs, 1992; Milton *et al*., 1994a; Milton and Hoffman, 1994; Hoffman and Ashwell, 2001; Archer, 2004). These changes involve reduction in cover, density of palatable plants, biological soil crust, and an increase in unpalatable plants, soil compaction and soil erosion (Roux and Opperman, 1986; Ahmed *et al*., 1987; Seitlheko *et al.,* 1993; Allsopp, 1999). In overstocked and heavily grazed veld, it is inevitable that palatable plants will produce less seed than unpalatable plants (Milton and Dean, 1990; Fuls, 1992; Todd, 2000; Riginos and Hoffman, 2003), which in turn will lead to a change in species composition in the long-term (Milton, 1995; Todd and Hoffman, 1999). However, changes in vegetation can be caused by drought or rainfall cycles (Hoffman and Cowling, 1990). For this reason repeated vegetation condition assessments to monitor the condition of natural veld are needed if reasons for change are to be identified.

Pyke *et al.* (2002) describe 'rangeland health' as the degree to which the integrity of the soil, vegetation, water and air as well as the ecological processes of the rangeland ecosystem are balanced and sustained. Trollope *et al.* (1990) defines the concept '*veld condition'* as *'the state of health of the veld in terms of its ecological status, resistance to soil erosion and its potential for producing forage for sustained optimum livestock production*'. Both definitions focus on the importance of the ecological health of a rangeland as an ecosystem and it is therefore important for livestock farmers to keep it 'healthy' to allow for optimum productivity. Classifying veld as ‘good’ or bad’ is made in terms of its current condition relative to its best possible condition in that veld type (Teague and Danckwerts, 1989).

The earliest development of vegetation assessments in South Africa dates back from the late 1930’s when the Department of Agriculture published a series of reports and bulletins dealing with veld management research. Acocks’ (1938) publication on the ecology of toxic plants that increased under overgrazing was one of the first. Since then numerous methods have been developed locally and tested with success in the rangelands of South Africa.

The objectives of this part of the research are to link the socio-economic and management findings (Chapter 4) with rangeland condition to achieve a predictive understanding of which management practices are the most important drivers of changes in veld condition. Furthermore, the chapter investigates whether free-range ostrich farming is primarily responsible for the deterioration in veld condition within the region.

5.2 Materials and methods

5.2.1 Research approach

There are five basic approaches to assessment of rangeland condition – (1) those based on primary productivity (Humphrey, 1949; Goebel and Cook, 1960), (2) on animal health and secondary production (Dean and Macdonald, 1994), (3) those based on vegetation composition (Tidmarsh and Havenga, 1955; Roux, 1963; Vorster, 1982; Du Toit, 1995), (4) those based on soils and geohydrology (Snyman and Fouché, 1993; Tongway, 1994; Mills, 2003), and (5) multicriteria approaches (Roberts, 1970; Savory, 1988; Herlocker, 1991; Milton and Dean, 1996; Orchard and Mehus, 2001).

The best-known methods for quantifying vegetation condition are the wheel-point method (Tidmarsh and Havenga, 1955), step-point method (Evans and Love, 1957), descending point method (Roux, 1963) and the line-point survey (Du Toit, 1995, 1998). All these methods record the cover or relative abundance of plant species in the herbaceous layer of the rangeland. The resulting data can be weighted according to the value of plants to domestic livestock, and in this way the botanical assessments can be used to calculate the grazing value of the rangeland. The weighting methods most often used to calculate the condition of Karoo veld from botanical surveys are the Ecological Index Method (Vorster, 1982) and the Grazing

Index Method (Du Toit, 1995; 1998). Most vegetation survey methods are, however very time-consuming.

Humphrey (1949) introduced a method known as the 'range-potential concept', which suggested that range condition is measured in terms of its potential forage production. Goebel and Cook (1960) considered total herbage production to be correlated with the condition of veld. However, biomass-based survey methods for assessing rangeland condition are difficult to apply in the Karoo because the vegetation comprises a mixture of succulents, woody shrubs and herbage. Teague and Danckwerts (1989) demonstrated that the use of species composition score alone is not adequate in assessing veld condition.

Multi-criterion assessment of South African rangeland condition was first proposed by Roberts (1970). In the USA, the National Research Council recommended assessments based upon multiple indicators of basic ecosystem processes (Orchard and Mehus, 2001). Petersen *et al*. (2004) has shown that veld assessment methods developed elsewhere are often not robust enough to be implemented in South African arid regions. A multiple-criterion, participatory method for rangeland assessment has recently been developed for use in arid savanna (Reed and Dougill, 2002). The Quick Rangeland Health Assessment method (Milton and Dean, 1996; Milton *et al*., 1998) is a semi-subjective, multicriterion method developed for the Karoo, and was chosen to measure veld condition in the study area. This is much quicker than conventional quantitative methods based on primary or secondary productivity, vegetation composition or soil variables. On average less than 30 minutes are needed to complete one assessment. Furthermore, a modification of this method to include species richness as one of the indicators provides valuable insight on the relationship between veld condition and species richness in an area well known for its biodiversity. The method will be discussed further in Chapter 6 where it is compared with the more conventional point-sampling method of Du Toit (1995), which was developed by the National Department of Agriculture.

5.2.1.1 Selection of plots

In selecting sites for veld assessment on the 100 properties used in the socio-economic survey (Chapter 4), the following were taken into consideration to avoid bias associated with subjective selection of the camp by the farmer or researcher. As a rule the veld camp northwest of the homestead was selected for the veld assessment for that specific farm. In certain cases where the landowner had no veld camps in this direction the researcher had to choose the veld camp on the grounds of accessibility on foot or by vehicle in a different direction.

In order to control for piosphere effects, water- or feeding point (in the case of ostriches camps) had to be located within the camp and the first assessment was performed at about 100 m from this point. The second assessment was done at 500 m from the feeding / water-point. At each of the 100 m and 500 m plots a 1.2 m dropper was put in place to permanently mark each plot. At ostrich farms the researcher had to ask permission from the farmer to mark the plots with droppers due to the potential risk it could pose to these birds because of their active behaviour. In such a case the dropper had to be hammered into a perennial shrub as a precaution against damaging an ostrich that might collide with it.

One of the main criteria for selecting the location of plots, apart from distance from the water- or feeding point, was that the vegetation within the plot should reflect the general state of the veld condition of that specific camp. According to Van Rooyen *et al*. (1994) heterogeneity and patchiness in arid areas is caused by spatial variation in rainfall and distribution of runoff water, which in turn affect both species diversity and grazing selection. Therefore, the researcher had to use vegetation cover and vegetation composition as an over-all guide in selecting the plot. An unmarked plot of about 5 m x 15 m was used for each veld assessment.

An Epson Photo PC 750 Z digital camera was used to keep a photographic record of each plot as suggested by Roberts (1970). The plot number and distance from water- or feeding point was written on an A4 size plastic-coated piece of white paper, using a non-permanent felt pen. The sheet was then temporarily stuck onto the dropper to easily identify the plot number and the distance from the water- or feeding point on the picture. A close-up photograph was taken of the soil to show the presence or absence of erosion, biological or mineral soil crust. A smaller piece of laminated paper of 5 X 5 cm was used in the same way to reference the soil pictures.

5.2.1.2 The veld assessment sheet

The quick veld assessment method, which was developed and described, by Milton and Dean (1996) was used to assess each of the two plots in a veld camp. The assessment sheet

(Appendix 2) makes provision for the following sections:

A. Site description

B. Grazing record

C. Scoring system, using seven indicators

The veld assessment sheet of Milton and Dean (1996) was adapted to include species richness as an indicator.

A. <u>Site description</u>

This section makes provision for general information such as the farm name, camp name, topography, GPS position, soil type, rockiness, vegetation type, distance from water, rain in the past three months, natural damage to vegetation, the presence of features such as gulleys (or referred to as 'dongas'), trampled paths or bare 'heuweltjies', dominant plant cover and the type and quantity of supplementary food. The latter was only applicable in ostrich camps where these animals are dependent on supplementary food. The geographical co-ordinates were recorded, using a Garmin GPS (Model GPS V), at each of the two assessments for a specific camp so that the markers (droppers) can easily be located for possible future follow-up research.

1. Soil texture

The reason for analyzing the soil texture was to investigate if there is any relation between veld condition and the percentage of soil clay in veld camps, especially ostrich camps. Soils with a high clay content are susceptible to soil erosion, capping and compaction near a water-point (Thrash and Derry, 1999). A small soil sample was taken to analyse the soil texture. The method described by Anonymous (2001) and modified by Braam Oberholzer (personal communication, 2003) was used to determine the soil texture. The soil was put through a 2 mm sieve to exclude any course material from the sample. A handful of soil, of about 25 g, was used and water was sprayed on it from a spray bottle while it was kneaded by hand until the soil:water ratio was correct. To achieve this, the soil should neither stick to the fingers (too wet) or crumble or break (too dry). The soil was shaped in a ball. If no stable ball can be formed, the sample is classified as sand with less than 10% clay. If a stable ball can be formed, the sample was then rolled on a dry wooden board in the form of a sausage of about 1 cm in diameter. The method and classification system in Appendix 3 was then used to further classify the samples into sandy loam (15 – 20% clay), sandy clay loam (20 – 35% clay), sandy clay (35 – 55% clay) and clay (>55% clay).

2. Percentage rockiness

The rockiness was recorded as the estimated percentage of rocks in each plot. The reason for this observation was to investigate the relation between veld condition and the percentage of rockiness within a veld camp.

3. Slope

The Little Karoo is topographically very variable (Watkeys, 1999), therefore it ranged from flat to very steep. Slope was recorded in categories as flat, flat to gentle slope (flat rolling), gentle slope, intermediate slope and steep on the veld assessment sheet.

B. Grazing record

In this section the camp area (in hectares), recommended stocking rate (in LSU x 356 days/ha), animal type, number of animals in camp and the grazing period or rotation was noted. The recommended stocking rates for each camp were obtained from the estimated grazing capacity map of the Department of Agriculture.

C. Scoring system

Each of the seven indicators (vegetation cover, forage value, grazing intensity, palatability, seedling ratio, soil health and species diversity) was scored a maximum of five to a minimum of one depending on the subjective observation of each category in the plots. The sum of these scores of each indicator adds up to give the veld condition score. The lower the total score, the poorer the condition of the veld.

The veld condition was classified into excellent, good, intermediate, poor or severely degraded condition by recalculating the veld score index of Milton and Dean (1996) to the final score of 35 points in this study. The same authors describe the different stages in veld condition as follows:

Excellent Veld (Score 32 – 35)

- Veld dominated by palatable plants and long-lived bossies or grasses

Good Veld (Score 25 – 31)

- Cover reduced by heavy grazing or drought, but composition is still good.
- Many shallow rooted grasses and succulents die during times of drought

- Seedlings should establish once drought is broken

Intermediate Veld (Score 18 – 24)

- Changes in plant populations
- Increase in seedlings of unpalatable plants, mat-forming succulents, *opslag* and alien weeds
- Veld less productive for livestock

Poor Veld (Score 12 – 17)

- Decreases or losses of palatable and trample-sensitive plants
- Reduction in living soil crust; microbe, insect, bird and mammal activity
- Soil shows numerous signs of erosion
- Capping and rills indicate that much of the rain is running off
- Carrying capacity is lower than normal for district, especially in drier season

Severely Degraded Veld (Score ≤11)

- Perennial cover almost nil
- Little organic matter protects or enter soil
- Little or no sign of animal activity
- Soils are capped, saline or mobile
- Rain infiltration poor; soil moisture holding capacity low
- Accelerated runoff causes artificial drought – little seedling germination

1. Vegetation cover

The vegetation cover is regarded as the percentage of soil covered or over-shadowed by plants. Plant cover is a very important factor in protecting the soil from raindrop impact that causes erosion (Milton and Dean, 1996; Snyman, 1998; Snyman, 1999). When plant cover is more than 50%, there is no or little soil loss and up to 90% of all precipitation stays in the veld (Milton and Dean, 1996). According to Snyman and Fouché (1993), there is usually a linear relationship between the range condition index and the basal cover in arid and semi-arid areas. Earlier plant surveys within the region indicate that the vegetation cover varies from 20% to 55% in the succulent vegetation types (Anonymous, 1999).

All living plant matter which include life forms from perennial tall shrubs, small shrubs succulents and grasses to '*opslag*' (short lived, shallow rooted grasses and annuals) were considered in estimating vegetation cover. Plate 5.1 a and b give an indication of how the vegetation cover was scored according to the matrix on the assessment sheet (Appendix 2).

a. Vegetation cover less than 10%: Score = 1. 100 m from feeding and water-point

b. Vegetation cover more than 50%: Score = 5. 500 m from feeding and water-point

Plate 5.1 a & b: Pictures showing the scoring of the same camp at distances of 100 m and 500 m from the feeding point.

2. Forage value

In assessing this indicator, palatable plants had to be identified and the percentage of these plants in relation to the percentage of vegetation cover within the plot had to be estimated. Trollope *et al*. (1990) defines the term 'palatability' as the acceptability of plants for animals as determined by specific characteristics of the forage. Palatability seems to vary within plant species, which could be contributed to abiotic factors such as soil and aspect (Danckwerts, 1989). In the southern hemisphere, northern aspect slopes in general produce more palatable forage (McCabe, 1987). The palatability values used by Van Breda, Nel and Bayer (undated), Van Breda and Barnard (1991), Le Roux *et al*. (1994), and Milton and Dean (1996) where plants are classified by using a star rating were used as a guide. Highly palatable plants like *Grewia robusta*, *Hermannia filifolia*, *Tripteris sinuata* and *Limeum aethiopicum* are rated as five star plants. Very palatable plants like *Rhigozum obovatum*, *Salsola tuberculata* and even exotic plants like *Atriplex semibaccata* var. *appendiculata*, are rated four-star plants. Examples of palatable plants (three star) are *Felicia filifolia*, *Galenia fruticosa*, *Ruschia spinosa* and *Carissa haematocarpa.* The less palatable plant category (two star) includes plants like *Eriocephalus ericoides*, *Rosenia humilis* and *Malephora lutea* that are only eaten by animals under pressure when food is scarce. Highly unpalatable or poisonous plants are regarded as one star plants which include plants like *Galenia africana*, *Chrysocoma ciliata*, *Pteronia pallens* and *Psilocaulon* spp. Palatability of plants throughout the Little Karoo seems to vary with the soil composition and aspect. The palatability of a given species e.g. *Zygophyllum* spp. which is regarded as an unpalatable species seem to vary (personal observation) depending on whether it is found in sweet or sour veld. Therefore, in some cases the researcher had to refer to the farmers' knowledge on plant palatability.

The percentage of plant species in the plot with palatability ratings in each of the star categories 2-5 was estimated and points were allocated according to the matrix on the assessment sheet. A low score for this indicator will therefore point to overgrazing.

3. Grazing intensity

Once the palatability of plants was identified, the researcher could then use these categories of one to five star plants to score grazing intensity. Grazing animals tend to show a preference to consume plants that are more palatable as proven by Joubert (1986) who have shown that sheep, even when stocking pressure was high, do not utilize unpalatable species to the same extent as more palatable ones. In the Karoo, sheep very seldom browse stems with thicker than 2 mm diameter for less palatable species, while for very palatable species (5-star plants) stems up to 5 mm in diameter are browsed (Du Toit, 1993; Du Toit, 1996). Goats, especially in the succulent thicket biome, have the tendency to trim palatable species like *Pappea capensis* (Plate 5.2 a) into umbrella shaped trees (Owen-Smith and Danckwerts, 1997). Milton *et al.* (1994b) has shown that ostriches tend to select and strip off leaves of palatable plants such as *Gazania* sp, *Indigofera* sp, and *Lepidium* sp as well as grasses or tug them out of the soil and swallow roots and all. In common with mammalian livestock, they tend to avoid poisonous plants such as *Euphorbia* spp (melktou), *Tylecodon* sp (Nenta), *Nicotiana glauca* (wild tobacco) and *Pteronia pallens* (Scholtzbos), but also strong-smelling, sticky plants and very salty succulents like *Augea capensis* (bobbejaankos or volstruisganna), *Mesembryanthenum crystallinum* (ysplant) and *Psilocaulon* spp (loogbossie or asbos) (Milton *et al*., 1994b).

a. *Pappea capensis* about 75 % browsed into umbrella shaped tree

b. Unbrowsed *Tripteris sinuata* in flower

c. *Limeum aethiopicum* browsed > 75 %

Plate 5.2 a, b & c Different highly palatable plants browsed at different intensities.

If camps are rested long enough, browsed plants can get the opportunity to grow back, flower and set seed (Figure 5.2 b). Plants that were grazed down to their wooden stem or base of the plant are considered to be 100% grazed (Figure 5.2 c). Herbivores will first select a range of the most palatable foods from the available forage; therefore the grazing impact will be the highest on the most palatable species available (Vesk and Westoby, 2001). Table 5.1 was used to score grazing intensity by firstly looking at the presence of five star plants to score grazing intensity. If plants with a higher star rating were absent in the plot the observed grazing intensity on less palatable species was used to obtain a grazing intensity score. Veld in poor condition was given a lower score – so heavily grazed palatable plants, or lightly grazed unpalatable plants receive lowest numerical scores.

Table 5.1 Scoring of grazing intensity

	Palatability of plants (star rating of plants)				
Grazing intensity	*	**	***	****	*****
>25%	1	2	3	4	5
50%		1	2	3	4
75%			1	2	3
100%				1	2

4. Disturbance indicators

Disturbance indicators include the presence of alien plants, mat-forming plants, like the Mesembryanthemum family and '*opslag*' (Plate 5.3), which is regarded as short-lived plants, shallow grasses and annuals which grow in areas that were disturbed by heavy grazing, trampling or other soil disturbance. Veld in good condition should be free of alien plants and should have little space for mat-plants (Milton and Dean, 1996). Mat-plants usually become dominant in disturbed areas where shrubs are removed due to overgrazing (Plate 5.4).

Plate 5.3 '*Opslag*' is short-lived plants, shallow grasses and annuals growing in disturbed areas.

Plate 5.4 *Malephora* sp. is an example of 'mat-forming plants' growing in disturbed areas

Alien weeds and invasive plants are commonly found all over the world. These plants are usually unpalatable to livestock and out-compete indigenous plants, reducing the grazing capacity of the veld.

5. Seedling ratio

Seedlings of only perennial plants that occurred within the plot were counted. In arid areas seedlings tend to grow underneath 'nurse plants' e.g. *Galenia* spp. so that care had to be taken to search for hidden seedlings. The ratio of palatable to unpalatable plants was used to score this indicator. Camps in good condition or camps undergoing an improvement in veld condition would have many more palatable seedlings than unpalatable seedlings. In the early part of the fieldwork the Little Karoo experienced a drought period and no seedlings were present. In such cases the seedling ratio indicator was excluded and the final veld score had to be recalculated.

6. Soil and habitat health

This indicator gives an indication of the ability of the soil to trap and absorb water and to support plants (Milton and Dean, 1996). Soil compaction by grazing animals can turn the soil surface into an impermeable layer (Roux and Opperman, 1986; Belnap, 2001), which reduces the infiltration rates, saturated hydraulic conductivities and water-stable aggregates of soil (Ahmed *et al.*, 1987; Dean, 1992; Seitlheko *et al.*, 1993; Snyman, 1998).

A maximum of up to five marks were scored for negative signs such as erosion and formation of physical soil crust (Plate 5.5 a & b). The more severe the erosion or crusting, the less marks it scored. A score to a maximum of five were also allocated if the soil in the plot shows positive signs like the presence of plant litter, animal diggings and cryptogram cover (Plate 5.6). A score for the indicator soil health was then calculated from the mean of the positive and negative signs scores. The balance between the marks allocated to positive and negative signs made up the score for this indicator.

a. Severe soil erosion in an ostrich camp

b. Physical soil crusting near ostrich feeding point

Plate 5.5 a & b Pictures showing negative signs of soils, which are indicative of camps in poor condition.

(Photo: Nelmarié Visser)

Plate 5.6: The presence of biological soil crust and plant litter are signs indicators of soil in good condition.

7. Species richness

As explained in Chapter 3 the Little Karoo region is renowned for its richness in plant species. The index for measuring species diversity was species richness, which Magurran (1988) describes as a measure of the number of species in a defined sample unit. All species that were observed within each plot were counted in the categories '*opslag*', perennial succulents, perennial small shrubs, perennial tall shrubs and perennial grasses. Therefore the species richness could be referred to as the species density, which Hurlbert (1971) describes as the number of species per specified collection area. A matrix to score species richness was worked out after the fieldwork was completed because the species richness for veld in good or bad condition within the region was not known.

5.2.2 Data analysis

The veld assessment data were captured in a spreadsheet using Microsoft® Excel. From Excel the data could then be directly imported to Statistica 6.1 (StatSoft Inc., 2003), which was employed for analyses of the data, except where indicated otherwise. The data were checked for normality by plotting the raw residuals in normal probability plots. When data were not normal distributed, an appropriate non-parametric method was used to verify the parametric results. A confidence level of 95% was used in all analyses. The following six hypotheses were tested:

Hypothesis 1: Animal type ratios are similar for all vegetation types

Vegetation types of the Little Karoo are known to differ in productivity and nutritional value to domestic livestock (Rutherford and Westfall, 1994). This hypothesis was erected to find out whether farmers actually manipulate their livestock composition to match the vegetation type or composition (resources in veld). It was tested by comparing observed with expected distributions of animal types using Chi-square statistics.

Hypothesis 2: Veld condition differs with distance from water- or feeding points

Grazing mammalian livestock usually forage outwards from a watering point, to which they are obliged to return frequently for drinking. In the same way ostriches utilized artificial watering points and feeding bins on a daily basis. According to Dean and Macdonald (1994) the introduction of such watering points in semi-arid areas of South Africa caused irreversible vegetation degradation. Distinct zones of bare soil and ephemeral plants are usually found around watering points, these are called piospheres (Lange, 1969; Andrew, 1988). This hypothesis was tested by comparing the two dependent variables (100 m and 500 m) using a non-parametric Wilcoxon matched pairs test. The result was then plotted as a Box-Whiskers plot.

Hypothesis 3: The best predictor of veld condition score is current stocking rate

Milton *et al.* (1997) have shown that overstocking of livestock has reduced palatable plants in some parts of the Succulent Karoo Biome. One could therefore expect a negative relationship between high stocking rate and veld condition, which should have a short-term negative effect on veld condition. The stocking density (in ha/LSU/yr) for each camp was calculated from the grazing record on the veld assessment sheet, and was expressed as a proportion of the estimated agricultural grazing capacity for the district. These data were then plotted against the veld condition score at a distance of 500 m from the water- or feeding point for each camp that was used for animal production.

A best subset regression to find subsets of predictor variables that best predict responses on the veld condition (as the dependent variable) was run on the data set. Continuous variables (percentage rockiness, stocking density, camp size and rest period) and dummy variables Little Succulent Karoo, Spekboom Succulent Thicket, South and South-West Coast Renosterveld (for categorical variable vegetation type); flat and gentle to steep (for categorical variable slope); sand, loamy sand, sandy loam, sandy clay and shale (for categorical variable soil type) and large stock, small stock, ostrich, mix and no animals (for categorical variable animal type) were put into the model. The analysis would identify those variables, that have the greatest effect on the veld condition within the study area.

A non-parametric Kruskal-Wallis ANOVA was used to investigate how other animal types differ from ostriches in terms of their effect on the veld condition. Non-parametric Kruskal-Wallis ANOVA was also used to compare veld condition among vegetation types (LSK differs from that in SSWCR and SST). Kruskal-Wallis ANOVA was used to compare the effect of different soil textures on the veld condition.

Hypothesis 4: Free-range ostriches have a greater effect on veld condition of plains than mammalian livestock

It is generally assumed that, despite their higher hoof pressure, cattle have less severe effect on plant cover than small stock, provided overstocking does not take place (Roux and Opperman, 1986). The effect that ostriches have on veld condition though trampling and grazing has never been measured before. This hypothesis was tested by comparing the veld condition scores of the two variables (ostrich and mammalian livestock) using a non-parametric Mann-Whitney U Test. The result was then plotted as a Box-Whiskers plot.

