UNIVERSITY OF KWAZULU-NATAL

A STRATEGY FOR OPTIMAL BEEF PRODUCTION OFF SOURVELD

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DECLARATION

The experimental work described in this research was carried out in the Dundee district of KwaZulu-Natal under the auspices of the School of Applied Environmental Sciences, University of KwaZulu-Natal, Pietermaritzburg. The work was supervised by Professor PJK Zacharias from July 1995 to September 2003.

The studies presented are the results of my own investigations, except where the work of others is acknowledged, and have not been submitted in any form to another Institute.

I declare the above statement to be true.

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ABSTRACT

The economic necessity of a better production strategy on sourveld promoted this study. Production of marketable two-tooth steers in the summer season and overwintering of all cattle without excessive feed costs were motivating factors. The problems of economic beef production were identified as resulting from the seasonal flow of forage quality from sourveld grass production. Season long rests, early burning and non-selective grazing of nutritious grass were identified as essential elements of a new utilization strategy. A 'forage reserve', built into the system to cater for fluctuations in grass production due to varied climatic conditions, is used as an indicator of the seasonal stocking rate. This provides a barometer in relation to the economic and ecological carrying capacity of the property.

Research was conducted on the winter utilization of rested veld and its effects on grass species composition and vigour in the following season. It was found that the winter grazing of the rested veld did not affect ($P>0.05$) the subsequent production in the three seasons of this study on 'Stratherne' in the Dundee district, KwaZulu-Natal South Africa (30°17'E 28°17'S). The grass species composition of four transects was recorded in 1994, prior to the implementation of the grazing system under test. The same transects were recorded again in 2002 to determine the effect of the change in utilization on grass species composition. It was found that a more productive state was developing in response to the strategy implemented in this study. The general trend has been for sites to move from a *Hyparrhenia hirta* dominated state to a more productive one associated with species such as *Themeda triandra*.

Summer mass gains of steers (147 kg and 143 kg over the two summers) have improved over the previous systems applied (average 119 kg), as a result of the more nutritious grazing. A greater proportion reached market readiness as two-year old to two and half year olds (97%) on veld, which is far superior to the 38% quoted from research using similar Bonsmara type steers from 'conventional' systems. Monitoring and flexibility are important in the application of the strategy to conditions in Africa. The principles of adaptive management (monitoring, recording, constant learning and adaptation) will build a data base to ensure long-term success of the strategy. A change of focus in grazing strategy from needs of animals to the needs of plants is strongly advocated.

KEYWORDS: grazing systems; forage quality; range management; natural farming

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I was fortunate to have had a father and a grandfather who knew how to produce fat cattle off the veld, without the use of cultivated crops or hay.

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CHAPTER 1

INTRODUCTION

1.1 Background

The majority of agricultural land in South Africa is extensive grassland, suitable only for livestock production. At present veld is classified subjectively by farmers and researchers alike, on its ability to support animals for varying periods of the year, with sourveld providing grazing for six months or less (Zacharias 1990). In sourveld areas an assumption is often made of inherent poor quality forage and this has led to excess utilization of costly hay. The situation can be further exacerbated by the incorrect utilization of the natural pasture (veld) in both the growing season and in the dormant period (winter). Animals that do not fatten off the veld need to be intensively fed, or kept a further year and sold as three and a half year olds. The result is that many small uneconomic feedlots have been constructed on farms. However, research by Kirkman & Moore (1995), indicates that veld remains a low cost source of feed on any farm, and it makes economic sense to investigate methods of utilizing veld throughout the year as the basis of any fodder flow programme. This dissertation addresses a possible strategy to optimise the utilization of sourveld throughout the year in beef production. The strategy suggested excludes the use of hay or other expensive preserved forages in the winter months.

The aim of beef producers should be to obtain the optimum production of saleable product (weaners, long yearlings, 30 month marketable steers and heifers, old cows and bulls). For example, in the case of marketing two-tooth steers and heifers, it would be to obtain the correct grade of finish (Class AB2*) off the veld in the most economic way. To achieve this aim, it is necessary to pay particular attention to the utilization and the composition of the natural pasture.

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* SAMIC (2001) regulates the classification of red meat in South Africa by age, fatness, conformation, damage and sex (Appendix A).

1.2 Justification

In his own production system, the author was dissatisfied with the low proportion of nutritious grass species caused by selective utilization, and the period it was taking for beef animals to reach market readiness off the veld. The problem was caused by the incorrect utilization of veld, which had resulted in an inferior veld composition. Prior to this study, the system applied on the production unit could be explained as follows. In the seventies and eighties, the farm was divided into nine sets of four-camp systems spread over the entire farm. Each of these four-camp systems was stocked at the rate of approximately 135 kg ha^{-1} (3.3 ha AU^{-1} or 0.3 AU ha^{-1}). Stocking rates are set in kg ha^{-1} as a grazing industry standard, and follow the recommendations of Peel *et al.* (1998). One camp in each four-camp system was rested during the growing season, to be utilized in the winter (May to August). In the growing season (September to April), the three other camps were grazed in a fixed rotation of two weeks in and four weeks out.

1.2.1 Problems with grass composition and utilization

The camps being stocked were selectively grazed. The grass composition as a result had a predominance of thatch grass (*Hyparrhenia hirta*). There was little rooigras (*Themeda triandra*), and a small proportion of *Hyparrhenia dregeana* (in poorly utilized areas). Problems encountered with the system included over utilization, so that at the end of winter, there would be little or no excess grass to burn. Consequently most camps were seldom burnt in early spring and this had undoubtedly led to an increase in *Acacia karroo* (personal observation).

1.2.2 Problems with condition of animals to market

Under the production system at the time, it was not possible to get cattle into a marketable condition until late in the growing season. At that time (mid-eighties), access to the government controlled markets was governed by quotas. Access to these markets was difficult when there was overproduction (in the late season). Even then 30% of the two-tooth animals (AB class) did not get into marketable condition by autumn, without the use of expensive supplements. These animals then either had to be fed or kept over and then sold the following summer as three year old animals, with a corresponding loss of carcass grade. In the winter, weaners were placed onto veld that had been rested for a full growing season and had to be supplemented with licks. As a result of a tall and stemmy sward structure, the rates of intake of the weaners were low; so they lost more mass than necessary.

1.2.3 Solution attempted

In an attempt to reduce the amount of mass lost by animals over winter, a small feedlot was started, but this did not provide a solution. Firstly, there was no farm produced feed or hay available. This meant purchasing feed and roughage and transporting it for an average of 30 km. This resulted in a high cost and an uneconomic production system, that was not able to compete with larger feedlot enterprises in the district. The only viable solution was to change the utilization strategy of the natural pasture and seek a more cost-effective production strategy.

1.3 Objectives of this study

The strategy selected needed to reduce mass loss or preferably maintain animals over the dormant period (winter) with the use of nitrogen-based protein licks, but without the use of hay. Veld composition needed to be improved, as the composition on the farm differed significantly from the benchmark (*sensu* Foran *et al.* 1978) for the area. Although utilization of rested veld in winter has been widely researched, there have been few studies that have analysed the effect of this utilization on the grass composition and future production of that veld. These two aspects of winter utilization form part of this dissertation.

Hypothesis 1: Winter utilization of rested veld does not influence the production or the species composition of that veld.

The other aspect that was investigated was the change in grass composition over a eight year period, with the application of a flexible non-selective grazing system instead of a fixed period rotational system.

Hypothesis 2: The grass species composition will change when a flexible non-selective grazing system is applied instead of a fixed period rotational system.

Several other aspects needed to be addressed before a utilization strategy could be recommended. These related to the animal production aspects of the system and had to be investigated at field-scale on the farm. In this case, a few aspects of livestock production have been investigated on a farm scale over the medium term (5-8 years). A comparison could then be made with available and published data from other sources, which would give an indication of the suitability of the suggested strategy for application in other sourveld areas.

Production statistics have been collected on the following aspects of livestock production:

1) the growth of steers on sourveld from weaning to marketing;
2) annual cattle livemass production on sourveld for period March to February of four different production seasons;
3) quarterly statistics on actual stocking rate (kg ha^{-1});
4) pregnancy diagnosis statistics of cows and heifers over seven seasons; and
5) carcass grades of milk-tooth (unshed) and two-tooth steers at graded abattoirs.

The data presented here are taken from animals in the production herds and no particular 'management' factor separated these from the full production unit on the property as a whole.

CHAPTER 2

LITERATURE REVIEW

2.1 Occurrence of sourveld and species composition

Sourveld occurs in areas of higher rainfall and high altitude which normally gives rise to soils with a low base status (Ellery *et al.* 1995). These grasslands are termed sour because the constituent grasses become unpalatable and drop in the levels of nutrients they contain at a comparatively early stage in growth, usually as soon as they flower and set seed (Scott 1955; Zacharias 1990). Veld is further classified into bioresource groups.

A bioresource group consists of a grouping of ecological units based primarily on climate and vegetation (Camp 1997). The expected frequencies of the different grass species in a bioresource group of veld in good condition, is referred to as the benchmark (Foran *et al.*1978) The benchmark species composition varies from one bioresource group to another. In Table 2.1, examples of the grazing value, palatability and frequencies of the different species in the benchmarks for Highland Sourveld (Foran *et al.*1978) and the Dry Highland Sourveld (Camp 1997) are included. The palatability of grass (P: palatable, I: intermediate and U:unpalatable) was determined in an empirical survey of grazed and ungrazed grassland in the SE Transvaal Highveld (Barnes 1990).

Table 2.1. The grazing value, palatability and benchmark grass species composition of Highland Sourveld and Dry Highland Sourveld

Veld grass species *** Palatable ** Intermediate * Unpalatable	Grazing value	Palatability. Barnes (1990)	Highland Sourveld (Foran *et al.* 1978)	Dry Highland Sourveld Camp (1997)
Alloteropsis semialata	3	I**	2	1
Andropogon appendiculatus	5	P***	1	1
Aristida congesta	0	U*		
Brachiaria serrata	3	P	1	1
Cymbopogon excavatus	1	U*		

Veld grass species *** Palatable ** Intermediate * Unpalatable	Grazing value	Palatability. Barnes (1990)	Highland Sourveld (Foran *et al.* 1978)	Dry Highland Sourveld Camp (1997)
Cynodon dactylon	3	I**		
Digitaria monodactyla	2			
Digitaria ternata	3			
Digitaria tricholaenoides	6	P***		
Diheteropogon amplectens	8	P		
Diheteropogon filifolius	0	U	2	1
Elionurus muticus	0	I	5	4
Eragrostis capensis	3		1	1
Eragrostis chloromelas	2			
Eragrostis curvula	5	I	1	1
Eragrostis plana	4	U	1	
Eragrostis racemosa	2	I	1	1
Eulalia villosa	3	P	1	1
Harpochloa falx	4	I	3	1
Helictotrichon turgidulum	1			
Heteropogon contortus	6	I	4	5
Hyparrhenia dregeana	4	I		
Hyparrhenia hirta (fine)	6	P	1	2
Microchloa caffra	1		1	1
Monocymbium ceresiifor.	6	P	2	
Panicum natalense	2	U		
Paspalum dilatatum	7			
Rendlia altera	0	U		1
Setaria nigrirostris	5	P		
Setaria sphacelata	5	P		
Sporobolus africanus	3			1
Themeda triandra	10	P	45	50
Trachypogon spicatus	3		2	1