Hypothesis 5: Veld condition score in camps under no fixed grazing systems is poorer than those in other grazing systems

Natural veld should supply the feeding needs of the grazing animal and the rest periods should be adequate for the growth requirements of the veld (Donaldson and Vorster, 1989). It can be assumed that the longer the camp rests, the more time the vegetation would have to flower and establish new seedlings. Four basic ‘grazing systems’ are employed by ostrich farmers, namely those that continuously use the same camp on an annual basis, two camp system, three camp system, and those who make use of no fixed system. Cattle farmers' grazing systems were grouped as those who make use of camps systems of three to six camps, short duration grazing systems and those making use of no fixed system. In both cases a Kruskal-Wallis test was done to compare the effect different camps systems have on the condition of the veld. A non-parametric Mann-Whitney U test was used to test whether there is a difference in veld condition where small stock is grazed in formal three to six camp systems or on farms where the manager make use of no fixed system.

Hypothesis 6: There is a positive correlation between veld condition and species richness of perennial plants.

According to Blench and Sommer (1999) biodiversity plays a crucial role in ecosystem stability, which can be measured by ecosystem properties, such as floristic composition and vegetation cover. Studies in a grassland community by Tilman and Downing (1994) have shown that primary productivity in more diverse plant communities is more resistant to, and recovers more rapid after a drought than in less diverse communities. Owen-Smith (1996) has shown that higher animal activity around waterholes, can lead to greater vegetation degradation, a decrease in ecosystem stability and a loss of biodiversity. Todd and Hoffman (1999) in a fence-line study in Namaqualand, found that overgrazing reduced the density of perennial plant species, but increased species density of ephemeral plants. One could therefore assume that veld in good condition should be more stable and richer in biodiversity. The species density (number of species per plot) was plotted against the veld condition score, which excluded the indicator "*species density*". This was done for plots assessed 500 m from the water, or feeding point, in all vegetation types to investigate the effect of veld degradation on species diversity. Ephemerals (*opslag*) were excluded from the data.

5.3 Results

Hypothesis 1 was rejected because animal type ratios differed significantly among vegetation types (Pearson Chi-square: 54.8879, df = 12, $p < 0.001$). The seven categories for land use in the assessed veld types are Angora (N = 10), sheep (N = 8), Boer goat (N = 2), ostrich (N = 41), cattle (N = 12), mixed livestock (N = 4) and none (camps which have never been used for grazing or are abandoned for many years (N = 21). Ostrich camps constituted most of the assessments with 41.84%, because ostrich production is the main farming activity in the Little Karoo. Ostrich camps are most likely to be found on Little Succulent Karoo vegetation (Figure 5.1).

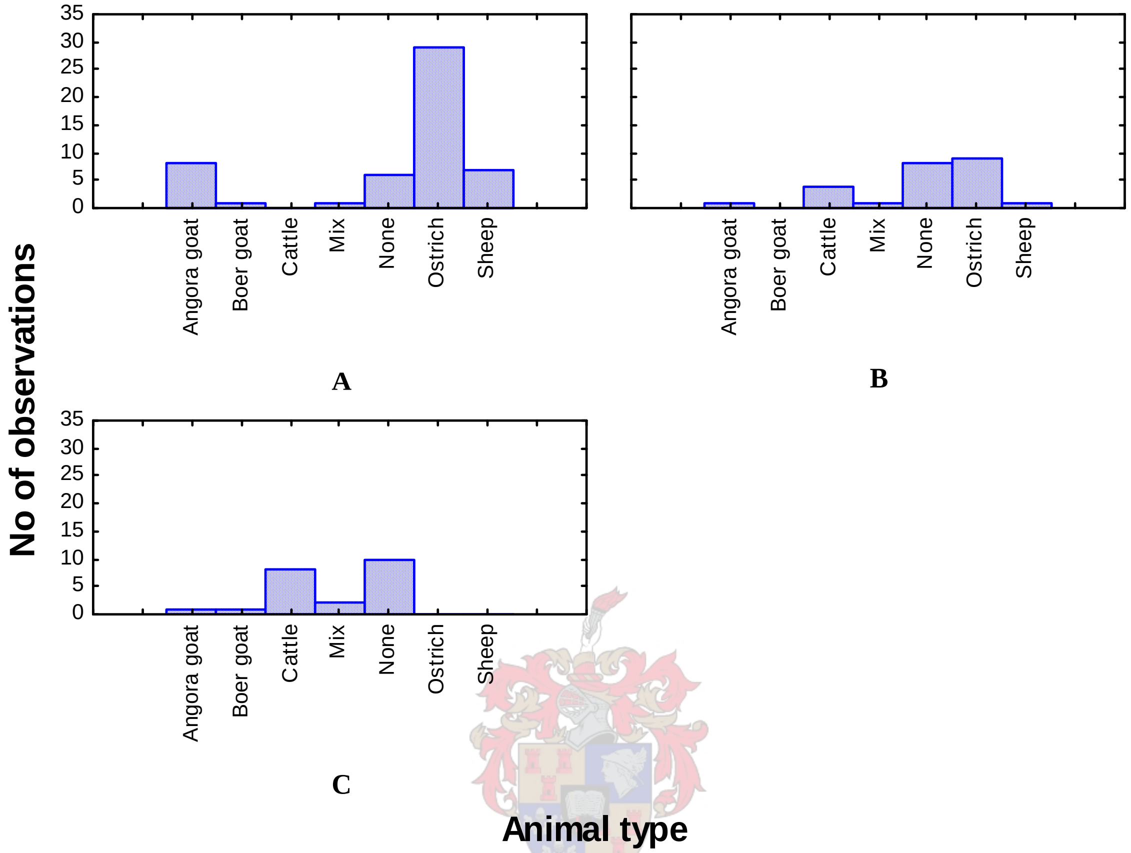


Figure 5.1 The numbers of farmers of a sample of 100 surveyed, keeping six breeds of domestic livestock and unused camps (None) in three vegetation types (A = Little Succulent Karoo, B = Spekboom Succulent Thicket and C = South and South-west Coast Renosterveld) in the Little Karoo.

Hypothesis 2 was accepted because there was a significant difference between the condition of the veld at 100 m and 500 m from the water- or feeding point (Wilcoxon matched pairs test; $N = 100$, $T = 686.5$, $p < 0.001$). The veld condition score was lower and more variable near water and feeding points where livestock concentrated (Figure 5.2).

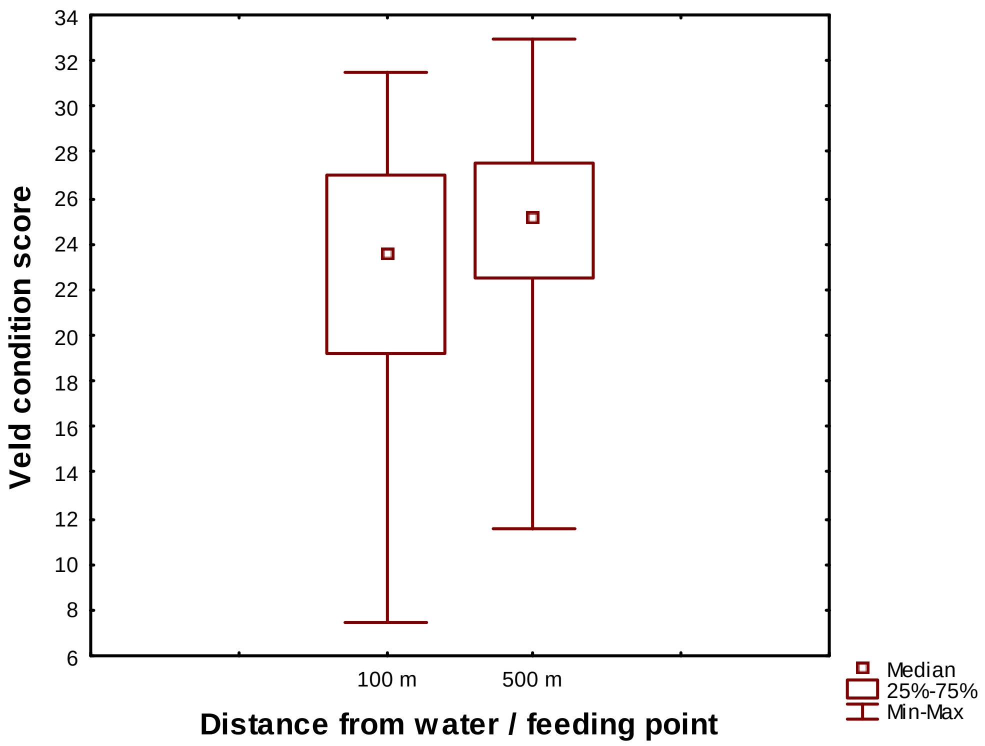


Figure 5.2 Box-Whiskers plot showing the difference in veld condition at 100 m and 500 m from water- or feeding point.

Current stocking densities in most camps exceeded recommended densities (Figure 5.3). Currently ostrich camps are overstocked at a stocking rate of 67.7% more than the estimated grazing capacity of the Department of Agriculture. Mammalian livestock is overstocked at 55.1% more than the estimated grazing capacity. There is also a weak, but significant negative correlation (Figure 5.3), between the veld condition score and the degree of current overstocking ($N = 59$, $r^2 = 0.0286$; $p > 0.05$). There was however no significant difference in veld condition between overstocked and understocked camps (Mann-Whitney U test: $U = 109.5$, $p < 0.05$)

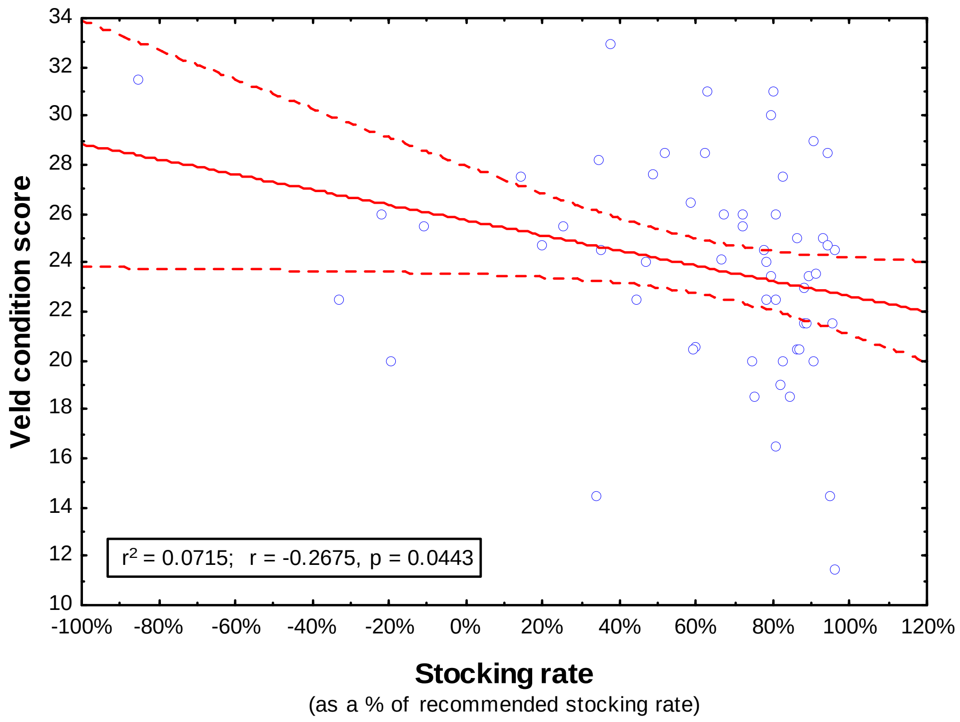


Figure 5.3 Relationship between veld condition and the degree of overstocking (excludes camps with no animals) (y = 25.7441-3.112*x).

The variables "plains", "Little Succulent Karoo vegetation type", "sandy loam soils", "ostrich", "stocking rate (ha/LSU/yr)" and "rockiness" explained 51.1% of the variance in veld condition (Table 5.2). Plains, Little Succulent Karoo vegetation type and ostriches are the three most important variables, which explains 45.2% of the variation in the model. The variable stocking density did not feature as one of the most important variables that negatively affect veld condition; therefore the result rejects Hypothesis 3.

Table 5.2 Summary of the results with environmental and management variables entered into a best subset regression model

R square	No. of effects	Plains	Little Succulent Karoo	Sandy loam soil	Ostrich	ha/LSU/yr	Rockiness
0.511649	6	-0.111839	-0.332891	-0.113465	-0.423811	0.184631	0.232324
0.501649	5	-0.100179	-0.355490		-0.396611	0.175033	0.198675
0.475725	4	-0.214012	-0.320301		-0.415530	0.162547	
0.451874	3	-0.221509	-0.310128		-0.367246		
0.371004	2	-0.279014			-0.460058		
0.301001	1				-0.548636		
0.253784	1		-0.503770				
0.180682	1	-0.425067					

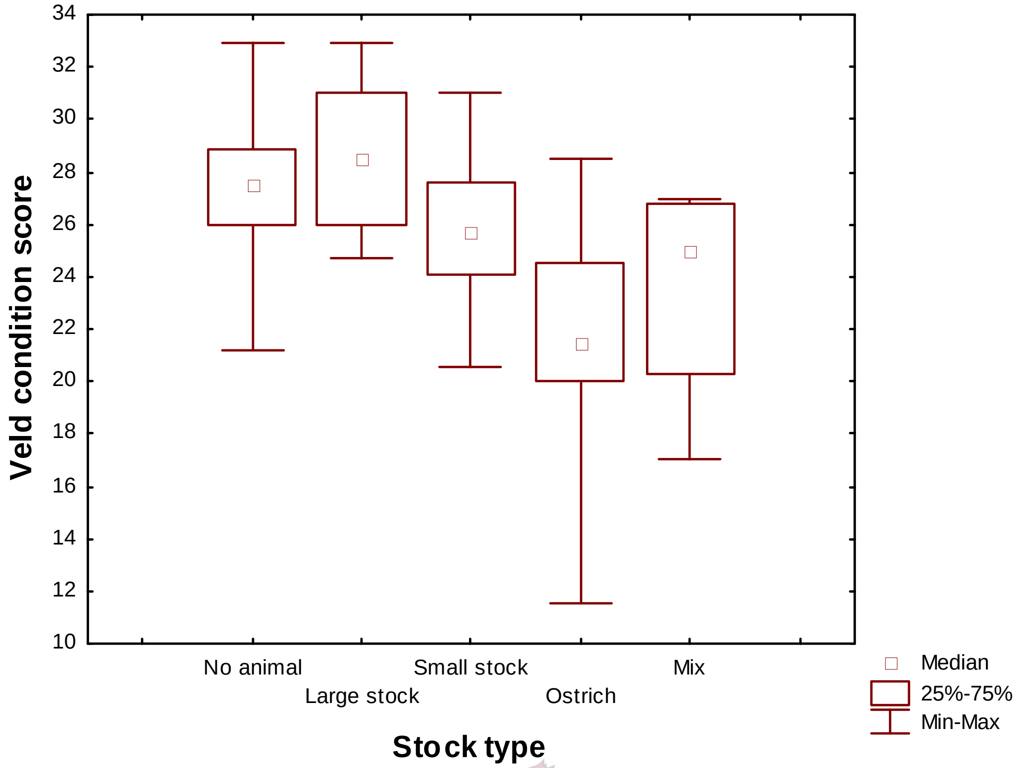


Figure 5.4 Comparison of veld condition score between camps with different stock types at a distance of 500 m from water (or feeding point).

Veld condition differed significantly with animal type group (Kruskal-Wallis test: $H_{(4, 99)} = 48.96850$ $p < 0.001$). Camps stocked with ostrich had a significantly lower veld condition score than destocked camps and camps stocked with large and small stock (Figure 5.4). However, condition of ostrich camps did not differ significantly from camps stocked with mixed stock types (Table 5.3).

Table 5.3 Multiple comparison test showing the differences within the different stock type variables

	No animal (N = 21)	Large stock (N = 13)	Small stock (N = 20)	Ostrich (N = 41)	Mix (N = 4)
No animal		1.000000	0.988127	0.000000	0.678460
Large stock	1.000000		0.572133	0.000001	0.428471
Small stock	0.988127	0.572133		0.002003	1.000000
Ostrich	0.000000	0.000001	0.002003		1.000000
Mix	0.678460	0.428471	1.000000	1.000000	

Veld condition differed significantly among vegetation types (Kruskal-Wallis test: $H_{(2, 99)}$ = 25.456, $p < 0.001$) at the distance 500 m from the water- or feeding point (Figure 5.5). The condition of LSK was the poorest and SSWCR the better of the three. Veld condition did not differ significantly with soil texture (Kruskal-Wallis test: $H_{(5,100)}$ = 0.805, p = 0.976).

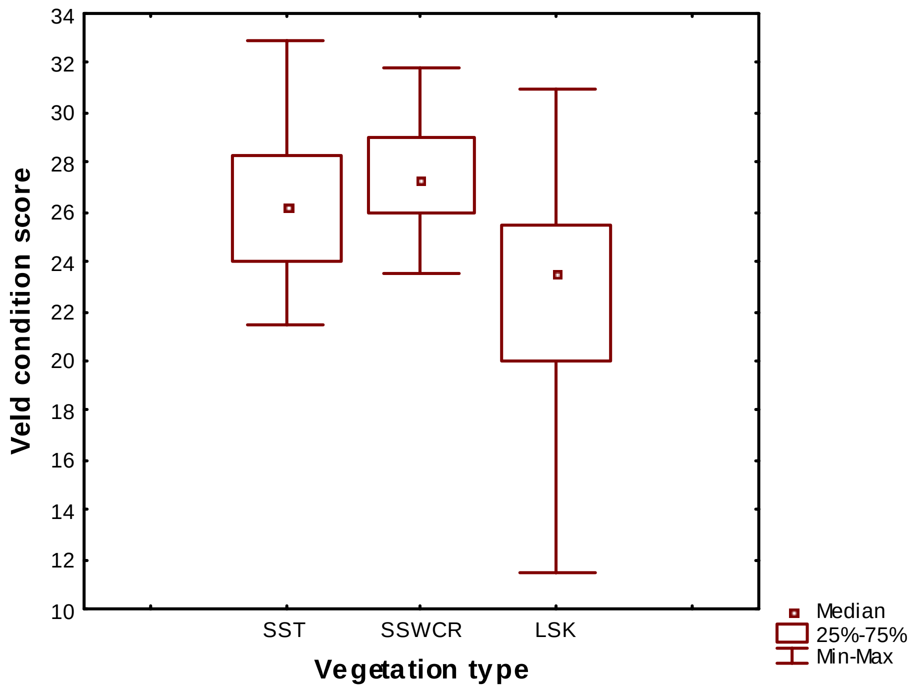


Figure 5.5 Comparison of veld condition score at 500 m from water / feeding point between Little Succulent Karoo (LSK), South and South-west Coast Renosterveld (SSWCR) and Spekboom Succulent Thicket (SST).

Hypothesis 4 was accepted because the veld condition in camps on plains was significantly poorer if stocked with ostriches when compared with those stocked with other types of livestock ($U_{(1,37)}$ = 40.500, p = 0.001, Figure 5.6).

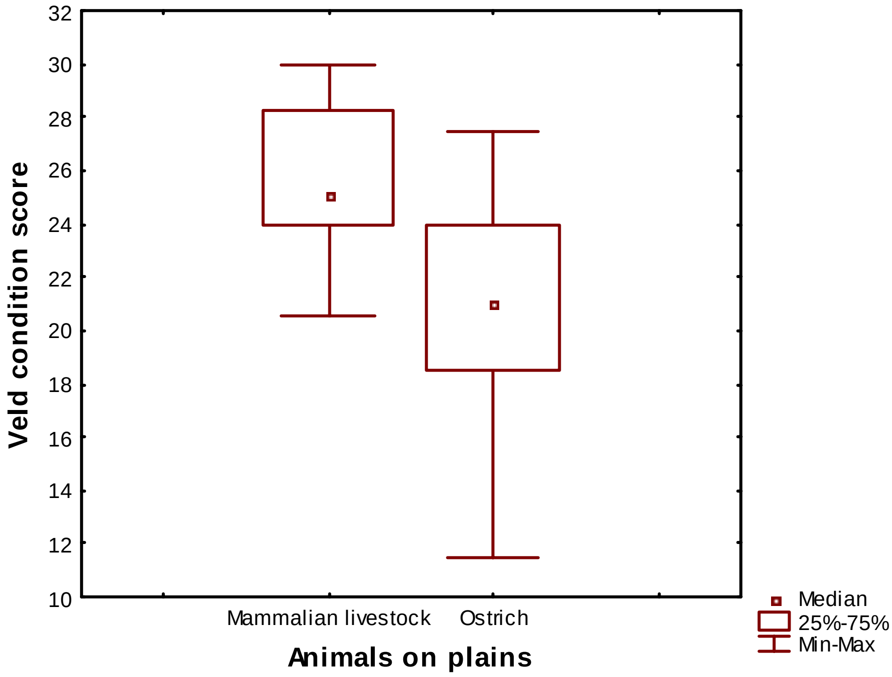


Figure 5.6 Box-Whiskers plot showing the difference in veld condition between ostrich camps and other camps on plains.

Hypothesis 5 was rejected because the veld condition score in camps under no fixed grazing systems did not differ significantly from those in other grazing systems for all animal types: Ostrich: ($H_{(3,39)} = 0.775$, $p > 0.05$), Large stock ($H_{(2,12)} = 2.798$ $p > 0.05$) and Small stock ($N = 19$, $U = 31.5$, $p > 0.05$). The veld condition in large stock camps in a three to six camp grazing system were slightly better than those managed under no fixed system and short duration grazing system.

Hypothesis 6 was accepted because there was a positive correlation between veld condition and species richness of perennial plants ($r^2 = 0.2419$; $r = 0.4918$, $N = 197$, $p < 0.001$, Figure 5.7).

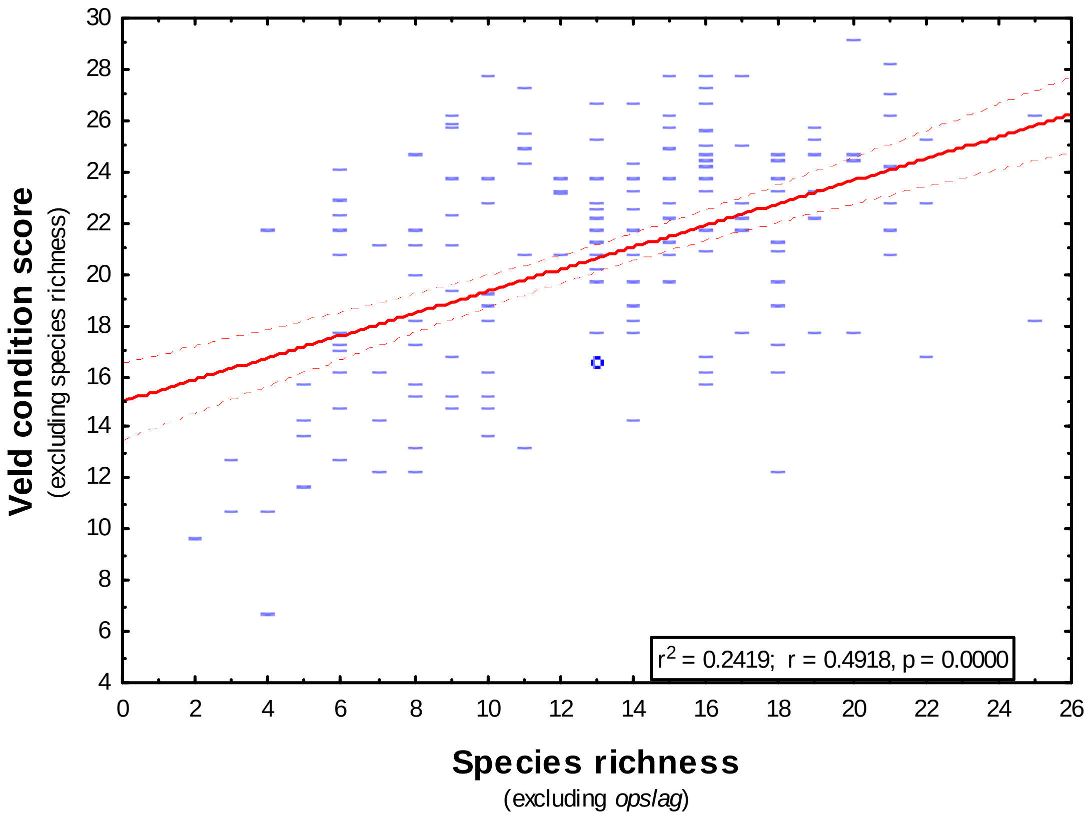


Figure 5.7: Relationship between veld condition (excluding a measure of species richness) and perennial plant species richness at distance 500 m from water- or feeding point for all camps (y = 15.0048 + 0.4314*x).