Veld grass species *** Palatable ** Intermediate * Unpalatable	Grazing value	Palatability. Barnes (1990)	Highland Sourveld (Foran *et al.* 1978)	Dry Highland Sourveld Camp (1997)
Tristachya leucothrix	9	P	20	20
Non-graminoid forbs and sedges	0	U	6	6

2.1.1 Influence of grazing patterns and rainfall

Manipulation of grazing patterns can fortunately shift the competitive balance between different species. The abundance of themeda in the sward can be increased relative to other species by the increased use of appropriate resting, fire and non-selective grazing. Morris & Tainton (1993), for example, found that defoliation reduces the yield of *Aristida junciformis* to a greater extent than it does the yield of *Themeda triandra*. Zacharias (1994) found over a period of six seasons that an increased frequency of defoliation shifted species composition, as might be expected, from a *Tristachya leucothrix* to a *Themeda triandra* dominated state. Another example of management of veld influencing species composition was reported by le Roux (1989) on work done at the Estcourt Research Station. He found that *Themeda triandra*, *Heteropogon contortus*, Cyperaceae, *Diheteropogon amplectens* and *Elionurus muticus* were favoured by frequent spring or autumn defoliation, whereas *Hyparrhenia hirta* and *Tristachya leucothrix* were favoured by infrequent defoliation. Stoltz (1993) found that *Tristachya leucothrix* was the most preferred grass in winter, but the more abundant *T. triandra* contributed more to the total diet. In a grazing trial over five years in the North-eastern Sandy Highveld, Kirkman (2001) found that the palatable species *Digitaria tricholonoides*, *Themeda triandra* and *Tristachya leucothrix*, all increased in proportion in the sward, where cattle utilization treatments incorporated rests. Where rainfall is erratic, it seems highly probable that rainfall fluctuations within and between seasons induce changes in floristic composition (Barnes & Denny 1991).

Changes in the composition of veld species take place where the fertility of the soil changes. This happens in places where cattle congregate, such as where the containers providing supplements are placed. The excessive deposits of dung have the effect of changing fertility status, and with it the species that dominate. Tidmarsh (1966) found that the application of fertilizers to more humid veld had similar effects. The response in grassland sward appeared that the dominant species died out and became replaced by others, and weed species intruded. Morris & Fynn (2001) also found that tall grassveld is totally transformed by fertilizer application, with Nitrogen appearing to be the main nutrient driving competitive interactions among the species.

2.2 Veld quality and quantity

2.2.1 Plant quality

Plant quality can be referred to as the usefulness of the forage to the animal (Zacharias 1990). The more mature the herbage, the more variables are involved in the determination of animal preference and so eventual performance, eg. the breaking tension of the leaves provides a significant contribution to the estimates of animal preference (Theron & Booysen 1966). The better the quality, the higher will be the content of crude protein and other nutrients. A minimum of 7-8% crude protein is required by ruminants to maintain them in a productive state (Meissner *et al.* 1999).

In a two year period (November 1933 to October 1935), veld samples collected from more than 700 farms, were analysed by scientists at the Onderstepoort Veterinary Research Institute. In the summer rainfall grassland areas, the crude protein varied from 7.0% to 9.0% in the summer and to between 3.3% and 4.0% in the winter. The phosphorus varied from 0.12% to 0.17% in summer to a low of 0.05% to 0.07% in the winter. The conclusion was that South African natural pastures are deficient in phosphorus, crude protein and in some cases sodium for a period ranging from five to nine months of the year (du Toit *et al.* 1940).

Celliers *et al.* (1995) doing work on fertilized and unfertilized *Cymbopogon-Themeda* summer veld near Potchefstroom found that the average daily gain (ADG) of steers could be reliably predicted from the crude protein (CP) or acid detergent fibre (ADF) content of the summer veld herbage. O'Reagain & Mentis (1988) working in the Natal Sour Sandveld near Dundee found that the mean dietary crude protein (CP) declined as the period of occupation in a camp increased from one to fourteen days (Spring 12.0 to 8.4%, summer 9.2 to 6.6%, autumn 8.8 to 5.0% and winter 6.5 to 4.0%). This reduction in crude protein, as the length of stay increased, applied to all seasons as the length of stay increased. Tainton *et al.* (1977b) found that the average protein content of summer harvested material from plots burnt in August and September (6.2 to 7.2%) was higher than the protein content (5.0 to 5.3%) of mown plots. There was, however, no difference in the protein content (5.7%) by early March.

Although sweetveld has the ability to carry stock throughout the year (Scott 1947), and sourveld, by definition, only for six months, research has not demonstrated that there is a significant difference in the quality of similar species that grow in both sweetveld and sourveld. Zacharias (1990) measured plant quality through cellulase dry matter disappearance (CDMD) to determine the difference in quality between the same species from sweetveld and sourveld. He found that although the sweet plants (from sweetveld area) had a higher CDMD value than sourplants (from sourveld area), the difference could not explain the difference in animal performance. This means that other factors also play a role in the decline in quality in sourveld. This underpins the perception, therefore, that sourveld is only useful for six months.