5.4 Discussion

It is essential for grazing animals to drink water on a daily basis; therefore they tend to forage outwards from a water-point. Grazing by foraging animals and the subsequent trampling effect by livestock's hooves or toes is more intense closer to the water-point (or feeding point), causing a piosphere effect (Lange, 1969). The veld condition near and further away from the water / feeding point in the Little Karoo is consistent with results in studies by Van Rooyen *et al.* (1991) and Ross (1995). Senzota and Mtahko (1990) has shown that the impact of trampling is greater than that caused by grazing closer to the water-point. The trampling caused by grazing animals results in compaction of the soil aggregates into a comparatively impermeable surface (Belnap, 2001), and compaction, especially near the water-points significantly reduces the infiltration rates, saturated hydraulic conductivity and water-stable aggregates of soil (Ahmed *et al.*, 1987; Seitlheko *et al.* 1993; Snyman, 1998).

In arid areas bare, hard soil does not provide ideal safe sites for large seeded plants to germinate (Milton and Dean, 1996) and also adversely affect the survival of seedlings (Du Preez and Snyman, 1993). Woody plants are browsed and trampled much more nearer to the water-points and tend to be replaced by unpalatable plants that are adapted to withstand browsing (Thrash and Derry, 1999). In the Little Karoo free-ranging breeding ostriches receive supplementary food at feed bins, usually placed near the water-points. This seems to increase the grazing pressure and trampling effect of these birds near the feeding bins.

From the result of the best subset regression analysis it is evident that the variables ostrich production, plains and Little Succulent Karoo were responsible for the greatest effect on the variability in the veld condition. All of these factors have a negative effect on veld condition but it must be taken into account that these three factors are confounded. In most cases (65.85%) ostrich camps were found on plains with 34.15 % on gentle to intermediate slopes. This would indicate that ostrich camps are mostly confined to the low-lying areas in the Little Karoo. In comparing the differences in veld scores of ostrich camps with other camps on plains, the result showed that ostrich farming on plains had a greater negative impact on the veld condition than other forms of livestock production. All of the assessed ostrich camps were found to be in the vegetation types of the Succulent Karoo Biome with the majority in the Little Succulent Karoo and the rest in Spekboom Succulent Thicket vegetation types. With 87.0% of ostrich camps found on the low-lying LSK, this probably explains why the veld condition score in this particular vegetation type is significantly lower when compared with Spekboom Succulent Thicket and South and South-west Coast Renosterveld.

The results presented in this study on the effect different animal types have on veld condition for all slopes and vegetation types confirms the fact that ostriches have the greatest negative effect on veld condition as suggested by the result from the best subset regression analysis. Despite the fact that ostriches receive supplementary food, the veld condition score was significantly lower than in camps with no animals, large stock and small stock even at distances further away from the water- or feeding point. In most instances it was observed in the field that even though ample supplement food is available, ostriches would still forage on the natural vegetation, especially after good rains when young shoots were available (personal observation). The availability of supplementary food does therefore not prevent ostriches from utilizing the most palatable plant species in the same way as their mammalian equivalents. According to Williams *et al.* (1993) ostriches spent nearly 80% of their active time walking and/or pecking and this behaviour can also contribute greatly to the rapid deterioration of the natural veld. Gatimu (1996) has shown that only a small percentage (12.8%) of ostriches in the Greater Karoo region use supplement feed at any particular time of day, while the rest spent their time in the veld. Due to the variability in topography in the Karoo (Watkeys, 1999) one will rarely find ostrich camps exclusively on plains. The presence of steep areas is therefore common in most camps. Ostriches usually avoid steep slopes; therefore the stocking density on plains is amplified, bringing about higher grazing pressure and increased trampling.

Cattle, even though they have the greatest body mass, higher hoof pressure (Willat and Pullar, 1983) and longer feeding time (Owen-Smith, 1988), have a less severe effect on veld condition than small stock or ostriches. Camps with cattle were even found to be in a slightly better condition than unutilized camps. Cattle farms in the Little Karoo region were mainly found to be in South and South-west Coast Renosterveld (66.7%), which was the vegetation type that scored the highest when compared to Spekboom Succulent Thicket and Little Succulent Karoo. Sheep are very selective grazers and have a slightly higher impact on veld condition because they are able to utilize the lower plant strata from 2.5 cm to 30 cm (Hugo, 1966; Noy-Meir, 1993). Goats are in general browsers that utilize shrubs from 10 cm to a height of 157 cm and according to Hugo (1966) they are considered to be more effective utilizers of vegetation than sheep or cattle. This possibly explains why veld condition on small stock farms is slightly lower than those on cattle farms. In the 'mix' category ostriches as well as mammalian herbivores utilize the same camps at different times of the year. Even though the veld condition score in this category was on average the second lowest, it did not differ significantly from the other groups, possibly because of small sample size.

The soil texture or the rockiness in the different camps did not seem to have any significant effect on the veld condition. It would therefore seem that erodibility of soils of different clay content does not play a role in protecting the veld against trampling by livestock. The negative correlation between stocking density and veld condition was expected, but was however extremely weak. What is evident from this correlation is the fact that the Little Karoo is overstocked with both ostriches and mammalian livestock. There is no significant difference in veld condition between over-stocked and under-stocked camps, which could be explained by possible higher historical stocking rates and land use. The current poor state of the veld condition in ostrich camps can be explained by the historical stocking rate pre-1988 when breeding birds as well as slaughter birds were kept at high numbers on the veld (Anonymous, 1988). It was only after 1988 that ostrich farmers were forced by *Bodembewaring* (the Soil Conservation division of the Department of Agriculture) to remove slaughter birds from the natural veld (personal communication Kobus Nel, 2003). The guidelines for ostrich farming, which were jointly issued by the Oudtshoorn Conservation committee and the Department of Agriculture as a response against the concern about the degradation in the Little Karoo, recommended that free-range breeding ostriches on natural veld should be kept at a stocking density of one bird per hectare (Anonymous, 1988). In terms of Regulations 10 and 11 of Conservation of Agricultural Resource Act, 1983, (Act 43 of 1983), this is a stocking rate twenty times higher than that of the estimated grazing capacity for the Olifants River-Gamka region (where the estimated grazing capacity is 60 ha/LSU). No statistics are available on historical free-range ostrich numbers. From the stocking rates recommended by the Oudtshoorn Conservation committee and the Department of Agriculture one can therefore assume that the region was highly overstocked with ostriches in the past.

5.5 Conclusion

The veld condition in the Little Karoo can be related to altitude, vegetation types and land use. In this topographically variable landscape veld condition is poorest at lower altitudes in the Little Succulent Karoo vegetation type and significantly better at higher altitudes, which are predominantly dominated by Spekoom Succulent Thicket and South and South-west Coast Renosterveld. Free-range ostriches, which are stocked at high densities, cause considerable damage through trampling and grazing to the natural vegetation, soil and vegetation composition, especially in Little Succulent Karoo veld. Field observations and plant surveys in camps where livestock had been removed for five years under the Livestock Reduction Scheme indicated extremely low improvement in the basal vegetation cover, and where it was evident, recruitment was mostly of seedlings of less palatable species (Anonymous, 1999). There can be no doubt that the extremely high overstocking of ostriches in the past must have contributed to the degradation of the natural veld, especially in the Little Succulent Karoo vegetation type. The current stocking rate in ostrich camps (overstocked at 67.7% over the estimated grazing capacity of the Department of Agriculture) and mammalian livestock camps (55.1% overstocked) together with the poor grazing rotation does not provide the ideal circumstances for veld condition improvement. It would seem that overstocking with ostriches has a much more severe effect on veld degradation than overstocking by mammalian livestock. The fact that ostriches cannot be moved from breeding camps for the entire breeding season of nine months even in times of drought could be the main reason for the degradation or slow natural rehabilitation of veld. The recommended rest period of two breeding seasons for each camp (Anonymous, 2003) seems inadequate for veld improvement especially when the stocasticity of recruitment events in the Karoo is taken into account (Wiegand *et al.*, 1995).

From a biodiversity perspective the results indicate that veld condition does influence the abundance of perennial plant species. Veld camps in good or excellent condition tend to have a greater diversity of plant species (species density) and in more degraded camps less species are found. This is an important issue in the Little Succulent Karoo vegetation type, which is of international importance because of its high biodiversity and endemism (Myers *et al.*, 2000). One could therefore conclude that the way free-range ostrich farming is practiced today has a negative effect on the veld condition and biodiversity, particularly within the Little Succulent Karoo vegetation type.

A summary of the findings of this chapter and Chapter 4 was condensed and communicated to the farmers of the Little Karoo in a preliminary report (Appendix 4).

5.6 References

Acocks, J. P. H. 1938. The vermeerbos problem in Griqualand West – a preliminary survey. Pages 76-85 in Pasture Research Progress Report 1, Department of Agriculture and Forestry, Pretoria.

Ahmed, H., Abdel-Magid, M. J., Trlica, M. J. and Hart, R. H. 1987. Soil and vegetation responses to simulated trampling. *Journal of Range Management*, **40**:303-306.

Allsopp, N. 1999. The effects of grazing and cultivation on soil patterns and processes in the Paulshoek area of Namaqualand. *Plant Ecology*, **142**:179-187.

Andrew, M. H. 1988. Grazing impact in relation to livestock watering points. *Trends in Ecological Evolution*, **3**:336-339.

Anonymous. 1988. Riglyne vir die bewaring van natuurlike weiveld met verwysing na volstruisboerdery (*official letter*). Oudtshoorn Bewaringskomitee and Departement van Landbou.

Anonymous. 1999. *Klein Karoo Streeksinligtingsdokument*. Oudtshoorn Proefplaas, Oudtshoorn.

Anonymous. 2001. *Modern Agriculture for 2001 Swaziland.* Second Edition. Oxford University Press, Oxford.

Anonymous. 2003. Riglyne vir die benutting van natuurlike veld deur volstruisboerdery – 'n gedragskode vir volstruisprodusente (a pamphlet). South African Ostrich Business Chamber, Oudtshoorn.

Archer, E. R. M. 2004. Beyond the "climate versus grazing" impasse: using remote sensing to investigate the effects of grazing system choice on vegetation cover in the eastern Karoo. *Journal of Arid Environments*, **57**:381-408.

Belnap, J. 2001. Biological Soil Crust and Wind Erosion. Pages 339-348 in Belnap, J. and Lange, O. L. (eds.). *Biological Soil Crusts: Structure, Function and Management*. Springer-Verslag, Berlin.

Blench, R. and Sommer, F. 1999. Understanding rangeland biodiversity. Working Paper 121. Overseas Development Institute, London.

Conservation of Agricultural Resource Act, 1983, (Act 43 of 1983). Government Gazette, No.9238, Pretoria.

Danckwerts, J. E. 1989. Animal performance. Pages 47-60 in Danckwerts, J. E. and Teague, W. R. (eds.). *Veld Management in the Eastern Cape*. Government Printers, Pretoria.

Dean, W. R. J. 1992. Effects of animal activity on the absorption rate of soils in the southern Karoo, South Africa. *Journal of the Grassland Society of southern Africa*, **9**:178-180.

Dean, W. R. J. and Macdonald, I. A. W. 1994. Historical changes in stocking rates of domestic livestock as a measure of semi-arid and arid rangeland degradation in the Cape Province, South Africa. *Journal of Arid Environments*, **26**:281-298.

Dean, W. R. J., Hoffman, M. T., Meadows, M. E. and Milton, S. J. 1995. Desertification in the semi-arid Karoo, South Africa: review and reassessment. *Journal of Arid Environments*, **30**:247-264.

Donaldson, C. H. and Vorster, M. 1989. *Veldbestuur in die Karoo – 'n strategie vir die toekoms.* Agriforum 1989, Departement van Landbou en Waterwese, Pretoria.

Du Preez, C. C. and Snyman, H. A. 1993. Organic matter content of a soil in a semi-arid climate with three long-standing veld conditions. *African Journal of Range and Forage Science*, **10**:108-110.

Du Toit, P. C. V. 1993. Stocking rate vs defoliation of Karoo bushes. *Karoo Agric*, **5**:17-21.

Du Toit, P. C. V. 1995. Grazing-index method of range condition assessment and comparison of techniques. *African Journal of Range and Forage Science*, **12**:61-67.

Du Toit, P. C. V. 1996. Karoobush defoliation in the arid Karoo. *Journal of Range Management*, **49**:105-111

Du Toit, P. C. V. 1998. Description of a method for assessing veld condition in the Karoo. *African Journal of Range and Forage Science*, **14**:90-93.

Evans, R. A. and Love, R. M. 1957. The step point method of sampling – a practical tool in range management. *Journal of Range Management*, **10**:208-212.

Fuls, E. R. 1992. Ecosystem modification created by patch-overgrazing in semi-arid grassland. *Journal of Arid Environments*, **23**:59-69.

Gatimu, L. N. 1996. The effects of free-ranging ostrich farming on arid rangeland in the Prince Albert district, South Africa. M.Sc.-thesis. University of Cape Town, Cape Town.

Goebel, C. J. and Cook, C. W. 1960. Effect of range condition on plant vigor, production, and nutritive value of forage. *Journal of Range Management*, **13**:307-313.

Herlocker, D. J. 1991. A survey method for classification of range condition. Ministry of Livestock Development, Nairobi, Kenya.

Hobbs, N. T. 1992. Modification of ecosystems by ungulates – invited paper. *Journal of Wildlife Management*, **60**:695-713.

Hoffman, M. T. and Ashwell, A. 2001. *Nature Divided – land degradation in South Africa*. University of Cape Town Press, Cape Town.

Hoffman, M. T. and Cowling, R. M. 1990. Vegetation change in the semi-arid eastern Karoo over the last 200 years: an expanding Karoo – fact or fiction? *South African Journal of Science*, **86**:286-294.

Hugo, W. J. 1966. *Die Kleinveebedryf in Suid-Afrika*. Departement Landbou-tegniese dienste. Staatsdrukker, Pretoria.

Humphrey, R. R. 1949. Field comments on the range condition method of forage survey. *Journal of Range Management*, **2**:1-10.

Hurlbert, S. H. 1971. The non-concept of species diversity: a critique and alterative parameters. *Ecology*, **52**:577-86

Joubert, J. G. V. 1986. Die uitwerking van 'n hoë veedigtheid op die benutting van etlike spesies in die Sentrale Hoër Karoo. *Tydskrif van die Weidingsvereniging van Suider-Afrika*, **3**:77-78.

Lange, R. T. 1969. The Piosphere: sheep track and dung patterns. *Journal of Range Management*, **22**:396-400.

Le Roux, P. M., Kotze, C. D., Nel, G. P. and Glen, H. F. 1994. *Bossieveld: grazing plants of the Karoo and karoo-like areas*. Bulletin 428, Department of Agriculture, Pretoria.

Magurran, A. E. 1988. *Ecological diversity and its measurement*. Princeton University Press, New Jersey.

McCabe, K. 1987. Veld management in the Karoo. *The Naturalist*, **31**:8-15.

Mills, A. J. 2003. Reciprocal relationships between vegetation structure and soil properties in selected biomes of South Africa. Ph.D-thesis, University of Stellenbosch, Stellenbosch.

Milton, S. J. 1995. Spatial and temporal patterns in the emergence and survival of seedlings in the arid Karoo shrubland. *Journal of Applied Ecology*, **32**:145-156.

Milton S. J. and Dean, W. R. J. 1990. Seed production in rangelands of the southern Karoo. *South African Journal of Science*, **86**:231-233.

Milton, S. J. and Dean, W. R. J. 1996. *Karoo Veld: ecology and management*. ARC-Range and Forage Institute, Lynn East, South Africa.

Milton, S. J. and Hoffman, M. T. 1994. The application of state-and-transition models to rangeland research in arid succulent and semi-arid grassy Karoo, South Africa. *African Journal of Range and Forage Science*, **11**:18-26.

Milton, S. J., Dean, W. R. J. and Ellis, R. P. 1998. Rangeland health assessment: a practical guide for ranchers in arid Karoo shrublands. *Journal of Arid Environments*, **39**:253-266.

Milton, S. J., Dean, W. R. J. and Siegfried, W. R. 1994b. Food selection by ostrich in southern Africa. *Journal of Wildlife Management*, **58**:234-249.

Milton, S. J., Dean, W. R. J., du Plessis, M. A. and Siegfried, W. R. 1994a. A conceptual model of arid rangeland degradation: the escalating cost of declining productivity. *BioScience*, **44**:70-76.

Milton, S. J., Yeaton, R. A., Dean, W. R. J. and Vlok, J. H. J. 1997. Succulent Karoo. Pages 131-166 in Cowling, R. M., Richardson, D. M. and Pierce, S. M. (eds.). *Vegetation of southern Africa.* Cambridge University Press, Cambridge.

Myers, N., Mittermeier, R. A., Mittermeier, C. G., da Fonseca, G. A. B. and Kent, J. 2000. Biodiverstity hotspots for conservation priorities. *Nature*, **403**:853-858.

Noy-Meir, I. 1993. Compensation growth of grazed plants and its relevance to the use of rangelands. *Ecological Applications*, **3**:32-34.

Orchard, C. and Mehus, C. 2001. Management by monitoring: Land EKG® monitoring approach helps variety of users assess rangeland health. *Rangelands*, **23**:28-32.

Owen-Smith, N. 1988. *Megaherbivores*. Cambridge Press, New York.

Owen-Smith, N. 1996. Ecological guidelines for waterpoints in extensive protected areas. *South African Journal of Wildlife*, **26**:107-112.

Owen-Smith, N. and Danckwerts, J. E. 1997. Herbivory. Pages 397-420 in Cowling, R. M., Richardson, D. M. and Pierce, S. M. (eds.). *Vegetation of southern Africa.* Cambridge University Press, Cambridge.

Pelser, A. J. and Kherehloa, T. 2000. Some causes and strategies pertaining to land degradation in southern Africa. *South African Journal of Agricultural Extension*, **29**:24-46.

Petersen, A., Young, E. M., Hoffman, M. T., Wynn-Jones, G. E. and Musil, C. F. 2004. The impact of livestock grazing on landscape biophysical attributes in privately and communally managed rangelands in Namaqualand. *South African Journal of Botany*, **70**:1-7.

Pyke, D. A., Herrick, J. E., Shaver, P. and Pellant, M. 2002. Rangeland health attributes and indicators for qualitative assessment. *Journal of Range Management*, **55**:584-597.

Reed, M. S. and Dougill, A. J. 2002. Participatory selection process for indicators of rangeland condition in the Kalahari. *The Geographical Journal*, **168**:224-234.

Roberts, B. R. 1970. Assessment of veld condition and trend. *Proceedings of the Grassland Society of South Africa*, **5**:137-139.

Riginos, C. and Hoffman, T. M. 2003. Changes in population biology of two succulent shrubs along a grazing gradient. *Journal of Applied Ecology,* **40**:615–625.

Ross, J. A. G. 1995. *The effect of sheep grazing on the recovery of succulent Karoo vegetation.* M.Sc.-thesis. University of Natal, Pietermaritzburg.

Roux, P. W. 1963. The descending-point method of vegetation survey. A point-sampling method for the measurement of semi-open grasslands and karoo vegetation in South Africa. *South African Journal of Agricultural Science,* **6**:273-288.

Roux, P. W. and Opperman, D. P. J. 1986. Soil Erosion. Pages 92-111 in Cowling, R. M., Roux, P. W. and Pieterse, A. J. H. (eds.). *The Karoo Biome: a preliminary synthesis. Part 1 – physical environment*. South African National Scientific Programmes Report No 124.

Roux, P. W. and Theron, G. K. 1987. Vegetation change in the Karoo biome. Pages 50-69 in Cowling, R. M. and Roux, P. W. (eds.). *The Karoo Biome: a preliminary synthesis. Part 2 – vegetation and history*. South African National Scientific Programmes Report No 142.

Roux, P. W. and Vorster, M. 1983. Vegetation change in the Karoo. *Proceedings of the Grassland Society of South Africa*, **18**:25-29.

Rutherford, M. C. and Westfall, R. H. 1994. Biomes of southern Africa: an objective characterisation. *Memoirs of the Botanical Survey of South Africa*. No. 63.

Savory, A. 1988. Biological monitoring notes. Centre for Holistic Resource Management, New Mexico.

Seitlheko, E. M., Allen, B. L. and Webster, D. B. 1993. Effects of three grazing intensities on selected soil properties in semi-arid Texas. *African Journal of Range and Forage Science,* **10**:82-85.

Senzota, R. B. M. and Mtahko, G. 1990. Effect of wildlife on a waterhole in Mikumi National Park, Tanzania. *African Journal of Ecology*, **28**:147-151.

Snyman, H. A. 1998. Dynamics and sustainable utilisation of rangeland ecosystems in arid and semi-arid climates of southern Africa. *Journal of Arid Environments*, **39**:645-666.

Snyman, H. A. 1999. Soil erosion and conservation. Pages 355-380 in Tainton, N. (ed.). *Veld management in South Africa*. University of Natal Press, Pietermaritzburg.

Snyman, H. A. and Fouché, H. J. 1993. Estimating seasonal herbage production of semi-arid grassland based on veld condition, rainfall and evapo-transpiration. *African Journal of Range and Forage Science,* **10**:21–24.

State of the Environment Overview Report. 2004. Department of Environmental Affairs and Development Planning, Report No. 329585/1.

StatSoft, Inc. (2003). STATISTICA (data analysis software system), version 6. www.statsoft.com.

Teague, W. R. and Danckwerts, J. E. 1989. Monitoring vegetation change and assessing veld condition. Pages 90 – 96 in Danckwerts, J. E. and Teague, W. R. (eds.). *Veld Management in the Eastern Cape*. Government Printers, Pretoria.

Tidmarsh, C. E. M. and Havenga, C. M. 1955. The wheel-point method of survey and measurement of semi-open grasslands and Karoo vegetation in South Africa. *Memoirs of the Botanical Survey of South Africa*, No. 29.

Tilman, D. and Downing, J. A. 1994. Biodiversity and stability in grasslands. *Nature*, **367**:363-365.

Thrash, I. and Derry, J. F. 1999. The nature and modelling of piospheres: a review. *Koedoe*, **42**:73-94.

Todd, S.W. 2000. Patterns of seed production and shrub association in two palatable Karoo shrub species under contrasting land use intensities. *African Journal of Range and Forage Science,* **17**:22-26.

Todd, S.W. and Hoffman, M.T. 1999. A fence-line contrast reveals effects of heavy grazing on plant diversity and community composition in Namaqualand, South Africa. *Plant Ecology*, **142**:169-178.

Tongway, D. 1994. Rangeland soil condition assessment Manual. CSIRO Division of Wildlife and Ecology, Canberra.

Trollope, W. S. W., Trollope, L. A. and Bosch, O. J. H. 1990. Veld and pasture management terminology in southern Africa. *Journal of the Grassland Society of Southern Africa,* **7**:52-61.

Van Breda, P. A. B. and Barnard, S. A. 1991. *Veld Plants of the Winter Rainfall Region: a guide to the use of veld plants for grazing.* Bulletin No. 422, Department of Agricultural Development, Pretoria.

Van Breda, P. A. B., Nel, E. J. and Bayer, M. B. (undated and unpublished) Data on palatability of plants in the Little Karoo and Ceres Karoo.

Van Rooyen, N., Bredenkamp, G. J. and Theron, G. K. 1991. Kalahari vegetation: veld condition trend and ecological status of species. *Koedoe*, **34**:61-72

Van Rooyen, N., Bredenkamp, G. J., Theron, G. K., Bothma, J. du P. and Le Riche, E. A. N. 1994. Vegetation gradients around artificial waterpoints in the Kalahari Gemsbok National Park. *Journal of Arid Environments*, **26**:349-361.