2.2.2 Veld quantity

Veld production varies from season to season depending on the amount and distribution of the rainfall, soils, average temperatures, and the vigour of the grasses. Coetsee (1975) reported an extreme difference of 515 kg ha^{-1} in 1968, compared with 2 684 kg ha^{-1} during 1971 in Cymbopogon-Themeda veld at Potchefstroom. de Waal (1994) found that animal performance reflected the seasonal variation in dry matter yield.

2.3 Resting of veld

There is general consensus among researchers that sourveld needs to be rested to maintain vigour (Scott 1955; Barnes 1956; Booysen 1969; du Toit & Ingpen 1970; Vorster & Visagie 1980; Barnes 1989b; Kirkman 1995; Peddie *et al.* 1995; Zacharias 1995; Owen-Smith 1999; Kirkman 2001). The loss of vigour in species that are defoliated is characterised by a marked reduction in root mass and mass of non structural carbohydrates (NSC) in the roots (Barnes 1989b).

In the fifties, Scott (1955) pointed out the three critical periods when plants should be rested from grazing. Firstly the spring period when plants draw on stored reserves (change over from seminal to the coronal root system), secondly the reproductive period (flowering and seeding), and thirdly in autumn when translocation of carbohydrates (reserves) to roots and stembases takes place. Barnes (1956) stated that a rest during the period when active shoot growth occurs, will result in a decrease of organic reserves. This research from the fifties had already indicated that there was a need for season long rests, as rests of shorter duration could actually decrease organic reserves. The importance of seeding rests was also emphasised.

Resting should be a necessary facet of any management system, and should be applied on a rotational basis. This is an important point! Veld that is rested for season after season, will change its species composition, and result in reduced ground cover. *Themeda triandra* reacts unfavourably to long periods of resting and to continued lenient use. Titshall *et al.* (2001) for example, found that at Ukulinga (Southern Tall Grassveld) where fire and utilization had been excluded in the no-burn plots for a period in excess of 50 years, there was only 0.8% *Themeda triandra* in the sward, but in plots with an annual winter burn, there was 38.0% *Themeda triandra* (Table 2.2).

"Any grazing, irrespective of grazing procedure, will result in a decline in vigour of particularly the preferred species. The only way to compensate for this severe loss of vigour caused by grazing is to implement periodic long term rests, that is, growing season rests." (Kirkman 1995). Zacharias (1995) contends that season long rests at regular and frequent intervals are far more important than grazing systems. Peddie *et al.* (1995) confirm these statements, as they found the vigour of *Themeda triandra* and *Tristachya leucothrix* in Highland Sourveld was only restored by the end of a full growing season's rest. During the first 27 to 31 weeks of rest, they had found that the topgrowth yields on heavily utilized plants had been significantly reduced, when compared to tufts leniently grazed. The proportion of palatable species in the North-eastern Sandy Highveld increased substantially in treatments comprising graze and rest in alternate years. Proportions of these palatable species declined in treatments with no rest (Kirkman 2001). The following remarks obviously apply 'The longer a grassland ecosystem can be left undisturbed, to engage in the core functions of primary and secondary production, energy flow, reproduction and nutrient cycling, the better' (Earl & Jones 1996). This is on the assumption that a full range of ecosystem components is present i.e. fire and grazing.

There was only one publication that did not fully support the idea that a full season's rest was beneficial. Savory & Butterfield (1999) state that the old belief that all land should be rested or left undisturbed in order to reverse its deterioration, has proven wrong. They describe environments as brittle and non-brittle, with brittle environments being those with the poorer distribution of humidity, particularly in the growing season, even though total rainfall may be high. They describe rest as being the most powerful tool to restore or maintain biodiversity and soil cover in nonbrittle environments. In very brittle environments, they believe rest to be extremely damaging to biodiversity and soil cover.

2.4 Winter utilization

In the late sixties, with the wider use of urea-based winter licks for livestock, grazing became a practical alternative to fire to remove the accumulated material. Scott (1970) wrote that "this new technique (use of urea licks) could be used to eliminate veld burning, although some researchers have cautioned against this." He cautioned that the effects on the sward would need to be monitored, but winter utilization would save a great deal of money. Stoltsz (1993) found that cattle and sheep graze selectively during both autumn and winter, but the degree of selection by the animals increases as winter progresses. He also found that even utilization of the sward was virtually impossible. There would always remain areas of unpalatable grasses that could only be effectively removed by mowing or burning.

2.4.1 Effect on grasses

The utilization of rested veld has been widely studied, with some researchers reporting positive responses and others reporting negative responses in different areas. This is examined as it appears that the context surrounding any particular period of rest may be important.

2.4.1.1 Positive comments on winter utilization

du Toit & Ingpen (1970), doing research at the Dohne Research Station, recommended winter utilization of veld in preference to burning. The reservation they expressed was that the utilization should not be too severe. Rethman *et al.* (1971) did research on winter grazing by sheep at the Nooitgedacht Research Station (North-Eastern Sandy Sourveld). They found that winter grazing, commencing after killing frosts, had no marked effect on the sward. du Toit *et al.* (1974) found the overall effect of winter grazing was beneficial, where the rested sites that were utilized were changed annually. They found that close (short) winter defoliation stimulated the sward to grow, even in mid-winter, irrespective of the moisture status of the soil. Vorster (1975) found that winter grazing with sheep and cattle was beneficial to the veld in dry *Cymbopogon-Themeda* veld at Glen Agricultural Research Station.

Boultwood & Rodel (1981) working at Henderson Research Station in Zimbabwe, found no evidence that grazing during the dry season, and then burning in the late dry season, either annually, biennially or triennially, resulted in a deterioration in grass species composition or yield of grass herbage. In the Southern Tall Grassveld at Ukulinga, Drewes & Tainton (1981) came to the conclusion that utilization of winter veld, which had been rested for the preceding growing season did not cause any permanent setback to *Themeda triandra*, when measuring regrowth during the subsequent spring. Swanepoel *et al.* (1997) also reported that winter grazing of rested veld did not have a negative effect on veld vigour in the Mpumalanga Southern Highveld. They conceded that the effects of winter grazing on veld vigour had not been fully investigated.

2.4.1.2 Negative comments on winter utilization

The major finding of Rethman & Booysen (1968) at the Ukulinga Experimental Farm, was the greater susceptibility of Tall Grassveld dominated by *Themeda triandra*, to winter defoliation instead of summer defoliation. Venter & Drewes (1968) stated that severe damage can be done to veld in Natal if it is overgrazed in winter. This is caused by pulling out of plants and by damaging the crown and root system. The result is weaker growth in spring and lower production in the following growing season. Kirkby (1971) found that irrespective of weather conditions, both early and late winter grazing appeared to have a depressive effect on spring growth at the Dohne Research Institute. Coetsee (1975) found that grazing during the dormant period did not affect total herbage yield, but severly damaged species such as *Themeda triandra, Eragrostis curvula* and *Digitaria eriantha* in *Cymbopogon-Themeda* veld at Potchefstroom.

On the basis of the inconclusive studies presented here, the conclusion can be reached that the utilization of rested veld needs to be carefully controlled, applying conservative stocking rates.

2.4.2 Effect on livestock

In areas of very high rainfall where grasses tend to mature early in the growing season, most classes of livestock lose mass during winter, even when supplied with protein rich supplements (Hardy 1994). This has been the finding of several other researchers as well. Elliott & O'Donovon (1971) working at Henderson Research Station, Zimbabwe, found that animals overwintered on adequate veld grazing in terms of available forage, lose weight because of a protein deficiency. They studied the effects of feeding different amounts of protein during winter to Hereford X Africander cattle after weaning. With no supplementation, the animals lost 12.7% of their livemass after weaning. Lyle *et al.* (1975) found that two year old steers lost 9.35% of their initial body mass on veld with a homemade lick which contained 15% urea (May to September). Meaker (1978) reported an average mass loss of 22% in cows overwintered on veld, comprising abandoned old cultivations, at Dundee Agricultural Research Station. This veld was not representative of natural grassland in the area. Drewes (1991) overwintered cows and replacement heifers on the northern variation of Cymbopogon-Themeda veld near Potchefstroom. One group was intensively fed hay, and the other group grazed rested summer veld. Those overwintered on veld were 19kg lighter at the beginning of summer, but when the calves were weaned in mid-May there was no difference in mass between the two groups. The important point is that both groups achieved the same conception rate. In addition the input costs of the two systems would have been very different, although these were not reported.

Günther (1986) overwintered steers in the Moist Tall Grassveld. He found mass losses of 10.8% on yearling oxen and 10.0% on 2 year old steers over the period 30 April to 31 August. Meaker (1988 pers. comm.) collected data from 200 Braford heifers at Besters near Ladysmith in the Dry Tall Grassveld. Mass loss was a mere 2.2% the first winter and 4.5% the second winter. van Pletzen *et al* (1995) overwintering 13 month Drakensberg steers on different winter licks and blocks, recorded mass losses of 6.4 to 9.5% in the period 1 May to 31 August 1994. O'Donovan (1997) overwintered sixty yearling steers on rested veld, consisting of a semi-vlei area, in the Moist Tall Grassveld. These steers had free access to a winter lick, but still lost 10.4% of their mass from the end of summer (279.1 kg) to the end of winter (250.0 kg).

It would appear that animals overwintered on veld in sourveld are likely to lose mass of between two and ten percent. What is also clear from these studies is that the restriction of mass loss during winter depends on management actions. These actions include light stocking of veld that has had a full season's rest, avoiding unnecessary handling of the animals and the provision of a urea-based protein lick at all times.

2.5 Removal of herbage after resting

The increased use of season-long rests, will result in an accumulation of unutilized material at the end of the dormant period. This material has to be removed, to provide nutritious grazing during the growing season, and to encourage a more even utilization of the sward. Animals tend to avoid unused areas and so perpetuate a patchy structure (du Toit 2003).

Researchers have found different effects of burning on production in the season following the burn, when compared to mowing or clipping. Some research indicated minimal effects on production (Barnes 1956 in Gwebi topland veld, Zimbabwe; Dillon 1980 in the Tall Grassveld of Natal with an August burn). Dillon (1980) did, however find the yield of veld from a burn after spring rains was considerably reduced, when compared to the yield of mown veld. Other researchers found significant improvement in production, if rested material was removed efficiently, without burning (Scott 1967; Venter & Drewes 1968; duToit & Ingpen 1970).