Vesk, P. A. and Westoby, M. 2001. Predicting plant species' responses to grazing. *Journal of Applied Ecology*, **38**:897-909.

Vorster, M. 1982. The development of the ecological index method for assessing veld condition in the Karoo. *Proceedings of the Grassland Society of Southern Africa*, **17**:84-89.

Watkeys, M. K. 1999. Soils of the arid south-western zone of Africa. Pages 17-25 in Dean W. R. J. and Milton, S. J. (eds.). *The Karoo: Ecological patterns and processes*. Cambridge University Press, Cambridge.

Wiegand, T., Milton, S. J. and Wissel, C. 1995. A simulation model for a shrub ecosystem in the semi-arid Karoo, South Africa. *Ecology,* **76**:2205-2211.

Willat, S. T. and Pullar, D. M. 1983. Changes in soil physical properties under grazed pastures. *Australian Journal of Soil Research*, **22**:343-348.

Williams, J. B., Siegfried, W. R., Milton, S. J., Adams, N. J., Dean, W. R. J., Du Plessis, M. A., Jackson, S. and Nagy, K. A. 1993. Field metabolism, water requirements, and foraging behavior of wild ostriches in the Namib. *Ecology*, **74**:390-404.

Personal communication:

Braam Oberholzer, 2003. Department of Agriculture: Western Cape, Elsenburg.

Kobus Nel, 2003. Department of Agriculture: Western Cape, Klein Karoo Agriculture Development Centre, Oudtshoorn.

CHAPTER 6: COMPARING THE QUICK RANGELAND HEALTH ASSESSMENT METHOD WITH AN OBJECTIVE VELD ASSESSMENT METHOD

6.1 Introduction

6.1.1 The problem

More than 80% of South Africa's land surface is considered grazing land or natural veld and is used for agricultural purposes (Hoffman and Ashwell, 2001) especially in providing forage for livestock. Significant deterioration in the condition of these rangelands has occurred in southern Africa since colonization and large areas of rangelands have become less productive than they were in the past (Roux and Vorster, 1983; Dean and Macdonald, 1994; Dean *et al.*, 1995). It therefore became imperative to focus attention on quantifying the rangeland condition of the grassland, savanna and the Karoo, which are the main livestock-producing rangelands in South Africa, so as to identify and modify management practices leading to veld deterioration.

Various methods of assessing rangeland condition are available (Friedel, 1990) and have been tested in different arid and semi-arid rangelands throughout the world. Assessment of rangeland condition may be based on (a) primary productivity (Humphrey, 1949; Goebel and Cook, 1960), (b) animal health and secondary production (Dean and Macdonald, 1994; Reed and Dougill, 2002), (c) vegetation composition (Tidmarsh and Havenga, 1955; Roux, 1963; Vorster, 1982; Du Toit, 1995), (d) soils and geohydrology (Snyman and Fouché, 1993; Tongway, 1994; Mills, 2003), (e) multicriteria approaches (Roberts, 1970; Savory, 1988; Herlocker, 1991; Milton and Dean, 1996; Reed & Dougill, 2002 Herrick *et al*., 2005), and (f) the application of satellite remote sensing and GIS for rangeland monitoring and management (Mackay and Zietsman, 1996). The choice of a particular approach to rangeland assessment will depend on the scale of the assessment, the type of rangeland and the knowledge, time and resources available to the assessor.

6.1.2 Applicability of rangeland assessment approaches to Karoo veld

6.1.2.1 Single criterion approaches

A plant biomass based method known as the 'range-potential concept' (Humphrey, 1949), suggested that range condition could be measured in terms of its potential forage production. Goebel and Cook (1960) considered total herbage production to be correlated with the condition of veld. However, biomass-based survey methods for assessing rangeland condition are difficult to apply in the Karoo because the vegetation comprises a mixture of succulents, woody shrubs and herbage. The above-ground parts of most of the herbaceous plants are renewed annually, but most of the above-ground biomass of shrubs comprises woody stems accumulated over many years. There is no uniform and efficient method for harvesting the annual biomass production of these diverse plant life-forms. Livestock indicators of rangeland quality include body weight, milk production and composition and calf weight (Reed & Dougill, 2002). These indicators are of little value where livestock receive food supplements (as is the case with ostriches in the Little Karoo).

Soil stability is considered by Wilson and Tupper (1982) to be more important than productivity and vegetation change in measuring veld condition. Assessment methods based on the effects management have on soil surface features, were developed by Tongway (1994) and Tongway and Hindley (1995). The latter method, which was developed for Australian grasslands, was proven not robust enough to be implemented in the Succulent Karoo (Petersen *et al*., 2004). One possible reason for failure of this method is that shallow soils and stony soil surfaces in the Karoo mask changes in soil indicators.

Botanical methods are based on the relative abundance of plant species known to increase or decrease in response to grazing, or known to be preferred, acceptable or rejected as food plants by livestock. Teague and Danckwerts (1989) demonstrated that the use of plant species composition scores alone is not adequate in assessing veld condition. Botanical assessment methods make use of either point-based or line-based methods for sampling the canopy cover of plant species. Tidmarsh and Havenga (1955) were the first to develop a technique to quantify the vegetation of the Karoo by means of the wheel-point survey method where a rimless wheel-point apparatus is rolled over the ground on its spokes and is used to measure basal cover. Roux's (1963) descending-point method was developed as an improvement to the wheel-point method, with which canopy spread and canopy cover is also measured along a chain or non-stretch rope at marked 1 m intervals. Line-intercept techniques, have been favoured in the Succulent Karoo (Stokes and Yeaton, 1994). Once the cover of various plant species has been quantified, veld condition is estimated by weighting the cover values by some index of the forage value of the various plant species (Stuart-Hill and Hobson, 1991).

Van den Berg and Roux (1974 in Stuart-Hill and Hobson, 1991) were the first to attempt to evaluate Karoo veld by classifying species into functional groups. Vorster (1982) developed the Ecological Index Method (EIM) to monitor changes in veld condition. A point survey method is used to measure the canopy cover of species, which are then allocated to one of three ecological groups, namely decreasers, invaders, and three categories of increasers. A veld condition index can then be calculated, which is compared to a benchmark site (Vorster, 1982). The Grazing Index method developed by Du Toit (1995) is used to calculate indices of veld condition, using "*objective grazing index values*". This indicates the value of each plant species to the farmer in terms of the quality and quantity of forage that the species provides, the availability of the plant through the year, and the degree to which the plant protects soil from erosion (Du Toit *et al*., 1995, Du Toit, 2002). Through incorporation of plant environmental interactions in the weighting of plant species, the veld assessment methods of Vorster (1982) and Du Toit (1995) resemble the multi-criterion approaches discussed below.

6.1.2.2 Multi-criterion approaches

Some farmers and rangeland scientists consider that veld condition should not be measured or defined by single criteria (Roberts, 1970; Wilson and Tupper, 1982; Milton *et al.*, 1998, Reed and Dougill, 2002). The first attempt to subjectively score veld condition in South Africa was proposed by Roberts (1970). With this method the indicators plant density, species composition, plant vigour, soil condition, and insect or rodent damage were used to classify veld in four veld condition classes. Due to the subjective approach of this method, it was not generally accepted for veld assessment (Tainton, 1988). Savory (1988) developed a method for farmers using soil and biological criteria, but many consider it to be too time-consuming. The Quick Rangeland Health Assessment method for Karoo veld (Milton and Dean, 1996, Milton *et al*., 1998) involves subjective assessment of cover and population status of palatable and unpalatable plants, of soil condition and of the activities of wild animals. The Land EKG® monitoring approach monitors ecological processes, such as mineral cycling, water cycling, biotic community and energy flow, using 22 ecological indicators in rangelands. This method is however still in the testing phase (Orchard and Mehus, 2001) and also seems to be very time consuming. Herrick *et al.* (2005) developed a multi-criterion method for long and short-term monitoring of rangeland condition. This method monitors soil and site stability, watershed function and biotic integrity. Fixed-point photography, line-point intercept, canopy gap intercept, basal gap intercept, soil stability tests, and belt transects (to monitor invasive species) are used in this method. Reed and Dougill (2002) used a participatory approach for identifying multiple criteria for rangeland assessment in arid savanna. A veld assessment manual was recently developed for Namibian farmers, using Local Level Monitoring as a tool to collect information on selected indicators to monitor environmental change (NAPCOD, 2003). This method, like that of Milton and Dean (1996) relies to a large degree on the subjective scoring of such indicators by farmers. The effectiveness of the Quick Rangeland Health Assessment method (Milton and Dean, 1996; Milton *et al.*, 1998), has not yet been thoroughly tested on a large scale.

6.1.3 Objectives

The objectives of this chapter are to test the assumptions that (1) the QRHA method is internally consistent (i.e. that all indicators in the QRHA method are equally sensitive) and (2) that the Karoo veld assessment scores obtained by using the quantitative Grazing Index Method (GIM) of Du Toit (1995, 1998) and the semi-subjective Quick Rangeland Health Assessment (QRHA) method (Milton and Dean, 1996; Milton *et al.*, 1998) are positively correlated.

6.2 Methods

6.2.1 Research approach

The Quick Rangeland Health Assessment (QRHA) method (Milton and Dean, 1996; Milton *et al.*, 1998), adapted as described in Chapter 5, was used to assess veld condition in 100 randomly selected veld camps in the Little Karoo near (100 m) and far (500 m) away from the water- or feeding point. Seven indicators (a) vegetation cover, (b) percentage palatable species, (c) grazing intensity, (d) palatable vs. unpalatable seedling ratio, (e) disturbance indicators, (f) soil health, and (g) species richness which were semi-subjectively scored, were summed to obtain an index of the veld condition in a camp. The Grazing Index Method (GIM) of Du Toit (1998) was then conducted in a subsample of 15 ostrich camps. These camps were selected so as to include a range of QRHA veld condition scores ranging from poor to good condition. Du Toit's (1995) Grazing Index Method, which was developed as an improvement on the Ecological Index Method of Vorster (1982), is described in detail in Du Toit (1998). Plant canopy cover data were obtained on 100 m line transects at each site using Roux's (1963) descending point method of plant survey. The number of strikes on all species in the transect gives an indication of the canopy cover in that camp (Du Toit, 1995). Cover data for each plant species are then multiplied by their unique "*objective grazing index value"* weighting factor and then are added to obtain the veld condition index. For plant species with no published GIV, expert advice was sought from Dr. Du Toit (Grootfontein Agricultural Development Institute) and Hannes Botha (Worcerster Veld Reserve).

6.2.2 Plot selection

A small, unmarked plot of about 5 m x 15 m was used for the Quick Rangeland Health Assessment for distances 100 m from the feeding or watering point. A second QRHA assessment was done 500 m from the feeding or water-point. Because of the heterogeneity and patchiness in arid areas (Van Rooyen *et al*., 1994), it is most important to carefully select a plot, which reflects the general state of the veld condition of that specific camp at each distance. Vegetation cover and vegetation composition was used as an over-all guide in selecting the plot.

The GIM assessments were done using 100 descending points along each of two 100 m transects, one near (100 m) and one far (500 m) from a feeding or watering point in each of the 15 selected camps (Figure 6.1). By recording the canopy spread cover at 100 points along the non-stretch measuring tape, an estimate of the plant canopy cover and the botanical species composition were obtained.

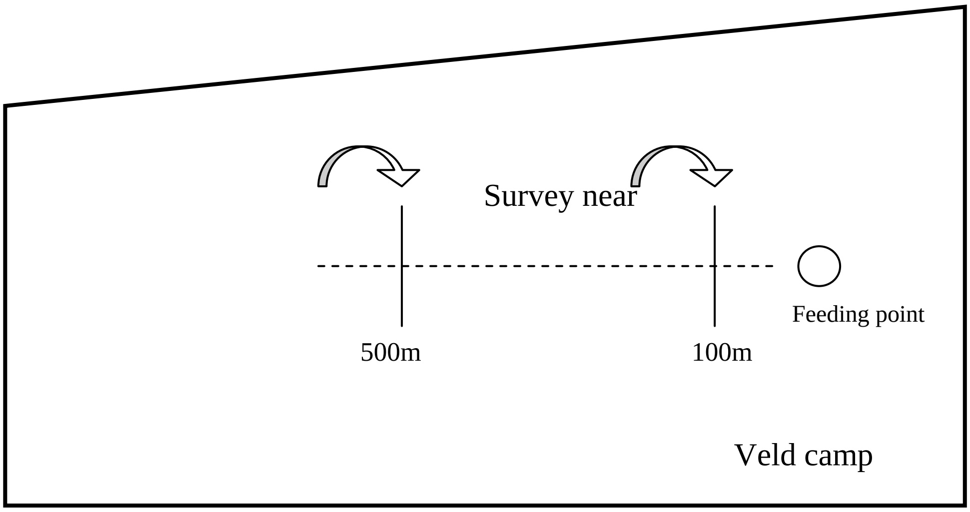


Figure 6.1 Layout for plots in ostrich camps using Du Toit's (1995) Grazing Index Method.

6.2.3 Data analysis

The veld condition data for QRHA and GIM were captured in a spreadsheet using Microsoft® Excel. From Excel the data could then be directly imported to Statistica 6.1 (StatSoft Inc., 2003), which was employed for analyses of the data. A confidence level of 95% was used in all analyses.

It is assumed that all of the seven indicators used to calculate veld condition score in the Quick Rangeland Health Assessment (QRHA) method would have equal mean values, be correlated and equally responsive to land-use. The hypothesis that all indicators in the QRHA method are equally sensitive was tested using indicator scores and final veld condition scores for 200 assessments representative of the Little Karoo region (Chapter 5) over three different vegetation types (Little Succulent Karoo, Spekboom Succulent Thicket and South and South-west Coast Renosterveld). Standard deviation was used as an indication of the sensitivity of the indicator to land-use. A principle component factor analysis was done using Statistica 6.1 (StatSoft Inc., 2003) to determine which underlying common factors are the most sensitive in assessing veld condition. A non-parametric Spearman rank correlation was used to test for positive association among variables.

The second hypothesis that there is a positive correlation between the Grazing Index Method (Du Toit, 1995) and the Quick Rangeland Health Assessment method (Milton and Dean, 1996) was tested by using regression analysis to compare veld condition scores obtained with the Quick Rangeland Health Assessment method with those obtained using the Grazing Index Method. A Pearson correlation analysis was used to further investigate the accuracy of estimating the percentage cover visually using the Quick Rangeland Health Assessment by comparing it with the measured vegetation cover using the Grazing Index Method.

6.3 Results

The mean values of the seven indicators used to calculate veld condition score in the Quick Rangeland Health Assessment method, together with their variances and standard deviation are given in Table 6.1. Standard deviation was lowest for vegetation cover and the highest for soil health. The standard deviation of vegetation cover is considerably lower than that of the other indicators. Spearman rank correlation of the veld assessment indicators showed that all indicators, except between vegetation cover and forage value, were positively correlated, but not all correlations were significant (Table 6.2). To explain the relationship among correlations a principal component factor analysis identified three factors (Table 6.3) that explained 75.69% of the variation in the model. These factors can be named: (a) 'livestock induced disturbances' (grazing intensity, disturbance indicators, soil health and species richness), (b) 'plant demographic indicators' (forage value and seedling ratio) and (c) vegetation cover. The livestock induced disturbances explained most of the variation (43.40%) and vegetation cover the least (12.36%) (Table 6.4).

Table 6.1: The mean, variance and standard deviation of indicators from the Quick Rangeland Health Assessment method to veld condition score

	Vegetation cover	Forage value	Grazing intensity	Disturb. indicators	Seedling ratio	Soil Health	Species richness
Valid N	200	200	200	200	154	200	196
Mean	4.640	2.290	3.315	4.340	2.844	3.020	3.020
Variance	0.483	1.343	1.232	1.190	1.361	1.434	1.056
Standard deviation	0.695	1.159	1.110	1.091	1.167	1.198	1.028

Table 6.2: Correlations among QRHA indicators for 200 sites in the Little Karoo

	Spearman Rank Order Correlations Marked correlations are significant at p <.05000						
VARIABLE	Vegetation cover	Forage value	Grazing intensity	Disturb. indicators	Seedling ratio	Soil Health	Species richness
Vegetation cover	1.000000	-0.070602	0.370187	0.055247	0.049382	0.304761	0.265737
Forage value	-0.070602	1.000000	0.149294	0.225762	0.677278	0.099995	0.136028
Grazing intensity	0.370187	0.149294	1.000000	0.403677	0.318118	0.550112	0.444817
Disturbance indicators	0.055247	0.225762	0.403677	1.000000	0.374227	0.467080	0.296634
Seedling ratio	0.049382	0.677278	0.318118	0.374227	1.000000	0.286820	0.203613
Soil Health	0.304761	0.099995	0.550112	0.467080	0.286820	1.000000	0.514967
Species richness	0.265737	0.136028	0.444817	0.296634	0.203613	0.514967	1.000000

Table 6.3: Factor loading from a principal component factor analysis on the indicators

Variables	Livestock induced disturbances	Plant demographic indicators	Vegetation cover
Vegetation cover	0.209910	0.042036	0.924198
Forage value	0.059677	0.926847	0.075932
Grazing intensity	0.767185	0.105007	0.320485
Disturbance indicators	0.773944	0.252682	-0.248564
Seedling ratio	0.258829	0.877778	-0.015444
Soil Health	0.772720	0.067994	0.320087
Species richness	0.724923	0.123129	0.143765

Table 6.4: The contribution of each factor to explain the variance in the model

Factors	Eigenvalue	% Total	Cumulative	Cumulative
Livestock induced disturbances	3.037653	43.39504	3.037653	43.39504
Plant demographic indicators	1.395352	19.93360	4.433005	63.32864
Vegetation cover	0.865513	12.36447	5.298518	75.69312

The indices of veld condition obtained by Du Toit's (1995) GIM and the Quick Rangeland Health Assessment method were positively and significantly correlated (r = 0.53, p < 0.01) (Figure 6.2).

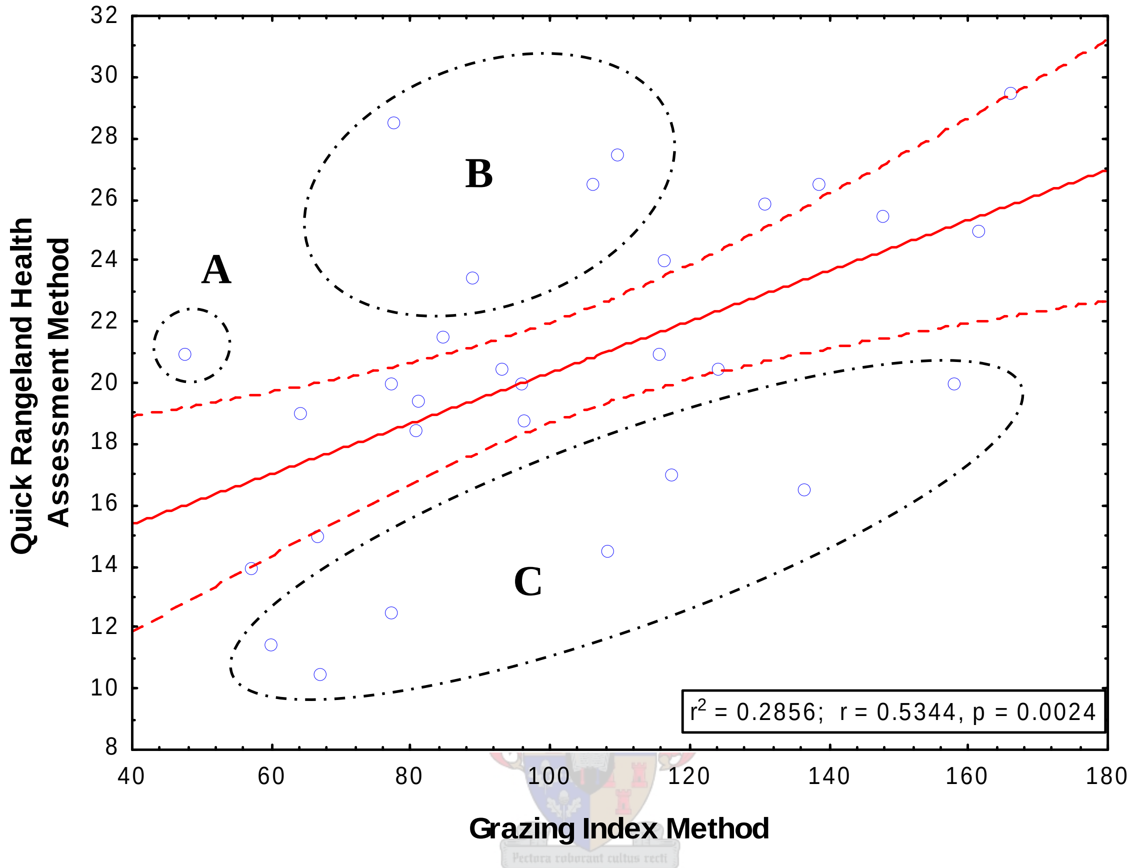


Figure 6.2 The veld condition scores obtained by using the Milton and Dean (1996) Quick Rangeland Health Assessment Method plotted against the veld condition scores of the same camps using the Grazing Index Method (Du Toit, 1995). (A, B and C = outlier groups)

There was a strong correlation (r = 0.77, p < 0.001) between the cover measured with the descending point method and the visual assessments made by the researcher during the QRHA sampling.

6.4 Discussion

The use of multiple indicators based on basic ecosystem processes, for rangeland assessments, has been recommended by the National Research Council (USA) (Orchard and Mehus, 2001). However, some multi-criterion assessments are time-consuming and therefore impractical for farmers and other land managers. There was a need to develop acceptable, quicker veld assessment methods, which can be easily applied by users from different backgrounds (e.g. range managers, extension officers, rangeland scientists). The Quick Rangeland Health Assessment method (Milton and Dean, 1996; Milton *et al.*, 1998) is a semi-subjective method, which was initially developed for rangeland managers to monitor veld condition change on their farms. A modification of this method to include species richness as one of the indicators provides valuable insight on the relationship between veld condition and species richness in an area well known for its biodiversity. There was a positive and linear relationship between species richness and veld condition for the 200 sites sampled in the Little Karoo (This thesis, Chapter 5).

The forerunners of the GIM were fundamentally agronomic in character (Tainton, 1988). Single indicator assessments, such as these were not primarily designed to measure veld condition. It is therefore mostly inadequate to determine rangeland health because they do not reflect nor assess the complexity of ecological processes. Yet, these methods have proven to give a fairly successful indication of veld condition.

Hypothesis 1 was rejected because sensitivity to land use varied considerably among indicators. From this I conclude that cover of Little Karoo vegetation is relatively insensitive to grazing, whereas livestock induced disturbances were highly variable. I hypothesize that cover is insensitive to grazing because unpalatable shrubs and succulents remain unutilised by grazing animals and may even increase in density once more palatable species have been removed. In the Little Karoo, grazing and browsing can therefore result in a good cover of mostly unpalatable plants, which can remain for very long periods of time (Milton *et al.*, 1997). Species richness and soil health are positively correlated with one another but negatively correlated with grazing intensity. This means that species richness and soil condition health scores decrease with increased grazing intensity. The weak and non-significant relationship between vegetation cover and seedling ratio should indicate, for example, that good cover alone (as perceived by farmers) does not guarantee that the veld would continue to be sustainable. The strong correlation between the indicators forage value and seedling ratio was expected because if forage value is high, palatable plants are present as a seed source to increase the amount of palatable seedlings which potentially can emerge. The opposite is also true if few palatable plants are present.

Hypothesis 2 was accepted because of the significant positive relation between the veld condition scores of the two methods. The outliers (Figure 6.2) illustrate the fact that a veld camp dominated by plants with low palatability (according to the Grazing Index Method) does not necessarily have poor veld condition, e.g. poor soil condition. A camp with unique succulent quartz patches within Succulent Karoo veld for example, will undoubtedly have a very low GIV score and low grazing capacity, but ecologically it could be in a very good condition. The outlier marked A (Figure 6.2) represents such an assessment with unique succulents, such as *Gibbaeum heathii*. Outliers (marked B, Figure 6.2) scored much higher compared to the result from the GIM, because these camps score reasonably high in the livestock induced disturbance and plant demographic factors. The bottom outliers (marked C, Figure 6.2) scored generally extremely low in all these indicators, except for cover.

Variations in the vegetation composition in the veld can also possibly explain the outliers, because in the Quick Rangeland Health Assessment method a small plot of 5 m x 15 m was selected for this study, whereas in the Grazing Index Method a length of 100 m was covered which would stretch through various patches. Plots selected for the Quick Rangeland Health Assessment method was selected off '*heuweltjies*' (mima-like mounds formed by termites), whereas the transect in the GIM would often stretch over or close to '*heuweltjies*', which covers about 3% of the landscape (Lovegrove and Siegfried, 1989). In applying the Quick Rangeland Health Assessment method it is important to measure a transect of at least 100 m (as recommended by Milton and Dean, 1996), because observations that integrate the natural variation in slope, soil and plant assemblages are needed to obtain a balanced and representative sample of the veld.

The strong correlation between the measured vegetation cover and the visually estimated cover in the Quick Rangeland Health Assessment method suggests that trained eyesight can be used in determining canopy cover. This is also the assumption underlying phytosociological methods such as the Zurich-Montpellier (Braun-Blanquet) method for sampling and classifying vegetation (Kent and Coker, 1992).

6.5 Conclusion

There is a worldwide tendency in rangeland assessment to move away from single criteria assessments to the use of a suite of key indicators. Veld condition assessments based on agronomic principles were designed to estimate grazing capacity and therefore lack in their ability to give a reliable indication of veld condition health in terms of biodiversity, erosion potential, and its future potential. The Quick Rangeland Health Assessment method has proven to be a useful method that can be used with reasonable accuracy to assess the veld condition in the Succulent Karoo biome by a single user. This method cannot be used to accurately estimate grazing capacity, but can be applied with success to assess veld condition. Further testing is needed to establish whether multiple users can successfully use this method, because the method relies to a large extent on subjective scoring of indicators. Even though earlier subjective methods (e.g. Roberts, 1970) were rejected (Tainton, 1988), this study proves that there is merit in reconsidering such approaches.

A major benefit of the QRHA method is heuristic, and it is for this reason that the method may have value in agricultural extension work. Land-users and extension officers can use such assessments as a basis for discussion. Those applying the method learn to look at various components of the veld in a structured way paying attention to seedling regeneration and soil condition as well as to cover and composition.

6.6 References

Dean, W. R. J. and Macdonald, I. A. W. 1994. Historical changes in stocking rates of domestic livestock as a measure of semi-arid and arid rangeland degradation in the Cape Province, South Africa. *Journal of Arid Environments*, **26**:281-298.

Dean, W. R. J., Hoffman, M. T., Meadows, M. E. and Milton, S. J. 1995. Desertification in the semi-arid Karoo, South Africa: review and reassessment. *Journal of Arid Environments*, **30**:247-264.

Du Toit, P. C. V. 1995. Grazing-index method of range condition assessment and comparison of techniques. *African Journal of Range and Forage Science*, **12**:61-67.

Du Toit, P. C. V. 1998. Description of a method for assessing veld condition in the Karoo. *African Journal of Range and Forage Science,* **14**:90-93.

Du Toit, P. C. V. 2002. Objektiewe weidingswaardes van Nama-Karooplantegroei: grasse en bossies van die Karoo. *Grootfontein Agric*, **4**:8-18.

Du Toit, P. C. V., Botha, W van D, Blom, C. D, Becker, H. R., Olivier, D. J., Meyer, E. M. and Barnard, G. Z. J. 1995. Estimating grazing-index values for Karoo plants. Technical Communication 239, Department of Agriculture, Pretoria.

Friedel, M. H. 1990. Some key concepts for monitoring Australia's semi-arid rangelands. *Australian Rangeland Journal*, **12**:21-24.

Goebel, C. J. and Cook, C. W. 1960. Effect of range condition on plant vigor, production, and nutritive value of forage. *Journal of Range Management*, **13**:307-313.

Herlocker, D. J. 1991. A survey method for classification of range condition. Ministry of Livestock Development, Nairobi, Kenya.

Herrick, J. F., Van Zee, J. W., Havstad, K. M., and Whitford, W. G. 2005. Monitoring manual for grassland, shrubland and savanna ecosystems. University of Arizona Press, Arizona

Hoffman, M. T. and Ashwell, A. 2001. *Nature Divided – land degradation in South Africa*. University of Cape Town Press, Cape Town.

Humphrey, R. R. 1949. Field comments on the range condition method of forage survey. *Journal of Range Management*, **2**:1-10.

Kent, M. and Coker, P. 1992. *Vegetation description and analysis*. John Wiley & Sons, New York.

Lovegrove, B. G. and Siegfried, W. R. 1989. Spacing and origin of Mima-like earth mounds in the Cape Province of South Africa. *South African Journal of Science*, **85**:108-112.

Mackay, C. H. and Zietsman, H. L. 1996. Assessing and monitoring rangeland condition in extensive pastoral regions using satellite remote sensing and GIS techniques: an application to the Ceres Karoo region of South Africa. *African Journal of Range and Forage Science*, **13**:100-112.

Mills, A. J. 2003. Reciprocal relationships between vegetation structure and soil properties in selected biomes of South Africa. Ph.D-thesis, University of Stellenbosch, Stellenbosch.

Milton, S. J. and Dean, W. R. J. 1996. *Karoo Veld: ecology and management*. ARC-Range and Forage Institute, Lynn East, South Africa.

Milton, S. J., Dean, W. R. J. and Ellis, R. P. 1998. Rangeland health assessment: a practical guide for ranchers in arid Karoo shrublands. *Journal of Arid Environments*, **39**:253-266.

Milton, S. J., Gourlay, I. D. and Dean, W. R. J. 1997. Shrub growth and demography in arid Karoo, South Africa: inference from wood rings. *Journal of Arid Environments*, **37**:487-496.

NAPCOD. 2003. *Local Level Monitoring for enhanced decision-making*. Windhoek, Namibia.

Orchard, C. and Mehus, C. 2001. Management by monitoring: Land EKG® monitoring approach helps variety of users assess rangeland health. *Rangelands*, **23**:28-32.

Petersen, A., Young, E. M., Hoffman, M. T., Wynn-Jones, G. E. and Musil, C. F. 2004. The impact of livestock grazing on landscape biophysical attributes in privately and communally managed rangelands in Namaqualand. *South African Journal of Botany*, **70**:1-7.

Reed, M. S. and Dougill, A. J. 2002. Participatory selection process for indicators of rangeland condition in the Kalahari. *The Geographical Journal*, **168**:224-234.

Roberts, B. R. 1970. Assessment of veld condition and trend. *Proceedings of the Grassland Society of Southern Africa*, **5**:137-139.

Roux, P. W. 1963. The descending-point method of vegetation survey. A point-sampling method for the measurement of semi-open grasslands and Karoo vegetation in South Africa. *South African Journal of Agricultural Science*, **6**:273-288.

Roux, P. W. and Vorster, M. 1983. Vegetation changes in the Karoo. *Proceedings of the Grassland Society of Southern Africa*, **18**:25-29.

Savory, A. 1988. Biological monitoring notes. Centre for Holistic Resource Management, New Mexico.

Snyman, H. A. and Fouché, H. J. 1993. Estimating seasonal herbage production of semi-arid grassland based on veld condition, rainfall and evapotranspiration. *African Journal of Rangeland and Forage Science*, **10**:21–24.

StatSoft, Inc. 2003. STATISTICA (data analysis software system), version 6. www.statsoft.com.

Stokes, C. J. and Yeaton, R. I. 1994. A line-based vegetation sampling technique and its application in succulent karoo. *African Journal of Range and Forage Science*, **11**:11-17.

Stuart-Hill, G. C. and Hobson, F. O. 1991. An alternative approach to veld condition assessment in the non-grassveld regions of South Africa. *Journal of the Grassland Society of Southern Africa,* **8**:179-185.

Tainton, N. M. 1988. A consideration of veld condition assessment techniques for commercial livestock production in South Africa. *Journal of the Grassland Society of South Africa*, **5**:76-79.

Teague, W. R. and Danckwerts, J. E. 1989. Monitoring vegetation change and assessment. Pages 90-92 in Danckwerts, J. E. and Teague, W. R. (eds). *Veld management in the Eastern Cape*. Department of Agriculture and Water Supply, Government printer, Pretoria, South Africa.

Tidmarsh, C. E. M. and Havenga, C. M. 1955. The wheel-point method of survey and measurement of semi-open grasslands and Karoo vegetation in South Africa. *Memoirs of the Botanical Survey of South Africa*, 29.

Tongway, D. 1994. *Rangeland soil condition assessment Manual*. CSIRO Division of Wildlife and Ecology, Canberra.

Tongway, D. and Hindley, N. 1995. *Manual: assessment of soil conditions of tropical grassland.* Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia.

Van Rooyen, N., Bredenkamp, G. J., Theron, G. K., Bothma, J. du P. and Le Riche, E. A. N. 1994. Vegetation gradients around artificial waterpoints in the Kalahari Gemsbok National Park. *Journal of Arid Environments*, **26**:349-361.

Vorster, M. 1982. The development of the ecological index method for assessing veld condition in the Karoo. *Proceedings of the Grassland Society of Southern Africa*, **17**:84-89.

Wilson, A. D. and Tupper, G. J. 1982. Concepts and factors applicable to the measurement of range condition. *Journal of Range Management*, **35**:684-689.

Acknowledgements

Pierre Du Toit 2004. Grootfontein Agricultural Development Institute

Hannes Botha, 2004. Department of Agriculture: Western Cape, Worcester Veld Reserve, Worcester.

CHAPTER 7: CONCLUSIONS AND RECOMMENDATIONS

7.1 Introduction

The purpose of this chapter is to bring into context the outputs of the forgoing chapters and to make final conclusions and recommendations on these main findings. The objectives of this thesis were:

1. To document veld utilisation practices by farmers in the Little Karoo,
2. To determine which environmental factor or veld management practices have the greatest effect on the perceived deterioration of veld condition within the region,
3. To determine the veld condition in the Little Karoo region through veld assessments within camps using the Quick Rangeland Health Assessment method of Milton and Dean (1996), and
4. To test the effectiveness of the Quick Rangeland Health Assessment method (Milton and Dean, 1996; Milton *et al*., 1998), which was developed for assessing rangelands in Karoo on a large scale and to determine whether there is a correlation between the above mentioned method and more conventional assessment methods.

The thesis has achieved these objectives. The results are synthesised below and novel and unexpected findings, shortcoming of the research and applications to management are pointed out.

7.2 Answers to major questions posed in this thesis

7.2.1 Current grazing management and farmers' perceptions in the Little Karoo

The age distribution of Little Karoo farmers does not differ from the national norm when compared to earlier studies (De Klerk, 1986), but the education level is much higher when compared to these same studies. Furthermore, farmers are quite established on these farms with more than 70% of them occupying the same farm for the past decade.

Farms in the Little Karoo region are relatively smaller (>60% smaller than 2000 ha) when compared to farms throughout the country and the Greater Karoo region. The region therefore has very few camps per farm compared to the situation north of the Swartberg

Mountain range (De Klerk, 1986). In general respondents are optimistic about the separation of their farms' 'vegetation types' (ecotopes) and slightly less than 50% of them consider it as good to excellent. This optimistic view is unexpected, especially if one consider the topographic variability in both slope and vegetation types. A diverse number of animal types are farmed in the Little Karoo, but ostrich farming remains the major agricultural activity within the region. Whereas mammalian livestock farming takes place in a variety of vegetation types and landscape units, ostriches are largely confined to the Succulent Karoo on flat to gently sloping topography of the Olifants River-Gamka agricultural region. Little Karoo farmers feel fairly optimistic that the number and quality of camps are adequate for their farming activities. The same positive perception applies for the grazing systems they employ. In reality less than 50% of free-range ostrich farmers make use of the recommended three-camp system, which allows the camp to rest for at least two breeding seasons, whereas more than 50% of other livestock farmers make use of a rotational grazing system.

When assessing the veld condition, respondents considered vegetation cover as the most important factor and second to that was the presence of palatable species. Very few farmers considered factors such as soil condition, grazing intensity, establishment of seedlings of palatable plants and disturbance indicators (alien invaders, '*opslag*' and mat-forming plants). More than 80% of respondents perceive that the veld condition on their farms is in good to excellent condition and less than 3% believe that their veld condition is poor. If the veld assessment score of the researcher is compared with the farmers' perception of the veld condition through a Pearson t-test ($t = -3.37$, $p < 0.001$, $N = 78$, Figure 7.1), it shows that there is a highly significant difference between the two groups. One possible reason for the difference could be the fact that farmers consider vegetation cover as the most important indicator of veld condition, while the researcher used seven indicators (which included vegetation cover) to score veld condition. Farmers therefore have a tendency to overestimate the grazing capacity of their farms. The majority of ostrich farmers have over estimated their farm's grazing capacity up to 66% when compared to the estimated grazing capacity of the Department of Agriculture for their region. More or less a third of mammalian livestock farmers under estimated the grazing capacity of their farms and therefore feel that their veld has a lower carrying capacity compared to the estimated grazing capacity of the Department.

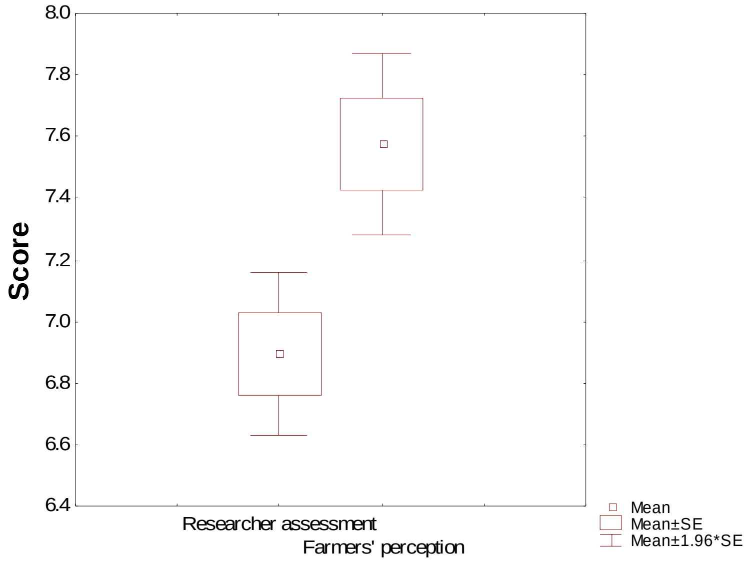


Figure 7.1 The comparison between the farmers' perception on veld condition and the veld assessment of the same farms score by the researcher.

Given the limiting factors (small farms, few camps, poor grazing capacity), which could negatively influence sustainable farming practices one could consider many farms within the Little Karoo as sub-economic units for commercial farming. Overstocking or feeding of livestock, such as is the case with ostrich farming, seems to be the only viable option to meet the economic needs of the landowner. The current stocking rate in ostrich camps (overstocked at 67.7% over the estimated grazing capacity of the Department of Agriculture) and mammalian livestock camps (55.1% overstocked) is evidence that farmers compensate for these limiting factors by overstocking in order to make a living from the land.

The majority of farmers are well aware of the Articles in the Conservation of Agricultural Resources Act of 1983 (CARA), but possibly due to economic reasons cannot adhere to this legislation. More than half of the respondents indicated that they try to rehabilitate trampled areas as expected under Regulation 13 and 14 of the CARA legislation, while 15% do so only occasionally and 31% do not rehabilitate veld at all. Regulation 14 and 15 of the same Act, which deals with the combat of alien vegetation, is best known to farmers. Alien vegetation is widespread in the Little Karoo with *Xanthium spinosum* (boetebos) the most common invasive plant. Eighty percent of respondents that have invasive alien species on their farms indicated that they try to control the spread of these plants.

7.2.2 Veld condition in the Little Karoo

Veld condition was assessed using the Quick Rangeland Health Assessment method (Milton and Dean, 1996) in randomly selected camps in the Little Karoo. Veld condition near water- or feeding points was significantly poorer than those further away because of the piosphere effect created through excessive trampling, browsing or grazing by livestock. It is evident that variability in the veld condition was explained mainly by vegetation type, topographic position and livestock type. Veld condition was poorest in ostrich camps, on plains, and the Little Succulent Karoo. Rockiness seems to have a positive effect on veld condition as it protects the soil from the effects of excessive trampling by livestock. The veld condition score in the Little Succulent Karoo veld type was found to be significantly lower than that of the South and South-west Coast Renosterveld and Spekboom Succulent Thicket. This can be explained by the high percentage of free-range ostrich camps (87.04%) found on the low-lying Little Succulent Karoo vegetation type. Ostrich camps on plains are in a poorer condition compared to mammalian livestock camps on plains. Therefore, one could conclude that ostriches, because of their active and territorial behaviour and trampling effect, are more destructive on natural vegetation than mammalian livestock at high stocking densities. Cattle seemed to have the least impact on natural vegetation.

The poor correlation between veld condition and stocking rate, and the fact that there is no significant difference in the veld condition in overstocked and understocked camps was quite surprising. The historical high stocking rates of both mammalian livestock and ostriches in the region must have contributed enormously to the degradation of the natural veld and could possibly explain this outcome.

From a biodiversity perspective the results indicate that veld condition does influence the abundance of perennial plant species. A novel finding from this study is the positive correlation between veld condition and the diversity of plant species (species density) of perennial plants. This finding is important in the Succulent Karoo biome, which is of international importance because of its high biodiversity and endemism (Myers *et al.,* 2000).

7.2.3 Comparison of quick and quantitative veld assessment methods

The Quick Rangeland Health Assessment (QRHA) method has proven to be a useful method that can be used with reasonable accuracy to assess the veld condition in the Succulent Karoo biome by a single user. A significant positive linear correlation was found by comparing veld condition scores obtained using this method with the Grazing Index Method (Du Toit, 1995). The study has also shown that the QRHA method cannot be applied to accurately estimate grazing capacity, but can be applied with success to give a reliable indication of veld condition.

Analysis of the different indicators has shown that cover of Little Karoo vegetation is relatively insensitive to grazing; whereas livestock induced disturbances were highly variable. This insensitivity of vegetation cover to grazing is due to the fact that unpalatable shrubs and succulents remain unutilised by grazing animals and may even increase in density once more palatable species have been removed. Species richness and soil health are positively correlated with one another but negatively correlated with grazing intensity, which means that species richness and soil condition health scores decrease with increased grazing intensity. One of the major benefits of the QRHA method is heuristic, and it is for this reason that the method may have value in agricultural extension work.

One weakness of the field methods applied in the use of the QRHA method in this research is that the plot size was too small to pick up any variations in soil and vegetation composition. A strip of about 100 m should have been used as suggested by Milton and Dean (1996). Due to time constraints only 30 assessments was done using the Grazing Index Method. Comparing a larger number of assessments might have given a different result.

7.3 Recommendations

7.3.1 Grazing systems and stocking rates

The answer to improving the veld condition in mammalian livestock camps is two-fold: (1) reduce the stocking rate and/or (2) allow for longer resting periods. The non-adoption of veld management practices (e.g. overstocking) of mammalian livestock by farmers can be explained by the incompatibility of the farmers need (limited farm size and camp numbers) with their economic need as shown by Düvel and Scholtz (1992). No grazing system employed by small and large stock farmers seems to be effective in significantly improving veld condition, but veld under a three to six-camp grazing system with large stock seemed to be in a better condition compared to other grazing systems. The use of multi-camp systems with the correct stocking rate, that allow for adequate resting periods, is therefore recommended for mammalian livestock farming. There is also a need to establish the present agricultural grazing capacities for mammalian livestock for the various habitat units as displayed in the recently produced vegetation maps of Vlok *et al.* (2005).

For ostrich farmers the same limitations apply as for farmers of mammalian livestock, but the answer is more complex. This study has indicated that no grazing system, not even the three-camp system, which has been recommended for more than two decades can prevent or reverse the degradation of natural veld caused by free-range ostriches at high densities. Ostrich farmers use the three camp system, resting camps for two years after stocking with ostriches, however, in contrast with managers of mammalian livestock, ostrich farmers are forced to keep ostriches in veld camps for the full duration of the breeding season of nine months (even in times of drought). To maintain production the birds are kept in good condition with supplementary forage. Rest periods are essential for the regeneration of Succulent Karoo veld, especially in this region with extreme erratic rainfall patterns. The recommended resting period of two years for ostrich camps is too short to allow for recruitment of seedlings. This study supports the recommendation of Gatimu (1996) that rest periods for ostrich camps should be increased to at least five years. The limited number and size of camps in the Little Karoo make this recommendation practically impossible to follow.

Keeping free-range ostrich numbers at the recommended stocking rate is not economically viable for the farmer. Therefore, alternative measures for egg production such the conversion of free-range ostrich farming into an animal husbandry system of small breeding camps is recommended and should be investigated as an alternative option to the unsustainable free range colony breeding system. Placements of small breeding camps, and even future feeding camps, would be critical to prevent erosion and dust storms. It is recommended that such camps should be placed on soils with a high degree of rockiness where no special plants are present. Policy is also needed to limit the number and area allocated to small breeding camps as a certain percentage of the total farm area because trampling by ostriches will destroy all vegetation in such camps. Informal interviews with farmers following this breeding system indicate that productivity and profits can be increased by selection for productive and highly fertile birds that also produce healthy chicks (personal communication Dolf Marais, 2005).

7.3.2 Economic considerations

Economic considerations seem to be the primary reason why ostrich farmers overstock breeding ostriches at such high densities on natural veld. The erection of small breeding camps by ostrich farmers has major economic implications due the high cost of fencing. These economic implications should be weighed up against the future of the rich biodiversity of the Little Karoo, which is of international importance and threatened by the current unsustainable free-range ostrich farming, and against the opportunities that small breeding camps present in terms of the opportunity for improved management efficiency and improvement of breeding stock. Government subsidies to farmers for the erection of such camps need to be considered.

Conversion of extensive to intensive breeding systems for ostriches, not only allow for better genetic selection, but could also serve as a potential marketing tool. Such ostrich products produced in this system could be labelled as 'green products' that would be more attractive to foreign markets.

7.3.3 Rehabilitation of veld

The study has shown that the Little Succulent Karoo vegetation type is in an extremely poor state and there is a definite need to rehabilitate this vegetation type. Milton *et al.* (2003) has shown that technical and economic factors hinder effective restoration of degraded areas. The study indicated that this is also the case in the Little Karoo. Apart from the financial implications, rehabilitation is also hampered by the lack of or the unavailability of indigenous seeds of palatable plants (Esler and Kellner, 2001; personal communication Hannes Botha, 2004). Therefore, initiatives like the Succulent Karoo Ecosystem Planning (SKEP) process, Spekboom Thicket Ecosystem Project (STEP), the Gouritz Initiative, together with Land Redistribution. (LRAD), Comprehensive Agriculture Support Package (CASP), the Landcare Initiative and local government should be used as vehicles to convert these challenges facing rehabilitation of degraded land into job creation opportunities for the poor in the region, by establishing indigenous seed producing farms. Funding for establishing such seed producing farms can be made available from LRAD, CASP, LandCare Initiative and local governments, while SKEP and STEP could fund research on which species would be the most appropropriate to grow, plant genetics and restoration techniques. Advisory services from the Department of Agriculture: Western Cape and the Worcester Veld Reserve could provide training to managers and personell from the local communities. Marketing and economic sustainability studies are firstly needed before such projects are initiated.

7.3.4 Incentives and stewardship

The relatively low grazing capacity of the region together with the relative small farming units diminishes the possibility of converting such farms into game farms (Tomlinson *et al.*, 2002) or successful mammalian livestock farms. Consolidation of such farms to form conservancies could be considered. A method for financially rewarding such farmers through tax rebates could be employed by motivating them to participate in the proposed Stewardship Programmes of CapeNature (Western Cape Nature Conservation Board) for the region. Care should be taken to ensure that such conservancies are not converted to game farms that are ecologically or economically unsustainable.