Savory & Butterfield (1999) advocate that fire should only be used when it is the most appropriate tool to achieve a personal holistic goal. They state that fire generally reduces the effectiveness of the water cycle as it exposes soil, destroys litter that slows water flow and maintains soil surface crumb structure and aeration. They also state that they are not aware of any soils that can withstand burning every two or three years on average, as is presently the practice in the Kruger National Park in South Africa. No research data was supplied to support these statements, and they contradict some long-term data (Tainton & Mentis 1984).

2.5.1 Mowing of veld

Researchers have found that production from mown plots is higher than from burnt plots. Scott (1967) found that production from mown plots to be 50% greater than from burnt plots in the Drakensberg conservation area. He had similar results in experiments at the Estcourt and Tabamhlope Research Stations. Growth in spring was usually two to three weeks earlier with no deterioration in botanical composition and an improvement in percentage cover (Scott 1970). Tainton *et al.* (1977b) also found that mown veld outyielded burnt veld through the summer season following the removal treatment. This was as a result of a greater number of overwintered tillers of greater mass that survived after mowing. This was offset later in the season, by the more rapid development of the tillers on the burnt veld.

However, only a small percentage of veld is mowable, and this requires expensive hay making and handling equipment. In addition, animals show superior mass gains on burnt veld (Zacharias 1995), so burning is considered as the only practical means of removal of accumulated herbage.

2.5.2 Burning of veld

Burning has been a sensitive issue in grassland management over several decades, with debate over the need and the frequency of fires, especially as this varies with the different veld types. Various governments of the Cape of Good Hope issued "plakaarts" making the burning of veld an offence (Scott 1970). However, the practice of burning has taken place for centuries. Indigenous people burnt grass presumably to improve pasturage for their livestock, and Kohi-San burnt so they could hunt game (Scott 1970). Fire is an effective agent in keeping grassland vigorous and productive. Many fires originate from lightning strikes, especially in the mountainous areas of Natal (KwaZulu-Natal). For example, there were seventeen fires in one season in 1937 at the Cathkin Park Forest Reserve that could only have been attributed to lightning (Scott 1970).

Research and experience has indicated that burning of veld has several benefits, provided that the burning takes place at the correct time, and the veld is utilized judiciously after the burns. Researchers have found that burning provides the following benefits to livestock producers:

1) Improves the quality of the herbage. Zacharias (1995) described burnt veld as providing nutritious grazing for livestock. He found there was an economic incentive for graziers to burn rangeland and graze it immediately (<14 days) after the fire (Zacharias 1994). In his research at the Dohne Research Station over a period of six years, treatments not burnt had resulted in poor sheep performance, but the early grazing of burnt veld by sheep had outperformed late grazing treatments by over 180% in terms of red meat production.

2) The early grazing of burnt veld reduces winter feeding costs (Zacharias 1994).

3) Removal of old grass after season long rests (shading effects). This is necessary as accumulation of dead herbage results in a loss of vigour of the desirable grasses (Barnes 1992).

4) Maintain a balance between grass and encroaching plants. Several researchers are of the opinion that encroachment takes place because fire has been eliminated, and no longer gives control of scrub seedlings (Scott 1967). In the Eastern Cape, Soil Conservation Committees insisted that burning was a wrongful practice, and should be stopped. This resulted in a very marked encroachment of bush into pure grassland areas (Scott 1970). In the absence of fire, trees are able to compete with grass more successfully for light, water and nutrients (Scott 1970). Where grass is well established and vigorous, germinating tree seedlings are unable to compete effectively with the grass roots for moisture, and either die or are held in check (Robinson 1975).

5) Prevention or reduction of patch selective grazing. Patch selective grazing can only be avoided by earlier stocking. Unpalatable species become more unacceptable as they mature. Bailey & Mappledoram (1983) reported on utilization of palatable *Themeda triandra* and unpalatable *Elionurus muticus* after burning at the Thabamhlope Research Station in the Highland Sourveld. They found that *Elionurus muticus* tufts, in spite of the bitter taste in the stem bases, were used as efficiently as *Themeda triandra* tufts up to the eighth week after burning. Thereafter the bitter tasting chemical with an obnoxious smell in *E. muticus* was present in adequate concentrations to deter grazing. However, *Elionurus muticus* was surprisingly also preferred over *Themeda triandra* as 28 week old mature forage under annual burning.

6) Changes in the grass species composition of the sward. Researchers and livestock producers have found that the proportion of *Themeda triandra* in the sward, will increase with increased frequency of burning. This is assuming that sound management practices, such as season-long rests are incorporated. Everson & Tainton (1984) found no significant change in veld condition on the Highland

Sourveld of Natal after 30 years of veld burning. However, after only five years of protection there was a decrease of *Themeda triandra* and an increase of *Alloteropsis semialata*. They came to the conclusion that a regular fire regime is essential. Further research on the response of *Themeda triandra* tillers to burning in the Natal Drakensberg was done by Everson *et al.* (1985), who found an exponential increase in the population with annual burning, a gradual increase with biennial burning and a loss of *Themeda triandra* from the sward where summer burning took place.

7) Improved ground cover by promoting lateral tillering. Lateral growth plays an important role in providing herbage that can be grazed. This observation explains why the ground cover improves where veld has been burnt and is then kept short. The research of Drewes & Tainton (1981) in the Tall Grassveld of Natal, contributes to an understanding of the significance of lateral tillering. Their research studied the effect of defoliation treatments (clipping and burning) at four different times (15 April, 15 June, 15 August and 15 October). They found relatively strong stimulation of secondary (lateral) tiller development occurred in all the defoliation treatments by burning. These lateral tillers on the burnt plots, produced as much available herbage above the defoliation height (5 cm) as did those tillers on lenient clipping treatments (10 cm height).