7.3.5 Veld assessments and awareness programmes

Farmers' perception on veld condition gives an indication of the inability of farmers to 'read the land', because they consider vegetation cover as the most important indicator of veld condition. The Quick Rangeland Health Assessment (Milton and Dean, 1996) method has proven to be an effective tool to assess veld condition in arid regions. The conventional objective method of assessing veld condition might be too technical for most farmers. Therefore, use of the less technical Quick Rangeland Health Assessment method is recommended to give landowners a better indication of the actual condition of the veld. The study has shown that Little Karoo farmers consider vegetation cover as the important factor when assessing their veld, while the importance of monitoring palatable species is ignored. Farmers were not directly questioned about their knowledge of plant species. Nevertheless, it would appear, on the basis of the way in which they evaluate their veld, that there is therefore a need to improve the knowledge of farmers regarding plant species, especially if they will use the QRHA method. Education programmes, that incorporate veld assessment methods, the importance of conserving biodiversity and ecosystem services, should be developed for landowners to improve their understanding of the sustainable use of our natural capital. More publications (e.g. Milton and Dean, 1996; Esler *et al.*, 2005) and even pamphlets written in less technical language are needed to broaden the farmers' veld knowledge in the Little Karoo.

7.3.6 Further research

Further research is needed to investigate whether multiple users can successfully use the QRHA method, because the method relies to a large extent on subjective scoring of indicators.

This study has shown that at present the majority of farming units are less than 2 000 ha with veld that has a relatively low grazing capacity. There is a need to investigate the minimum size of farming unit that is required in order for it to be economically and ecologically sustainable in the long-term. Economic studies are needed to determine whether the implementation of a small breeding camp system in the ostrich industry would be able to turn sub-economic farming units into sustainable farming units in the Little Karoo. The recommended size of small breeding camps is 0.25 ha (Anonymous, 2003), but many ostrich farmers make use of camps larger than one hectare where they keep more than the conventional trios or ostrich pairs. Such farmers also consider these larger camps as small breeding camps. Research is needed to determine the minimum and maximum size of such camps, which will maintain or improve production when compared to free-range ostriches. Research is also needed to determine what percentage of a farming unit can be allocated to small breeding camps and to determine the best placement of such camps.

7.4 Achievements of this research

As indicated above, the research has achieved all its major objectives. The most novel and unexpected finding was the positive correlation between veld condition and the diversity of plant species (species density) of perennial plants. This finding is important in the Succulent Karoo biome, which is of international importance because of its high biodiversity and endemism (Myers *et al.,* 2000).

The major contribution of this research is that it provides baseline data on veld management practices in the Little Karoo, which will be valuable for further studies in this region. Results from this study were communicated to farmers in the Little Karoo to inform them about the result in a less technical preliminary report (Appendix 4). The study tested the possibility of employing a subjective veld assessment method. Results obtained by this method are positive correlated with the conventional method used by the Department of Agriculture. Therefore this method proves to be useful in agricultural extension.

This study confirms that there is truth in the allegations from institutions (Department of Agriculture: Directorate Resource Conservation, 1992; Western Cape Nature Conservation Board, 2001), authors (e.g. Hoffman, 1996; Van Eeden, 1996) and the public that free-range ostriches are the major cause of veld degradation in the Little Karoo. The study also shows that the current grazing systems and veld management practices are unsustainable. I have also proposed possible solutions to mitigate damage caused by ostriches, as well as to increase farmer awareness of veld condition, and to develop skills and resources for veld restoration, and identified research needs.

7.5 References

Anonymous. 2003. Riglyne vir die benutting van natuurlike veld deur volstruisboerdery – 'n gedragskode vir volstruisprodusente (a pamphlet). South African Ostrich Business Chamber, Oudtshoorn.

De Klerk, C. H. 1986. *'n Ondersoek na faktore wat in die weg staan van die aanvaarding van aanbevole veldbeheerpraktyke*. Suid-Afrikaanse Instituut vir Landbouvoorligting, Pretoria.

Department of Agriculture: Directorate Resource Conservation, 1992. Official letter to land owners, 23/03/1992. Reference number: 10/2/5-ST/7.

Düvel, G. H. and Scholtz, H. P. J. 1986. The non-acceptability of recommended veld management practices. *Suid-Afrikaanse Tydskrif vir Landbouvoorligting*, **15**:1-10.

Du Toit, P. C. V. 1995. Grazing-index method of range condition assessment and comparison of techniques. *African Journal of Range and Forage Science*, **12**:61-67.

Esler, K. J. and Kellner, K. 2001. Resurrecting degraded Karoo veld. *Farmers' Weekly*, March 9. pp. 24-26.

Esler, K. J., Milton, S. J. and Dean, W. R. J. 2005. *Karoo Veld: ecology and management.* Briza Publishers, Pretoria.

Hoffman, T. 1996. Little Succulent Karoo. Page 61 in Low, A. B. and Rebelo, A. G. (eds.). *Vegetation of South Africa, Lesotho and Swaziland*. Department of Environmental Affairs and Tourism, Pretoria.

Gatimu, L. N. 1996. The effects of free-ranging ostrich farming on arid rangeland in the Prince Albert district, South Africa. M.Sc.-thesis. University of Cape Town, Cape Town.

Milton, S. J. and Dean, W. R. J. 1996. *Karoo Veld: ecology and management*. ARC-Range and Forage Institute, Lynn East, South Africa.

Milton, S. J., Dean, W. R. J. and Ellis, R. P. 1998. Rangeland health assessment: a practical guide for ranchers in arid Karoo shrublands. *Journal of Arid Environments*, **39**:253-266.

Milton, S. J., Dean,W. R. J. and Richardson, D. M. 2003. Economic incentives for restoring natural capital in southern African rangelands. *Frontiers of Ecology and the Environment*, **1**:247-254.

Myers, N., Mittermeier, R. A., Mittermeier, C. G., da Fonseca, G. A. B. and Kent, J. 2000. Biodiverstity hotspots for conservation priorities. *Nature*, **403**:853-858.

Tomlinson, K. W., Hearne, J. W. and Alexander, R. R. 2002. An approach to evaluate the effect of property size on land-use options in semi-arid rangelands. *Ecological Modelling*, **149**:85-95.

Van Eeden, F. 1996. Waak teen veldagteruitgang. *Landbouweekblad*, April, 19. pp. 36-38.

Vlok, J. H. J., Cowling, R. M. and Wolf, T. 2005. A vegetation map for the Little Karoo. Unpublished maps and report for a SKEP project. Supported by CEPF grant No. 1064410304.Western Cape Nature Conservation Board, 2001. Official letter to South African Ostrich Business Chamber 04/12/2001.

Personal communication

Hannes Botha, 2004. Department of Agriculture: Western Cape, Worcester Veld Reserve, Worcester.

Dolf Marais, 2005. Farmer. Swartbult, Prince Albert.

APPENDIX 1

No: …………….

Vraelys oor bestuur van natuurlike weiding (vee/volstruisboerdery) **in die Klein Karoo**

(Inligting verskaf in hierdie vraelys sal streng vertroulik hanteer word)

1. Algemene inligting
2. Volstruise
3. Persepsie en kennis van doeltreffendheid
4. Rotasiebeweiding
5. Veebelading
6. Veldbenutting
7. Skeiding van veldsoorte
8. Brand van veld
9. Veldherstel
10. Verklaarde onkruide en indringerplante
11. Wetgewing

BOER:

Naam: …………………………………………………………………….

Adres: ..……….………………………………………………………..

……………………………………………………………………………

……………………………………………………………………………

Plaasnaam: ….………………………………………………………

Tel nr. …………………………………………………………………….

Faks nr. ………………………………………………………………..

Boerderygebied: ………………………………………………………

Veldtipe: ……………………………………………………………

Opnemer se naam: …………………………………………………….

Algemene indrukke:

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

………………………………………………………………………………………………………

1. Algemene inligting

1) Hoe oud is u tans?

………………..

2) Wat is u hoogste opvoedkundige kwalifikasie? …..

a) Ongeskoold
b) Geskoold
c) Naskoolse opleiding
d) Spesialis in vakgebied

3) Hoe lank boer u al?

………………….

4) Hoe lank boer u al op hierdie spesifieke plaas?

…………………………….

5) Wat is die gemiddelde jaarlikse reënval van u plaas? …………………..mm

6) Wat is die oppervlakte van die grond waarop u boer? (Aantal ha) ………………………….

(M.a.w. grond wat u besit, huur, in vennootskap met iemand boer, ens)

7) Hoeveel van bogenoemde plaaseenheid is nou (datum van opname)

a) Veld (Aantal ha) ……………………………….
b) Meerjarige aangeplante weidings/droogte voergewasse (aantal ha)………………….
c) Ander bewerkte grond (aantal ha) …………………………..
d) Oulande/kweeklande (aantal ha) …………………………………

Hoeveel van die 'ander bewerkte grond' word jaarliks benut vir:

e) Kontantgewasverbouing (droëland) (aantal ha) …………………………..
f) Eenjarige voergewasse (Droëland) (aantal ha) …………………………….
g) Besproeiing van kontantgewasproduksie (aantal ha) ……………………….
h) Besproeiing van voerproduksie (aantal ha) ………………………………

8) Word u natuurlike veld vir boerderydoeleindes gebruik (m.a.w. vee/volstruise loop daar) …..

a) Ja
b) Nee

9) Hoeveel veldweikampe (geleentheidskampe en klein kampies om die huis uitgesluit) is daar op u plaas?

…………………………

10) Wat is die gemiddelde grootte van die kampe? ………………………………

11) Hoeveel veldweikampe het permanente veesuipings (wat in normale jare water dwarsdeur die jaar aan diere kan voorsien)? …………………………..

12) Waar in die kampe is die suipings geleë? ……

a) Sentraal
b) In ‘n hoek
c) Teen een van die kante

13) Gemiddeld hoeveel suipings is daar per kamp?

a) 1
b) 2
c) 3

14) Watter soort vee/wild hou u aan?

a) Skaap Ras: ………………………………………………………..
b) Bees Ras: ……………………………………………………….
c) Bokke Ras: ……………………………………………………….
d) Perde/Donkies Ras: ……………………………………………………….
e) Volstuise …………………….
f) Wild Spesies: ……………………………………………………………..

(Aan die opnemer: Indien met klein- en grootvee boer vra die volgende vraag)

15) Indien van toepassing, hoekom laat loop u nie kleinvee en grootvee saam in die kampe nie? (noteer maksimum drie) **…..**

a) Kuddes loop wel saam
b) Hou net klein- of grootvee aan
c) Veeverliese kom voor
d) Kuddes word te groot
e) Te klein kampe
f) Diere groei swakker
g) Probleme by veesuipings en lekbakke
h) Bemoeilik bestuur
i) Terrein te moeilik
j) Diere benut dieselfde weiding
k) Onprakties
l) Diefstal
m) Weet nie
n) Ander redes, noem…………………..
………………………………………..
……………………………………….
……………………………………….

16) Hoe lank boer u al met die spesifieke diere? **…..**

a) Kleinvee ……………………….
b) Grootvee ……………………….
c) Volstruise ……………………….
d) Wild …………………………….
e) Ander …………………………..

17) Indien u voorheen met ander diere op die plaas geboer het, waarmee was dit? …..

a) Kleinvee
b) Grootvee
c) Volstruise
d) Wild
e) Ander …………………………..

18) Vir hoe 'n lang tydperk het u met bogenoemde diere geboer voor u oorgeskakel het?

a) Kleinvee ………………………..
b) Grootvee ……………………….
c) Volstruise ………………………
d) Wild ……………………………
e) Ander …………………………..

19) Watter persentasie van u boerderyinkomste is afkomstig van die veevertakking?

……………….

20) Watter faktore reken u kan daartoe bydra dat u 'n hoër inkomste uit u veeboerdery kan verkry? (noteer maksimum drie) a)

a) Meer grond
b) Beter teel- en seleksiepraktyke
c) Beter byvoeding
d) Beter minerale byvoeding
e) Beter plaasbewerking
f) Beter gehalte veld (Veldbestuur)
g) Beter bestuur
h) Hoër veegetalle
i) Laer veegetalle
j) Aanplant van weidings/droogtevoergewasse.
k) Beter pryse
l) Ander, noem …………………….
…………………...…………………

*Aan die opnemer: Indien die boer **NIE** sy natuurlike veld benut vir boerderydoeleindes nie, laat afdelings 3 tot 8/9 uit.*

2. Volstruise

Aan die opnemer: vul slegs in, indien die respondent met volstruise ook / slegs met volstruise boer.

21) Watter persentasie van u boerderyinkomste is afkomstig van die volstruisvertakking?………

22) Hoeveel ha van u plaas word vir volstruisboerdery gebruik? ……………………..

23) Met hoeveel volstruise boer u tans? ………………………..

24) Watter volstruisprodukste bemark u?
- a) Vel
- b) Vleis
- c) Vere
- d) Kuikens

25) Op watter deel van u plaas loop die volstruise?
- a) In veld
- b) Aangeplante weidings
- c) Ander kampe (kweek, stoppelland, ens)
- d) Voerkraal
- e) Ander, noem……………………………………………………………………………
  ……………………………………………………………………………………………….

26) Hoeveel ha natuurlike veld per volstruis word tans benut? ………………………..

27) Indien die volstruise in die veld loop, loop hulle
- a) saam met vee
- b) op hul eie

28) Indien hulle op hul eie loop, hoe besluit u in watter kampe om die volstruise te laat loop?
- a) Kyk watter kamp is geskik vir volstruise
- b) Kyk watter kamp is te swak om vee te dra
- c) Volg wisselstelsel soortgelyk aan die vir vee sou gebruik, gebruik dieselfde kriteria om te besluit wanneer om volstruise te verskuif.
- d) Ander, noem……………………………………………………………………………
  ……………………………………………………………………………………………….
  ……………………………………………………………………………………………….

29) Wat is die gemiddelde tropgrootte van die volstruise wat in die veld loop?

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

30) Wat is die gemiddelde veldkampgrootte waarin die volstruise loop? ……………………….

31) Wat is die helling van die veldkampe waarin die volstruise loop?

a) gelyk vlakte (0-2°)
b) Gemiddelde helling (>2-15°)
c) Steil helling (>15°)

32) Kry u volstruise byvoeding op die veld?

a) Ja
b) Nee

33) Indien JA, kry hulle

a) slegs aanvullende voeding, of
b) ‘n volledige rantsoen

34) Tydens watter maande van die jaar is u volstruise gewoonlik op die veld?

a) Januarie	g) Julie
b) Februarie	h) Augustus
c) Maart	i) September
d) April	j) Oktober
e) Mei	k) November
f) Junie	l) Desember

DIE VOLGENDE VRAE HANDEL ALMAL OOR U NATUURLIKE VELD
(*Aan die opnemer: Indien die boer NIE sy natuurlike veld benut vir boerderydoeleindes nie, laat afdelings 3 tot 8/9 uit.)*

3. Persepsie en kennis van doeltreffendheid

35) Ten opsigte van die doeltreffendheid waarvolgens u normaalweg die volgende praktyke toepas, waar sou u uself op 'n 10 punt skaal plaas, waar 1 = besonder swak en 10 = besonder goed. **…..**

a) Die kampvoorsiening per kudde ……….
b) Die boeveelheid vee wat u normaalweg op u plaas dra (veebelading) ……….
c) Die doeltreffendheid waarvolgens u u weiveld benut ……….
d) Die reserwe weiding/voer wat u vir die buite seisoen beskikbaar het. ……….
e) Die mate waarvolgens die verskillende veldsoorte op u plaas geskei is ……….
f) Die wisselweiding wat u toepas ……….
g) Die toestand waarin u weiding verkeer (veldtoestand) ……….
h) Die toestand waarin die boere in die distrik se weiveld verkeer ……….
i) Die tydperk wat u u weikampe gedurende die groeiseisoen bewei ……….
j) Die tydperk wat u weikampe kans kry om te rus gedurende die groeiseisoen ………
k) U kennis oor weiveld en weiveldbeheerpraktyke. ……….

36) Besit u 'n veldbestuursplan?

a) Ja
b) Nee

4. Rotasiebeweiding

37) Verduidelik asb. kortliks watter rotasiestelsel (wisselweiding) volg u gedurende normale reënjare met u verskillende kuddes. ….…………

Sleutel:

a) Volg ‘n definitiewe sisteem/metode van veldbeheer met ses kampe of meer per kudde gedurende die groeiseisoen. Die weiperiode gedurende die groeiseisoen is nie langer as 14 dae nie, terwyl die rusperiode gedurende die groeiseisoen optimaal is vir die meeste voortreflike spesies van die veldkomponent

b) Volg ‘n definitiewe sisteem/metode van veldbeheer met 4-5 kampe per kudde. Die weiperiode gedurende die groeiseisoen wissel van ongeveer 7 tot 21 dae, terwyl die rusperiode gedurende die groeiseisoen slegs redelik optimaal is vir die voortreflike spesies van die veldkomponent.

c) Volg ‘n veldbeheerstelsel waar die rusperiode gedurende die groeiseisoen sodanig is dat dit net gedeeltelik aan die fisiologiese behoeftes van die weiplante (grasse, bossies en struike) voldoen. Goeie spesies word in die reël oorbenut voordat van kamp verwissel word. Die rusperiode gedurende die groeiseisoen is nie vir alle weiplante voldoende nie. Onvoldoende kampe is gedurende die groeiseisoen beskikbaar vir die hoeveelheid kuddes om goeie veldbeheer te kan toepas.

d) Volg geen spesifieke metode van veldbeheer nie, probeer af en toe kampe rus. Die weiperiodes gedurende die groeiseisoen is heeltemal te lank wat aanleiding gee tot die oorbenutting van goeie plante (grasse, bossies en struike), terwyl die rusperiode inkonsekwent en onvoldoende is. Daar is gedurende die groeiseisoen te veel kuddes vir die beskikbare kampe om selfs ‘n redelike veldbeheerstelsel te kan toepas.

e) Pas geen veldbeheer toe nie.

f) Ander, noem ……………………………………………………………………………………
…………………………………………………………………………………………………
………………………………………………………………………………………………..
………………………………………………………………………………………………..

(Aan die Opnemer: Indien bg antw. 43 e is, laat vrae 44 tot 48 uit)

38) Dit word algemeen beweer dat daar onder praktiese boerderyomstandighede, waar ‘n rotasiestelsel (wisselweidingstelsel) met ses kampe of meer per kudde (waar baie gereeld volgens graad van benutting gewissel word) gevolg word, sekere praktiese probleme opduik. Watter probleme word volgens u mening ondervind ? (of sal volgens u mening ondervind word) (noteer maksimum drie).

a) Veld word te lank (bv. gras)	j) Diere bly in kamp agter	**…..**
b) Bemoeilik kudde bestuur	k) Moeilik om vee bymekaar te maak.	
c) Veeverliese kom voor	k) Veld se voedingswaarde daal te veel	
d) Verlaging in lampersentasie	l) Vee verloor kondisie	
e) Veroorsaak veldagteruitgang	m) Geen probleme	
g) Uittrapping om veesuipings	n) Weet nie	
h) Produksieverliese	o) Ander redes, noem …………………………..	
i) Arbeidsprobleme	…………………………………………………	

39) Hoeveel beter of swakker is die weiveldbeheerpraktyke wat u tans volg as die van die rotasiestelsel met die ses kampe of meer per kudde?

a) Ba.ie beter
b) Beter
c) Net so goed
d) Swakker
e) Baie swakker
f) Weet nie

40) In die groeiseisoen, wat beskou u as die ideale tydperk (dae) wat kampe wat in ‘n beweidingstelsel in geskakel is:

a) bewei moet word voordat dit weer ‘n ruskans moet kry?
   (i) in geval van skape …….
   (ii) in geval van beeste …….
   (iii) in geval van volstruise …….
b) laat rus word voordat dit weer bewei word?
   (i) in geval van skape ……
   (ii) in geval van beeste ……
   (iii) In geval van volstruise …….

41) Hoe lank volg u al die stelsel, wat u tans gebruik?

……………………..

42) Hoekom het u op hierdie stelsel besluit?

a) Mede-boere wat die stelsel gebruik het goeie veld- en veeproduksie verkry.
b) Is deur voorligter aanbeveel.
c) Is vir my die mees praktiese
d) Ander, noem ……………………………………………………………………………………..
   …………………………………………………………………………………………………

43) Hoe groot is u gemiddelde kuddegrootte gedurende

a) lamtyd ……………………….
b) kalftyd ……………………….
c) paartyd (skape) ………………
d) paartyd (beeste) ……………...

5. Veebelading

44) Wat is volgens u mening die langtermyn weidingskapasiteit (drakrag) van die natuurlike weiding (ha/kve of gve) van u plaas (m.a.w. die oppervlakte weiding wat benodig word om een grootvee- of kleinvee-eenheid per jaar te dra)?

a) Skape (ha/kve) …………………….

b) Beeste (ha/gve) …………………….

c) Bokke (ha/gve) …………………….

d) Volstruise (ha/gve) ………………….

e) Wild (ha/bve)(blaarvreter) …………… (ha/gve)(grasvreters) ………………..

45) *Die amptelike langtermyn drakrag (weidingskapasiteit)* van die Departement van Landbou vir die natuurlike weiding in u omgewing is ……………ha/kve en ………….ha/gve (opnemer moet drakragsyfer verstrek). Op 'n 10-punt skaal (1 = baie onrealisties, 10 = baie realisties) hoe realisties reken u is hierdie syfer

a) vir die omgewing ……….

b) vir u eie plaas? ……….

46) Indien u nie die drakragaanbevelings van Dept. gebruik nie, hoe bepaal u die drakrag van u plaas?

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

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

6. Veldbenutting

47) Beskik u oor weirekords van u weikampe? M.a.w. hou u rekords van die veebelading, rus- en weiperiodes, skaap/beesweidae ens., wat elke kamp op u plaas gedurende die jaar ontvang het?

a) Ja
b) Gedeeltelik
c) Nee

48) Indien "Ja" kan ek dit sien asb? **…..**

a) Beskik oor volledige weirekords wat wei- en rustydperke aandui. Dit maak verder voorsiening vir die opteken van aanmerkings oor kampe, veebelading en bees/skaapweidae, spesiesamestelling ens. en maak gebruik van die rekords.
b) Redelike goeie rekords wat hoofsaaklik wei- en rustydperke wat kampe ontvang het, aandui
c) Swak rekords, die beweiding wat kampe ontvang het word in 'n sakboekie of op een of ander plek aangeteken wat die indruk skep dat dit nie permanente rekordhouding verteenwoordig nie.
d) *Hou geen weirekords nie.*

49) Het u enige voorsiening gemaak om vir die eerste 4 tot 6 weke van die groeiseisoen of na die eerste goeie reëns, vee van die natuurlike veld af te hou? **…..**

Aanslag van opnemer:

a) Maak voorsiening vir al sy veld
b) Tussen 75% en 99% van die veld
c) Tussen 50% en 74% van die veld.
d) Tussen 25 % en 49% van die veld
e) Minder as 25% van die veld

50) Dink u dat die wyse waarop u u veld gedurende normale jare benut enigsins aanleiding gee tot veldagteruitgang (die inkom van swakker grasse, bossies en struike)?

a) Nee
b) Onseker
c) Ja

51) Gedurende die groeiseisoen, hoe besluit u wanneer 'n kamp genoeg bewei is?

a) Kyk na benutting van indikator spesies (goeie plante)
b) Indien die helfte van weiding reeds benut is
c) Indien plante kort gevreet is
d) As die weiding in kamp op is
e) Wissel volgens 'n vaste roetine (14 dae of korter)
f) Wissel volgens vaste roetine (langer as 14 dae)
g) Geen spesifieke metode nie
h) Kyk na kondisie van vee
i) Weet nie
j) Ander, noem ………………………………….
………………………………………………..
……………………………………………….