In sourveld areas, veld fires can be seen on most days of the year. The effects of burning in different seasons varies and research shows that severe damage can be done to ground cover and the species composition of the veld by incorrect burning and post-burn utilization practices. There are two important issues involved, namely the time of burning, and then post-burn utilization practices. The effects of burning of veld will be considered at the following times; autumn, winter, spring and summer.

2.5.2.1 Burning in autumn

The practice of burning in autumn still continues, although it is not recommended. This burning is done to produce some green grass before the winter. It has been shown by all workers to be extremely deleterious to the veld (Scott 1967). Complete defoliation during the growing season, by fire or mowing, markedly reduces the relative abundance of *Themeda triandra* and overall grass basal cover (Tainton & Mentis 1984).

2.5.2.2 Burning in winter

The question of burning in winter also causes much debate. This is so, as the interpretation varies as to what period is being referred to as winter. Winter, for the purposes of this study, will be referred as the period from the beginning of May to the end of August. Conditions can vary significantly over a period of four months, and especially from year to year. The moisture regime of the particular year, will determine the period of dormancy of the veld in winter. In dry years, the veld is likely to be dormant for the majority of the period. In years when rain falls in either July or August, the grass will start to grow, as soon as temperatures start increasing towards the end of winter. This aspect complicates the debate on the timing of burning of the rested veld. Burning in winter has been done to try to get green grass earlier for livestock. This practice was not allowed prior to 26 June 1992 (Govt Gazette No. 14058), and is not generally recommended by grazing advisors and extension personnel.

The general opinion was that burning in mid-winter had been shown by all workers to be extremely deleterious to the veld (Scott 1967). However, later research has questioned this statement. The dormancy of the grass, and whether the burn is to control bush encroachment, have become the important issues. Dillon (1980) concluded that in Tall Grassveld, veld should be burnt before the grass has commenced growth, if it is desirable for *Themeda triandra* to remain dominant. Similar statements have been made by other researchers. Trollope (1987) found that burning when grass was dormant (mid-winter) had no deleterious effect on the recovery of grass when compared with burning after the first spring rains. Danckwerts & Hobson (1993) stated that the time of burning is not critical, provided it is not very early (autumn) or very late (summer). They were of the opinion that burning to remove old, unpalatable grass should only take place after rain, in the period before the normal onset of the growing season. Burning before the first rains is necessary if the objective is also to control bush encroachment, which needs a high intensity fire capable of killing areal portions of woody plants (Trollope 2001).

2.5.2.3 Burning in spring

Spring coincides with the onset of the growing season. Conventionally, burning in spring has been recommended. The guidelines for burning vary with the different burning zones, with earlier burning allowed in the moister grassveld types than in the drier grassveld types. In the Cool Moist Grassveld, veld may be burnt from 1 August to 30 September, preferably after a rain. In Dry Tall Grassveld, the period allowed for burning is from 15 August to 31 October, only within five days after 15mm of rain has fallen within 24 hours (Government Gazette No. 14058, 1992). In sourveld areas, burning could take place without rain after the normal onset of the growing season (Danckwerts & Hobson 1993). In addition, biennial burning is the maximum frequency that fire might be needed (Barnes 1992).

2.5.2.4 Burning in summer

Burning of veld in summer, when it is actively growing has been condemned by researchers. The veld composition deteriorates, as *Themeda triandra* will be lost from the sward where summer burning takes place (Everson *et al.* 1985). Burning at this time has a disastrous effect on the productivity, basal cover and botanical composition of the grass sward (Trollope 1989). Barnes (1992) observed that annual burning in the mid- and late-growing season in the South-East Transvaal (Mpumalanga), with the aim of providing nutritious autumn or winter grazing, has resulted in undesirable changes in grass species composition.

2.5.3 Absence of utilization, burning and mowing

Undesirable changes in species composition will result if humid grassland is not utilized or burnt over a period of time. This fact has been clearly demonstrated by research carried out at Ukulinga (MAP > 700 mm, 770m a.s.l). The foresight of grassland scientists at the University of Natal led to the establishment of the Veld Burning and Mowing Trial (BMT) initiated by J.D. Scott in 1950. The trial on the plateau at Ukulinga, has contributed critically to the core knowledge of sustainable management of humid grassland in South Africa (Morris & Fynn 2001). Exclusion of fire and utilization at Ukulinga (Southern Tall

Grassveld) has promoted an open savanna of exotic and indigenous *Acacia* spp. and broadleaf species, and the transformation of the original palatable *Themeda triandra* - *Tristachya leucothrix* sward to one dominated by *Aristida junciformis* and *Eragrostis curvula* (Table 2.2). Numerous exotic woody species (Wattle, Jacaranda and Syringa) have also invaded the no-burn plots (Titshall *et al.* 2001). This trial clearly illustrated the undesirable consequences of no utilization or burning over an extended period.