52) Indien u u plaas se veldtoestand beoordeel, watter faktore neem u in ag? (maks. 3)

a) Let op die voorkoms van klimaksspesies (‘goeie’ spesies)
b) Let op velddigtheid (veldbedekking)
c) Let op grootte en groeikragtigheid van beweibare plante
d) Toestand van die grond en habitat (plantegroeibedekking, aanwesigheid van korsmosse, ens)
e) Intensiteit van beweiding
f) Vestiging van saailing van meerjarige plante (vreetbare vs nie-vreetbare plante)
g) Teenwoordigheid van versteuringsindikators (bv. onkruidspesies, indringerplantspesies, matvormende plantspesies, opslag, ens)
h) Weet nie
i) Ander, noem ………………………………………………………………

53) Hoe gereeld doen u ‘n beraming van die toestand van u veld?

a) Elke seisoen
b) Sesmaandeliks
c) Jaarliks
d) Tweejaarliks
e) Vierjaarliks
f) Ander, noem …………………………

54) Vandat u boer het die weiveld op u plaas:

a) Baie verbeter
b) Verbeter
c) Dieselfde gebly
d) Verswak
e) Baie verswak
f) Weet nie

7. Skeiding van veldsoorte

55) Wat is volgens u mening die voordele verbonde aan die skeiding van verskillende veldsoorte op u plaas? (Maks. 3)

a) Eweredige benutting van veld
b) Hoër drakrag (verhoogde produksie)
c) Vinniger veldherstel
d) Skei smaaklike en onsmaaklike veld
e) Voorkom veldagteruitgang
f) Beter benutting van smaaklike en onsmaaklike veldkomponente
g) Bied geen voordele
h) Weet nie
i) Ander voordele, noem……………………
………………………………………………

56) Watter hindernisse reken u ondervind die boere in u omgewing om die veldsoorte op hul plase behoorlik te kan skei? (maks. 3)

a) Te hoë kostes
b) Tekort aan kapitaal
c) Te lae subsidies
d) Te moeilike terrein
e) Waterprobleme
f) Hellingsprobleme
g) Te min kennis
h) Nie nodig om veldsoorte te skei nie
i) Is reeds goed geskei
j) Geen hindernisse
k) Weet nie
l) Ander hindernisse, noem
…………………………………….
…………………………………….
……………………………………

57) Dra u kennis van enige skaars of bedreigde plantspesies, plantegroeigemeenskappe of habitas op u grond of huurgrond?

a) Ja
b) Nee

58) Het u enige spesiale maatreëls getref om hierdie spesies of gebiede te beskerm? (byvoorbeeld: deur dit af te kamp of van beweiding te onttrek)

a) Ja
b) Nee

8. Brand van veld

59) Brand u veld?

a) Ja

b) Soms

c) Nee

<u>Aan die opnemer: Indien JA/Soms vra res van vrae in afdeling</u>

60) Gemiddeld hoeveel persent van u veld brand u jaarliks?

………………..

61) Om watter rede(s) brand u veld? (maks. 3)

a) Verwydering van onsmaaklike materiaal

b) Voorsiening van beter kwaliteit weiding

c) Kampwisseling by wild

d) Parasietbestryding

e) Terugbring van veld na subklimakstoestand

f) Bosbestryding

g) Om veld kort te hou

h) Verjonging van veld

i) Weet nie

j) Ander redes, noem…………………

62) Gemiddeld elke hoeveel jaar brand u of is u van plan om weer dieselfde kamp(e) te brand?

……………………

63) Wat gebruik u as indikators om te besluit wanneer om die veld weer te brand?

…………………………………………………………………………………………………

…………………………………………………………………………………………………

64) Watter tyd van die jaar reken u kan brand toegepas word?

a) In herfs net voor eerste reëns

b) In herfs net na eerste goeie reën

c) In herfs 14 dae na eerste goeie reën

d) In lente wanneer veld brandbaar is

e) Gedurende midsomer

f) Gedurende die midwinter

g) Gedurende die laatsomer

h) Geen definitiewe tyd

i) Weet nie

j) Ander tydperke, noem……………………

……………………………………………..

65) Hoe behandel u u veld nadat dit gebrand het? (hetsy die veld doelbewus of per ongeluk gebrand het)**...**

a) Laat veld rus vir groeiseisoen en wei in somer

b) Laat veld rus in voor- en midwinter, wei in nawinter

c) Laat veld rus in voorwinter en wei res van winter

d) Wei veld onmiddelik na eerste herfsreëns

e) Laat rus vir twee groeiseisoene en wei net in somers

f) Geen spesifieke behandeling

g) Weet nie

h) Sodra veld uitspruit

i) Ander behandelings, noem ……………

…………………………………………….

..…………………………………………..

9. Veldherstel

66) Watter van die volgende twee stelsels reken u sal die beste resultate ten opsigte van veldverbetering lewer?

a) Dat die staat die oprigting van weiveldbenuttingswerke (kampe en veesuipings) subsidieer, of

b) Die praktyke wat die boer volg om sy veld te verbeter te subsideer (bv. Om die voorgeskrewe veebelading te handhaaf, veld korrek te benut, ‘n rotasiestelsel met ‘n minimum van ses kampe per kudde toe te pas, ens.)

67) Met watter van die volgende drie behandelings reken u gaan die beste resultate m.b.t. veldherstel verkry word?

a) Die opleiding van boere m.b.t. die basiese beginsels van weiveldbeheer.

b) Streng wetstoepassing

c) Of albei

d) Geeneen van bogenoemde benaderings nie.

68) Met die oog op toekomstige droogtehulp, wat reken u is die teenprestasie ten opsigte van bewaringsboerdery wat die vee/volstruisboer gedurende normale reënjare moet lewer? (maks 3)

a) Korrekte veebelading handhaaf

b) Voldoende fasiliteite oprig

c) Beter veldbeheer toepas

d) Voer opberg

e) Boerderyvertakkings reorganiseer

f) Weidings aanplant

g) Voergewasse aanplant (Bv Lusern, ens)

h) Droogtevoergewasse aanplant

i) Kapitaal opbou vir droogtetye

j) Swak dele van plaas voorkeurbehandeling gee

k) Geen teenprestasie

l) Weet nie

m) Ander, noem …………………………

69) Doen u enige iets om uitgetrapte areas/ kaalkolle en erosieslote in die veld te herstel?

a) Ja

b) Soms

c) Nee

70) Indien **nee**, hoekom nie?

a) Te hoë kostes

b) Te min kennis

c) Te lae subsidies

d) Weet nie

e) Ander redes, ……………………….
……………………………………..

71) Indien ja, wat?

a) Insaai van inheemse saad

b) Insaai van soutbosse

c) Pak van takke

d) Meganiese bewerking, Bv. happloeg

e) Kombinasie van b en d

e) Kombinasie van a en b

f) kombinasie van a en c

g) kombinasie van a,c en d

h) kombinasie van a en d

i) Kombinasie van c en d

j) Kombinasie van a,b,c en d

k) Ander, noem ………………………………

72) Pas u u veelading aan tydens 'n droogte?

a) Ja
b) Soms
c) Nee

73) Indien wel, hoeveel % vermindering?

………………..

74) Watter hindernisse ondervind u om nog beter weiveldbeheer op u plaas toe te pas as wat tans die geval is? (maks 4)

a) Geen hindernisse
b) Huidige praktyktoepassing is voldoende
c) Te min kampe
d) Waterprobleme
e) Moeilike terrein
f) Te veel diere
g) Te veel kuddes
h) Te groot veetroppe
i) Finansiële probleme
j) Hoë kostes
k) Te min kennis
l) Bestuursprobleme
m) Arbeidsprobleme
n) Moet veld kort hou vir skape
o) Bemarkingsprobleme
p) Beskik oor onekonomiese eenheid
q) Ongediertes
r) Diefstal
s) Droogtes
t) Swak skeiding van veldsoorte
u) Verkeerde veld tot lande verhouding
v) Huidige subsidieëring onvoldoende
w) Moeilik om wild van kamp te verwissel
x) Weet nie
y) Ander hindernisse, noem ………………….
………………………………………………..
……………………………………………….

10. Verklaarde onkruide en indringerplante

75) Kom daar enige verklaarde onkruide of indringerplante op u plaas voor?

a) Ja
b) Nee

76) Indien ja, watter soort verklaarde onkruide of indringerplante word op u grond gevind?

a) Prosopis / Muskietboom
b) Lantana
c) Hakea
d) Kaktus
e) Soetdoring (Acacia karroo)
f) Boetebos
g) Selonsroos
h) Kankerroos
i) Swartwattel
j) Ander, noem ……………………..
……………………………………

77) Pas u enige beheermaatreëls toe?

a) Ja
b) Nee

78) Indien **ja**, watter metodes volg u?

a) Biologiese beheer
b) Meganiese beheer
c) Chemiese beheer
d) Kombinasie

79) Indien meganiese beheer, watter metodes volg u?

a) Kettingsaag
b) Uit ploeg
c) Afkap met byl
d) Ander, noem ………………………………..
e) Brand
………………………………………………
………………………………………………

80) Indien chemiese beheer, watter metodes volg u?

a) Loofbespuiting met rugsak
b) Lugbespuiting
c) Stambespuiting
d) Ander, noem ……………………..
………………………………………………
………………………………………………

11. Wetgewing

81) Van watter van die volgende artikels in die Wet op die Bewaring van Landbouhulpbronne (Wet 43 van 1983) dra u kennis van?

Bewerking van nuwe grond en grond met ‘n helling (Regulasies 2 en 3).

a) Beskerming van bewerkte grond teen erosie deur die werking van water en wind (Regulasies 4 en 5).
b) Voorkoming van versuiping en verbrakking van grond onder besproeiing (Regulasie 6).
c) Die benutting en beskerming van vleie, moerasse, watersponse en wateraflope (Regulasie 7).
d) Die benutting en beskerming van veld teen agteruitgang en vernietiging (Regulasie 9).
e) Dat slegs die getal diere (of gemiddeld getal per jaar op plaas) soos deur die vasgestelde weikapasiteit aanbeveel vir elke streek of deur die uitvoerende beampte bepaal, op u plaas aangehou mag word (Regulasies 10 en 11).
f) Voorkoming en beheer van veldbrande. Grondeienaar moet toestemming van uitvoerende beampte verkry om veld te brand en gebrande veld as weiding te gebruik (Regulasie 12).
g) Herstel en herwinning van geërodeerde, versteurde of ontblote grond (Regulasies 13 en 14).
h) Verklaarde onkruid en indringerplante, en bosindringing en die beheer daarvan (Regulasies 15 en 16).

82) Is u daarvan bewus van die voorgestelde wysiging aan die Wet op die Bewaring van Landbouhulpbronne (Wet 43 van 1983) rakende verklaarde onkruide en indringerplante?

a) Ja
b) Nee

83) Dra u kennis van die volgende nuwe wetgewings?

a) Wet op Nasionale Omgewingsbestuur (Wet 107 van 1998)
b) Artikel 21 en die nuwe regulasies onder die Wet op Omgewingsbewaring (Wet 73 van 1998)
c) Nasionale Waterwet (Wet 36 van 1998)
d) Nasionale Wet op Veld- en Bosbrande (Wet 101 van 1998)
e) Grondbelastingwet (‘Property Rates Bill 2000’)

VELD ASSESSMENT SHEET **APPENDIX 2**

SITE DESCRIPTION **No.:**

Assessment date			
Farm Name			
Camp Name			
Topography at site			
GPS position			
Soil type		**Rockiness (% of soil surface)**	
Vegetation type			
Distance from water		**Rain in past three months**	
Damage by:	hail Y / N ; drought Y / N ; caterpillars Y / N ; locusts Y / N		
Present:	dongas Y / N ; trampled paths Y / N ; bare heuweltjies Y / N		
Food supplement provided?	Y / N	**Type and Kg/day or week:**	
Cover dominant species of plants	eg. Pteronia, Ruschia, Augea		

GRAZING RECORD		
Camp Area		
Recommended Grazing Capacity		**LSU x 365 days/ha**
Animal type in camp	**Number of animals in camp**	
Grazing period / Rotation		

Indicator	**SCORE**				
	< 20 %	20%-29%	30%-39%	40%-50%	>50%
A. Vegetation cover	1	2	3	4	5

B. Forage value	< 20%	21 - 40%	41 - 60%	61 - 80%	> 80%
(% palatable plants)	1	2	3	4	5

C. Grazing intensity	100%	75%	50%	25%	0%
(% plant use)	1	2	3	4	5

D. Disturbance indicators	100% of all cover	75% of all cover	50% of all cover	25% of all cover	<20% of all cover
(Alien plants, opslag, mat plants)	1	2	3	4	5

E. Seedlings ratio	5:95	20:80	40:60	60:40	80:20
(palatable to unpalatable)	1	2	3	4	5

F. Soil health					
- signs: erosion, capping	1	2	3	4	5
+ signs: lichens, diggings, litter	1	2	3	4	5

* Mean of pos. & neg. signs = soil health

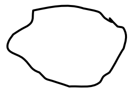
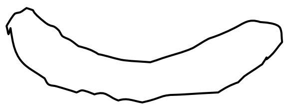
G. Species in plot

Plant category	**N species**
Opslag (short-lived, shallow-rooted grasses and annuals)	
Perennial succulents	
Perennial small shrubs (e.g. Pteronia)	
Perennial tall shrubs (e.g. Euclea, Putterlickia)	
Perennial grasses	

COMMENTS:						
Total score indicates the following veld condition	Severely degraded	Poor	Intermediate	Good	Excellent	**Score**
Excludes Indicator G (species in plot)	6- 10	11 -15	16 - 21	22 - 27	28 - 30	

APPENDIX 3

Method of analyzing soil texture

Description		**Texture / % clay**
If no ball can be rolled (or just rolled)		Sand 0 – 10 % clay
If a sausage can just be formed		Loamy sand 10-15 % Clay
If the sausage can be slightly bent		Sandy loam 15 – 20 % clay
If the sausage can be bent almost half-way round		Sandy loam clay 20 – 35 % clay
If the sausage can be bent more than half-way round		Sandy clay 35 – 55 % clay
If the sausage can be formed into a ring		Clay > 55 % clay

APPENDIX 4

Opsomming van bevindings uit studie: Veldbestuurpraktyke van volstruis- en veeboere in die Klein Karoo (Voorlopige verslag)

C F CUPIDO

Hierdie is slegs 'n verkorte weergawe van die resultate wat verkry is uit die ontleding van die data rakende die veldbestuurpraktyke in die Klein Karoo. Een honderd respondente het deelgeneem aan die opname. Die data word waar moontlik in grafieke en tabelle voorgestel met 'n kortlikse verduideliking daarvan. Let asseblief daarop dat sekere grafieke in Engels is aangesien dit die taal is waarin die tesis gepubliseer gaan word.

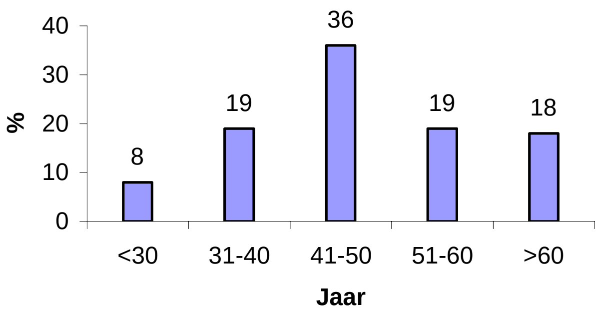
Die studie kan verdeel word in twee dele:

1. Opname d.m.v. die vraelys wat handel oor algemene inligting, volstruisboerdery en die volgende aspekte van veldbestuurpraktyke: rotasiebeweiding, veebelading, veldbenutting, skeiding van veldsoorte, veldherstel, verklaarde indringerplante en wetgewing.
2. Bepaling van die veldtoestand

Deel 1: Vraelys

Ouderdom van boere in Klein Karoo

Die ouderdomverspreiding van boere in die Klein Karoostreek word uitgebeeld in Figuur 1.



Figuur 1: Ouderdom van boere in die Klein Karoo

Die grootste komponent van respondente was in die kategorie 41 tot 50 jaar oud (36%) en sowat 73% is ouer as 40 jaar. Meer as 50 % van die boere in die monster het meer as 20 jaar boerdery-ondervinding en meer as 70% boer al vir meer as 10 jaar op dieselfde plaas.

Opleiding

Nege-en-veertig persent van die respondente is geskoold, 36 % het opleiding na matriek ontvang en 14 % kan as 'n spesialis beskou word.

Plaasgrootte en -indeling

Vanuit Tabel 1 kan afgelei word dat die plase in die Klein Karoo relatief klein is met meer as 60% van die plase wat kleiner is as 2000 ha.

Tabel 1: Die aantal en persentasie van plase in verskillende plaasgrootte kategorieë

	Respondente	
Plaasgrootte (ha)	**N***	**%**
< 500	23	23.23%
501 - 1000	16	16.16%
1001 - 2000	22	22.22%
2001 - 3000	10	10.10%
3001 - 4000	7	7.07%
4001 - 5000	6	6.06%
>5000	15	15.15%
Total	99	100.00%

*N = aantal respondente

Vanuit Tabel 2 kan afgelei word dat meer as 90% van alle plase se oppervlakte natuurlike veld is, terwyl slegs 4.54 % van die totale oppervlak van landbougrond gebruik word vir aangeplante weidingsgewasse. Die rede hiervoor is die gebrek aan water in hierdie semi-ariede streek.

Tabel 2: Die indeling en oppervlakte (in ha) van grondgebruik binne die monster van plase in die Klein Karoo

	Ha	**% van plaas**
Oppervlakte van plase	281 447	
Veld	257 431	91.47%
Gewasaanplanting	12 779.5	4.54%
Ander gebruike	9 641.5	3.43%
Ou lande	1665	0.59%
Totaal	281 517	100.02%

Waterpunte

Ongeveer 77 % van alle kampe het permanente waterpunte. Daar is gemiddeld twee waterpunte per kamp wat gemiddeld 182.66 ha per kamp bedien.

Vee- en volstruisboerdery

Alhoewel die Klein Karoo bekend is as die belangrikste volstruisproduserende streek ter wêreld, word daar ‘n baie groot verskeidenheid van vee tesame met volstruise op die plase aangehou. Hierdie verskeidenheid van vee word uitgebeeld in Tabel 3. Hierdie tabel gee die aantal en die persentasie van respondente wat aangedui het dat hulle wel die ras en tipe dier op hul plaas aanhou. Volstruise word deur die meeste respondente aangehou (N = 82), terwyl Merino (N = 44) die skaapras is wat die meeste aangehou word. Bonsmaras (N = 13) is die mees populêre beesras waarmee daar in die streek geboer word en as daar gelet word op die frekwensie van die aantal kruisrasse (N = 12), wil dit blyk dat daar baie met beeste geteel word in die streek. Boerbok (N = 15) en Angora (N = 7) is die boksoorte wat die meeste aangehou word en Angoras is hoofsaaklik beperk tot die

Uniondale landboustreek, terwyl boerbok nie beperk is tot een spesifieke landboustreek nie. Die kombinasie van volstruis- met veeboerdery word deur Tabel 3 voorgestel. Wild (N = 14) word in die meeste gevalle aangehou vir die boer se eie gebruik en baie min boer werklik kommersieël op groot skaal met wild as die hoofbron van inkomste.

Tabel 3: 'n Opsomming van die veerasse, wild en volstruise wat aangehou word in die Klein Karoo

Bok

	Frekwensie (aantal respondente)	Persentasie
Boerbok	15	53.6
Angora	7	25.0
Ander	1	3.6
Boerbok/Angora Kombinasie	5	17.9
Totaal	28	100.0

Skaap

	Frekwensie (aantal respondente)	Persentasie
Dorper	44	74.6
Merino	5	8.5
Damaras	1	1.7
Ille de France	3	5.1
Ander	4	6.8
Dorper/Damaras Kombinasie	2	3.4
Totaal	59	100.0

Bees

	Frekwensie (aantal respondente)	Persentasie
Bonsmaras	13	22.4
Afrikaner	4	6.9
Nguni	4	6.9
Fries	2	3.4
Jersey	2	3.4
Brahman	2	3.4
Hereford	7	12.1
Holstein	1	1.7
Kruis	12	20.7
Santa Gertrudes	2	3.4
Angus	2	3.4
Simmentaler	1	1.7
Kombinasie van rasse	6	10.3
Totaal	58	100.0

	Frekwensie (aantal respondente)	Persentasie
Wild	14	100.0
Volstruise	82	100.0

Slegs 14 respondente (17%) boer slegs met volstruise terwyl die res van die boere met 'n kombinasie van volstruise en vee boer. Hierdie kombinasies met hul persentasies word in Tabel 4 uitgebeeld. Die volstruis, bees en bokkombinasie het die meeste voorgekom (N = 23).

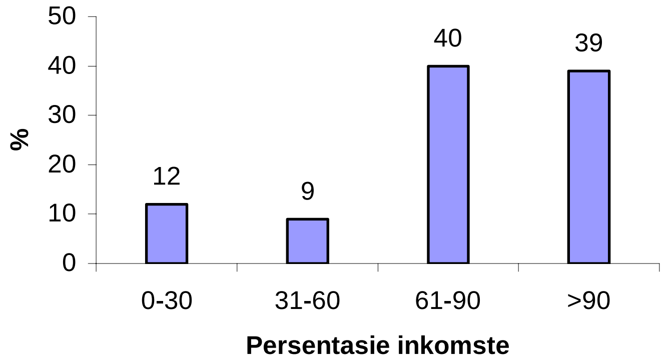
Tabel 4: **Die kombinasies van volstruis en vee waarmee geboer word in die Klein Karoo**

Volstruis / Vee kombinasies	N*	%
Slegs volstruis	14	17.07%
Volstruis & bees	19	23.17%
Volstruis & skaap	7	8.54%
Volstruis & bok	1	1.22%
Volstruis, bees & skaap	23	28.05%
Volstruis, bees & bok	3	3.66%
Volstruis, skaap & bok	9	10.98%
Volstruis, bees, skaap & bok	6	7.32%
Totaal	82	100.00%

*N = aantal respondente

Inkomste uit vee- en volstruisboedery

Figuur 2 toon die verpreiding van inkomste uit vee- en volstruisboerdery relatief tot ander inkomstebronne.



Figuur 2: Die verspreiding van inkomste uit vee en volstruisboerdery

Net minder as 80% van die boere verkry 'n inkomste van meer as 60% uit vee en/of volstruisboerdery en daarom is boerdery in die streek tot 'n groot mate van die natuurlike veld afhanklik.

Volstruisboerdery

Volstruiskuikens, broei- en slagvolstruise word op verskillende dele van die plaas aangehou vir verskillende tye van die jaar. Tabel 5 gee 'n aanduiding van waar hierdie voëls aangehou word, asook die aantal respondente wat aangedui het waar hulle hul volstruise aanhou.

Tabel 5: **Die deel van plaas en aantal respondente wat aangedui het waar volstruise aangehou word.**

Deel van plaas	Aantal respondente
Veld	48
Aangeplante weidings	76
Voerkrale	64
Klein broeikampies	14
Ander kampe	17

Slegs broeivoëls word op die veld toegelaat en slagvoëls en kuikens is beperk tot die aangeplante weidings en voerkrale. ‘n Baie groot persentasie van volstruisboere (58.53 %) maak gebruik van die natuurlike veld waar broeivoëls toegelaat word om in troppe te paar en slegs 20.73 % (N = 17) maak gebruik van die klein broeikampstelsel. Uit die 48 volstruisboere wat van topparing gebruik maak, gee 95.83% (N = 46) byvoeding vir die volstruise. Die voëls is dus tot ‘n groot mate nie afhanklik van die veld nie, maar deur persoonlike observasie was dit duidelik dat volstruise tog die veld benut, veral na die goeie reën wat in 2003 geval het. Sowat 4.17% (N = 2) van volstruisboere verskaf geen byvoeding aan volstruise nie. Uit die 46 wat byvoeding verskaf, gee 86.96% (N = 40) ‘n volle rantsoen terwyl 13.04% (N = 6) slegs aanvullend byvoeding verskaf.

Wisselweiding

In Tabel 6 word die verskillende wisselweidingstelsels wat in die Klein Karoo deur volstruisboere en deur alle boere gebruik word, uitgebeeld:

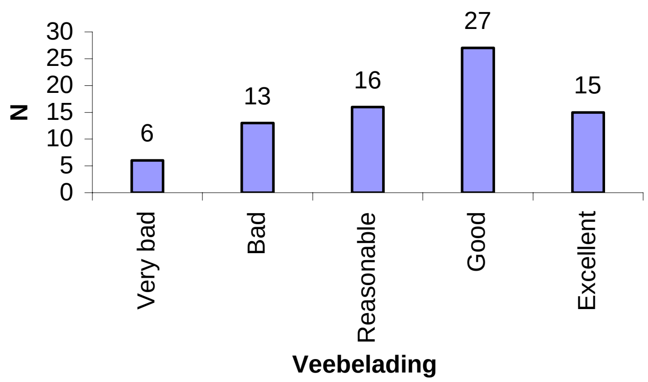
Tabel 6: Wisselweidingstelsels wat deur onderskeidelik volstruisboere en alle boere in die Klein Karoo gebruik word.

Wisselstelsel	**Volstruise** Aantal respondente	**Alle diere** Aantal respondente
Seskampstelsel	0	3
Vier- of vyfkampstelsel	1	4
Driekampstelsel	21	25
Tweekampstelsel	5	4
Kort druk beweidingstelsel	0	6
Aanhoudende beweiding	8	9
Geen vaste stelsel	7	15
Ander	6	12
Aantal respondente	**48**	**78**

Oor die algemeen is die driekampstelsel die mees populêre wisselstelsel in die Klein Karoo. Meer as 40% van volstruisboere gebruik hierdie stelsel omdat dit vir die meeste van hulle die mees praktiese een is. Kampe in hierdie stelsel word vir een broeiseisoen benut en is dan veronderstel om vir twee jaar daarna te rus.

Veebelading

Respondente se siening oor hul eie veebelading word in Figuur 3 uitgebeeld.



Figuur 3: Siening van boere oor hoe goed of swak hul veebelading is.

Dit blyk hieruit dat boere in die distrik tevrede is en gemaklik voel oor die aantal vee en volstruise wat hulle in die veld aanhou. Op ‘n vraag om vas te stel tot watter mate hulle saamstem met die aanbevolle drakrag wat deur die Departement van Landbou neergelê is, is die onderstaande resultaat gekry.

Tabel 7: Boere se siening oor die drakrag soos aanbeveel deur die Departement van Landbou

	Eie plaas		Distrik	
	N*	**%**	**N***	**%**
Stem glad nie saam nie	7	8.97%	10	12.82%
Stem nie saam nie	12	15.38%	9	11.54%
Stem tot ‘n mate saam	14	17.95%	11	14.10%
Stem saam	19	24.36%	24	30.77%
Stem heeltemal saam	12	15.38%	11	14.10%
Weet nie / onseker	14	17.95%	13	16.67%
Totaal	78	100.00%	78	100.00%

N* = aantal respondente

Respondente moes aandui wat hulle dink die langtermyn weikapasiteit van hul veld is vir onderskeidelik volstruis, skaap, bees en bokke en hierdie data is uitgedruk as ‘n oor- of onderskatting van hul eie plaas se weikapasiteit wanneer dit vergelyk word met dit wat deur die Departement van Landbou aanbeveel word. Die resultaat word in Tabel 8 opgesom. Hieruit kan afgelei word dat volstruisboere minder geneig is om te reken dat hul veld se weikapasiteit swakker is as die aanbevolle weikapasiteit van die Departement. Sowat ‘n derde van skaap-, bok- en beesboere meen dat hul veld ‘n laer weikapasiteit het. Dit blyk uit die tabel dat volstruisboere meer geneig is om die weikapasiteit van veld te oorskat (50% van respondente) en onder die indruk verkeer dat hul veld vanaf 34% tot >66% meer volstruise kan dra as aanbeveel deur die Departement terwyl veeboere minder geneig is om hul veld se weikapasiteit te oorskat.

Tabel 8: Die oor- of onderskatting van die respondente se eie plaas se weikapasiteit wanneer dit vergelyk word met die aanbevole weikapasiteit van die Departement van Landbou

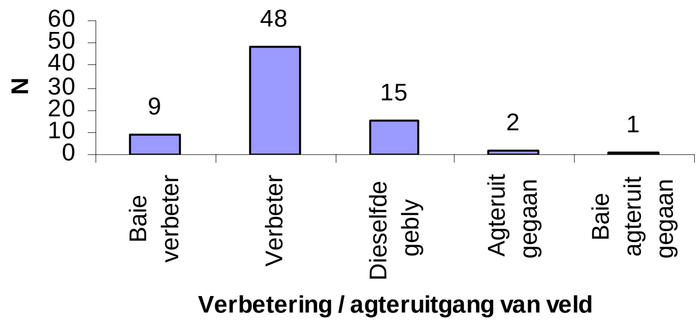
Kategorieë vir oor of onderskatting van drakrag	**Volstruis**		**Skaap**		**Bees**		**Bok**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Onder	5	10.42%	10	37.04%	8	28.57%	7	38.89%
0 tot 33% oor	1	2.08%	5	18.52%	3	10.71%	6	33.33%
34 tot 66% oor	10	20.83%	6	22.22%	5	17.86%	2	11.11%
> 66% oor	14	29.17%	0	0.00%	6	21.43%	1	5.56%
Weet nie/onseker	18	37.50%	6	22.22%	6	21.43%	2	11.11%
Total	**48**	**100.00%**	**27**	**100.00%**	**28**	**100.00%**	**18**	**100.00%**

*N = aantal respondente

‘n Groter persentasie (37.5%) volstruisboere as veeboere (gem 18.25%) was onseker oor hoe hul plaas se weikapasiteit vergelyk met die aanbeveel deur die Departement van Landbou.

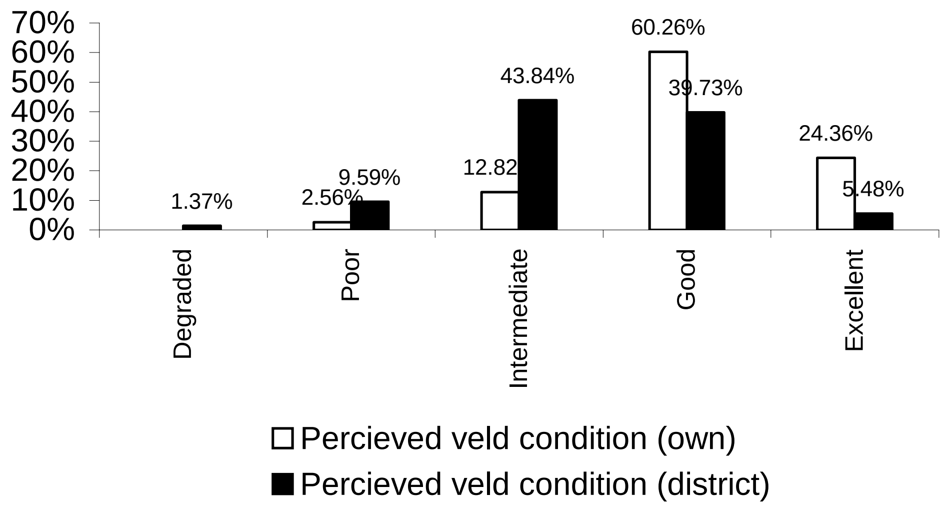
Veldbenutting

Slegs sewe respondente het aangedui dat hulle volledige weirekords hou terwyl 14 gedeeltelik hou en 56 geen weirekords hou nie. Figuur 4 toon aan dat meer as die helfte van respondente beweer dat die weiveld op hul plaas die afgelope tyd verbeter of baie verbeter het. Slegs 'n klein persentasie van respondente het beweer dat die veld op hul plaas agteruitgegaan het.



Figuur 4: Die siening van respondente oor die verbetering of agteruitgang van hul veld oor die afgelope aantal jare.

Figuur 5 toon aan hoe respondente die toestand van hul eie veld (wit kolomme) en die van die distrik se toestand klassifiseer. Oor die algemeen is respondente meer optimisties oor hul eie veld se toestand as die van die distrik. Meer as 80% van respondente glo dat hul veld in 'n goeie of uitstekende toestand verkeer en minder as 3% glo dat hul veld in 'n swak toestand is. Meer as 45% glo dat die distrik se weiveld in 'n goeie tot uistekende toestand verkeer en sowat 10% glo dat die weiveld in die Klein Karoo in 'n swak tot uiters swak toestand verkeer.



Figuur 5: Siening van respondente van hul eie en distrik se veldtoestand.

Veldherstel

Meer as die helfte (54% , N = 42) van respondente probeer om uitgetrapte areas te herstel terwyl 15% (N = 12) dit soms doen en 31% (N = 24) glad nie hul veld probeer rehabiliteer nie. Redes wat aangevoer word vir geen rehabilitasie is uiteenlopend waarvan o.a. geen agteruitgang, hoë koste, en die bewering dat veld self herstel, die meeste aangevoer word. Respondente wat wel veld probeer rehabiliteer maak gebruik van tegnieke soos uiteengesit in Tabel 9.

Tabel 9: Rehabilitasietegnieke wat deur respondente gebruik word.

Rehabilitasietegnieke	**Aantal respondente**
Saai inheemse saad	10
Plant soutbos	13
Pak van takke	18
Meganiese bewerking	21
Pak van klippe	10
Ander	11
Totaal	**83**

Meganiese bewerking en pak van takke is die mees populêre rehabilitasietegnieke.

Indringerplante

Uit alle respondente ondervind 82% probleme met indringerplante en 18% het geen indringerplante op hul grond nie. Drie-en-tagtig persent van respondente het aangedui dat hulle indringerplante probeer beheer en vier respondente pas geen beheer toe nie. Die indringerplante wat die meeste probleme veroorsaak word in Tabel 10 gelys:

Tabel 10: Indringerplante op plase in die Klein Karoostreek.

Indringerplante	**Aantal respondente**
Xanthium spinosum (boetebos)	74
Xanthium strumarium (kankerbos)	18
Nerium oleander	10
Acacia karoo (soetdoring)	8
Prosopis glandilosa	8
Acacia mearnsii (swartwattel)	7
Hakea sp.	7
Opuntia sp. (turksvy)	7
Datura stramonium (olieboom)	6
Nicotiana glauca (wildetwak)	5
Solanum elaeagnifolium	3
Ander	11

Boetebos (*Xanthium spinosum*) is by verre die indringerplant wat die meeste probleme veroorsaak. Uit Tabel 10 kan gesien word dat die indringerplante wat wel probleme gee die is wat langs of naby waterkanale groei. Alhoewel Soetdoring ‘n inheemse boom is, beskou ‘n klein persentasie van die respondente die boom as ‘n probleemplant a.g.v. bosverdigting.

Meganiese beheer met die hand of graaf word die meeste gebruik om indringerplante te beheer, waarskynlik omdat chemiese beheer aansienlik duurder is.

Wetgewing

Dit blyk uit die data dat die meeste respondente kennis dra van die artikels van die Wet op die Bewaring van Landbouhulpbronne (Wet 43 van 1983) en die Nasionale Waterwet (Wet 36 van 1998), maar minder bekend is met die Nasionale Wet op Omgewingsbestuur (Wet 107 van 1998).

Deel 2: Veldtoestandbepaling

Die subjektiewe veldtoestandbepaling van Milton en Dean (1996) is gebruik vir die toestandbepaling van 'n veldkamp wat ewekansig op die plaas gekies is. Twee opnames is gedoen; een 100 m vanaf 'n waterpunt en een 500 m vanaf die waterpunt. Slegs die opnames 500 m vanaf die waterpunt se data is gebruik vir hierdie verslag.

Plantbedekking, % vreetbare plante, % plante afgevreet, teenwoordigheid van versteuringsindikatore bv. indringerplante, teenwoordigheid van vreetbare en onvreetbare saailinge, toestand van grond en aantal spesies in die area is punte aan toegeken en 'n finale punt uit 35 is uiteindelik toegeken aan die kamp. Op grond van die punt wat behaal is, is die kamp se veldtoestand as volg geklassifiseer:

Uitstekend (Telling 32 – 35)

- Veld gedomineer deur vreetbare plante en meerjarige bossies of grasse

Goeie toestand (Telling 25 – 31)

- Bedekking verminder, maar samestelling steeds goed.
- Saailinge sal vestig na droogtes

Intermediêre Veld (Telling 18 – 24)

- Verandering in plantspesiesamestelling
- Toename in onvreetbare saailinge, matvormende sukkulente, opslag en indringer onkruid
- Veld raak minder produktief vir vee

Swak Veld (Telling 12 – 17)

- Vermindering in vreetbare plante en plante sensitief vir vertrapping
- Grond toon tekens van erosie
- Min reënwater deur grond geabsorbeer – vloei weg en neem bo-grond saam
- Drakrag van veld verminder

Uiters swak Veld (Telling ≤11)

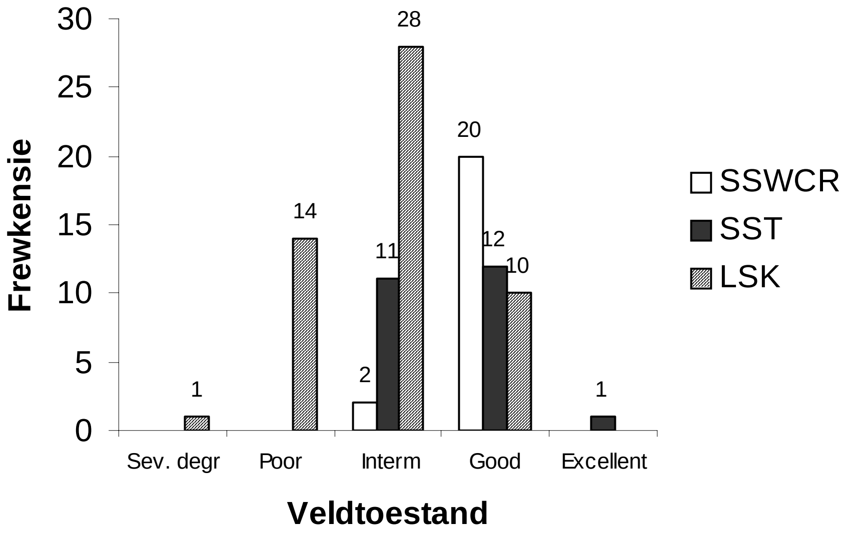
- Bedekking feitlik nul
- Min organiese material bedek of beskerm grond of dring grond in

Die verskillende plantegroeitipes in die streek is gebruik om te beskryf hoe die veldtoestand daarin lyk.

SSWCR = Renosterveld wat meesal in die Kamanassie en Kangoboerderygebiede en dele van Uniondale voorkom

SST = beter bekend as die Rante Struikveld met spekboom

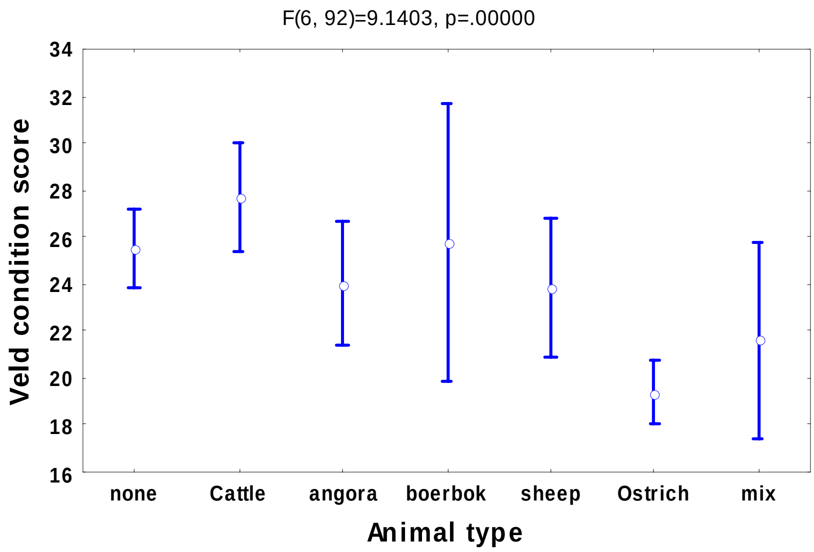
LSK = Klein Sukkulente Karoo = plat vygieveld in Ladismith en Olifantsrivier-Gamkaboerderygebiede



Figuur 6: Veldtoestand in die verskillende plantegroeitipes

Figuur 6 toon aan dat die Klein Sukkulente Karooveld die swakste daaraan toe is en dat dit die enigste veld tipe is waar kampe in 'n swak en uiters swak toestand gevind is. Slegs 10 van die kampe in Klein Sukkulente Karooveld is in 'n goeie toestand gevind, terwyl in die Rantestruikveld meer as 50% van kampe in 'n goeie toestand en 11 in 'n intermediêre tostand verkeer het. Alhoewel Renosterveld 'n baie lae weidingswaarde het, is gevind dat die veldtoestand in die meeste kampe goed is. Wanneer die verskille in veldtoestand statisties ontleed word, is Klein Sukkulente Karooveld in 'n baie swakker toestand is as die Rantestruikveld en Renosterveld.

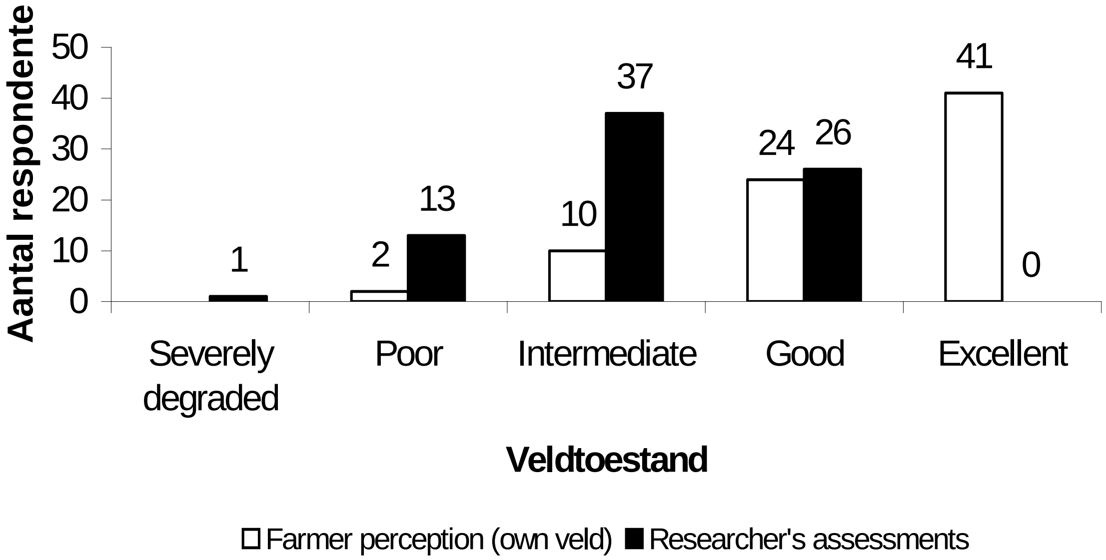
Figuur 7 toon die uitslag wanneer die effek van die verskillende boerderybedrywighede in verskillende kampe statisties vergelyk word.



Figuur 7: Die effek van verskillende tipe boerderybedrywighede op die veldtoestand in die Klein Karoo

Volstruiskampe wat hoofsaaklik in die Klein Sukkulente Karooplantegroei gevind word, is in die swakste toestand, terwyl beeskampe in die beste toestand verkeer. Waar geen diere in kampe voorgekom het, het die veld ook agteruitgegaan. In die kombinasie kategorie waar die kamp in alle gevalle deur volstruise saam met ander diere gebruik was, was die kampe in die tweede swakste toestand. Die Klein Sukkulente Karooveld is normaalweg op vlaktes in die Klein Karoo wat die mees geskikste is vir volstruisboerdery en dit is juis hierdie kampe wat in 'n swakker toestand verkeer. Kampe op vlaktes met vee daarin was in 'n beter toestand wanneer dit statisties vergelyk was met volstruiskampe op vlaktes.

Wanneer die veldtoestand soos gemeet deur die navorser vergelyk word met die van die siening van die respondente, is daar statisties 'n beduidende verskil in die klassifikasie van die veldtoestand. Figuur 8 stel die verskille in elke kategorie grafies voor.



Figuur 8: Die verskil in die veldtoestand soos gemeet deur die navorser en die siening van die respondente.

Hieruit kan afgelei word dat veeboere geneig is om die veldtoestand op hul plase tot 'n baie groot mate te oorskat. Volgens die navorsers se meeting is geeneen van die 41 plase wat deur hul eienaars as uitstekend geklassifiseer is in 'n uitstekende toestand nie

Algemene gevolgtrekking

In die Klein Karoostreek is meer as 90% van die landbougrond natuurlike veld wat aangewend word om hoofsaaklik volstruise, tesame met 'n baie groot verskeidenheid van vee te produseer. Vanuit die statistieke kan afgelei word dat net minder as 80% van die boere 'n inkomste van meer as 60% uit vee en/of volstruisboerdery verkry en daarom is boerdery in hierdie streek tot 'n groot mate van die benutting van natuurlike veld afhanklik.

Tropparing met volstruise op natuurlike veld word deur 'n baie groot persentasie van volstruisboere (58.53 %) toegepas en 'n driekampwisselweidingstelsel word in die meeste gevalle van gebruik gemaak. Tropparing word hoofsaaklik bedryf op Klein Sukkulente Karooveld op vlaktes wat die geskikste veldtipe is om volstruise op aan te hou. Daar is gevind dat die Klein Sukkulente Karooveld in die swakste toestand verkeer wanneer dit vergelyk word met Rantestruikveld en Renosterveld. Daar is ook bevind dat volstruiskampe wat hoofsaaklik op Klein Sukkulente Karooveld aangehou word in die swakste toestand verkeer.

In die algemeen glo meer as 80% van vee- en volstruisboere dat hul veld in ‘n goeie of uitstekende toestand verkeer en minder as 3% glo dat hul veld in ‘n swak toestand is. Dit is in kontras met die bevindings van die navorser wat bevind het dat die veld in ‘n swakker toestand verkeer as die siening van die boere in die streek. Dit wil blyk dat volstruisboere nie reken dat hul veld se weikapasiteit swakker is as die aanbevole weikapasiteit van die Departement van Landbou nie. Sowat ‘n derde van die veeboere meen egter dat hul veld ‘n laer weikapasiteit het. Dit wil ook voorkom dat volstruisboere meer geneig is om die weikapasiteit van hul plaas te oorskat (50% van respondente) en die meeste verkeer onder die indruk dat hul veld vanaf 34% tot >66% meer volstruise kan dra as die 20 ha per volstuis wat deur die Departement aanbeveel word (op veld met ‘n weikapasiteit van 60 ha/GVE). Om met hierdie lae belading met volstruise te boer is natuurlik onekonomies en as dit in die reël toegepas moet word, kan dit die reeds wankelende bedryf en die ekonomie in die streek in duie laat stort. Anders as in die geval van veeboerdery is die produksie in die volstruisbedryf tot ‘n groot mate nie afhanklik van die veldtoestand nie, aangesien broeitroppe oorwegend ‘n volle rantsoen byvoeding in die veld ontvang. As die bogenoemde feite in ag neem word, kan daar dus verwag word dat volstruisboere meer geneig sal wees om te oorbewei as veeboere.

Oorbenutting of wanbestuur van natuurlike veld lei uiteindelik tot veldagteruitgang soos daar gesien kan word in die geval van die Klein Sukkulente Karooveld. Hierdie veldtipe wat deel vorm van die Sukkulente Karoo bioom word beskou as een van slegs 25 biodiversiteit brandpunte[1] in die wêreld en wat dit uniek maak is dat dit die enigste een is wat in ‘n semi-ariede streek voorkom. Aangesien die volstruisbedryf gemik is op uitvoere sal daar in die toekoms meer druk op die bedryf wees om bewaringsboerdery toe te pas sodat hierdie sensitiewe bioom, wat van internasionale belang is, ook bewaar sal bly vir die nageslag. Verskeie vertoë is alreeds gerig deur navorsers en die publiek dat volstruisboerdery moet wegbeweeg van tropparing wat die veld beskadig. Wat verblydend is, is dat 17 % (N = 14) van volstruisboere met sukses boer met klein broeikampies met trios wat bestaan uit twee wyfies en ‘n mannetjie. Die maak van hierdie kampies is egter baie duur en maniere moet gevind word om volstruisboere te subsidieer met die oprigting van hierdie tipe kampe, aangesien hierdie praktyk lyk na die goue middeweg tussen ‘n meer aanvaarbare volstruisbedryfpraktyk en bewaringsboerdery.

Vir enige ander navrae:

Kontak Clement Cupido

Tel: 021-8085323

Faks: 021-8085331

e-pos: clementc@elsenburg.com

[1] Biodiversiteit brandpunte = internasionaal erkende streke met ‘n unieke verskeidenheid van plantegroei wat bedreig word.