Table 2.2 Mean (n=3) percent composition of selected species of the herbaceous sward in fire exclusion and annually winter-burnt plots at Ukulinga (Titshall *et al.*2001)

Grass species	Fire-exclusion	Annual winter burn
Aristida junciformis	19.1	0.2
Eragrostis curvula	18.4	0.5
Themeda triandra	0.8	38.0
Tristachya leucothrix	2.8	8.6
Herbaceous forbs	32.7	7.0
Basal cover (%)	8.1	11.8

2.6 Summer utilization

The traditional view is that as the growing season progresses, the proportion of high quality short leafy herbage in the sward decreases. This can, however, be restricted by keeping the grass short. Scott (1955) referred to attempts to lengthen the grazing season by systems of heavy grazing with short rotations, to keep the veld so short that it does not reach the unpalatable stage of growth until very late in the season.

Researchers have shown that the grazing capacity of grassland can be increased in several ways, amongst them the following:-

1) By changing defoliation patterns, so that there is green leaf for a longer period, than where the grass is allowed to grow unchecked (Barnes 1989a; Barnes & Denny 1991). Effective grazing can delay the onset of senescence in the grasses. Barnes (1989a) found this particularly in the case of themeda, and to a lesser extent with

trachypogon. The standing crop of green leaf was also found to be at a maximum later in the season.

2) By increasing the proportion of more productive and palatable grasses (Barnes & Denny 1991; Barnes 1992). This also involves the greater use of the less palatable species by the grazing animals. Palatable grasses evolve under a regime of heavy utilization and unpalatable species are generally avoided. The research of Venter (1968) confirms this point. He found that the more palatable species were more severely defoliated than the unpalatable *Aristida junciformis,* once it was established in the veld. However, when a system of grazing allows for complete utilization of all species, the unpalatable species are placed at a comparative disadvantage. The research of Morris & Tainton (1993) illustrates this point. They found that at all levels of competition, defoliation reduced the yield of *A. junciformis* to a greater extent than *T. triandra.*

3) By improving grass vigour as a result of the increasing frequency of growing season rests.

4) By early utilization of burnt veld. This assists in the utilization of all grass species in the sward. Bailey & Mappledoram (1983) caution that grazing of *Elionurus muticus* and *Diheteropogon filifolius* soon after burning may increase the risk of soil erosion, especially on steeper slopes. However, they concede that *Elionurus muticus* and *Diheteropogon filifolius* benefit from delaying grazing, as they become more unpalatable and are then selected against. Stocking too early after burning has been regarded in the past as a major cause of veld degredation (Hardy 1994). However, grazing of burnt veld immediately after the burn, will result in superior livestock mass gains (Zacharias 1994). Danckwerts (2001a) has described this ability of cattle to gain mass quickly, as 'riding the nutrient wave'.

5) From the carry-over effect of various utilization treatments which may be greater in the subsequent season, than their effect during the season of application (Danckwerts & Barnard 1981).

A grazing strategy should not involve more than two consecutive years of grazing. Peddie (1994) found high mortality of *Themeda triandra* after the third grazing season, especially by sheep. Grazing for two seasons was not problematic.

The utilization strategy selected could be based on an attempt to utilize all the species (non selective grazing), or only the more palatable species (controlled selective grazing or high production grazing). Other options available are continuous grazing, fixed or flexible grazing rotations or holistic management.

2.6.1 Non selective grazing

Non selective grazing is also referred to as high utilization grazing. Acocks (1966) described a system of non-selective grazing, the objective being to utilize all the species in the sward. He had observed that in rural areas, where grazing is both so heavy and so continuous as to be non-selective, parts which are not reduced to *Cynodon dactylon* or dongas, were still covered with very short but very dense climax (or sub-climax) grassveld. This has also been borne out by the observations of McKenzie (1982). He found that in spite of very high stocking rates in the Transkei for several decades, many areas have high basal cover and many climax grass species. Hardy (1994) however found that excessive and prolonged grazing leads to a loss of palatable species such as *Themeda triandra*, and the establishment of pioneer grazing tolerant species such as *Eragrostis curvula, E. plana, Sporobolus africanus* and *S. pyramidalis.*

The following points need to be considered to successfully apply non-selective grazing:

1) Early stocking

   This has the advantage that livestock graze the burns non-selectively, allowing the manager to keep the grass uniform and short, as a 'veld pasture'. McNaughton (1984) uses the descriptive term 'grazing lawn'. Grasses kept grazable under continuous grazing because they were kept short and palatable, become ungrazable by small concentrations of stock when they are rested and allowed to grow out (Acocks 1966). Bailey & Mappledoram (1983) found that the grass sward in the Highland Sourveld has considerable resilience toward grazing, and can make a marked recovery in only a few months. Researchers have found increased livestock gains by animals stocked shortly after the start of the growing season. Barnes & Dempsey (1992) found the production of 80% more livemass from Merino lambs placed on veld shortly after the start of the growing season, than those lambs placed on the veld two to three weeks later. This can be explained in that the veld became more mature and unpalatable before it was stocked with the second, later, group of lambs. In the case of cattle, there must be sufficient grass available for the animals to obtain the required food intake. Owen-Smith (1999) found that the rate of food intake of cattle drops when grass height falls below 100 mm.

Certain problems have also been encountered by researchers with early stocking. Coetsee (1975) found that early summer grazing of Cymbopogon-Themeda veld at Potchefstroom, stimulated undesirable species such as *Elionurus muticus.* Tainton *et al.* (1977b) cautioned against grazing August burnt veld before it had recovered sufficiently. By doing so, seasonal yields would be drastically reduced for a long period in late winter and early spring. Dillon (1980) was also of the opinion that an adequate rest should be allowed after burning before veld should be grazed in spring. Trollope (1989) also found considerable circumstantial evidence of veld deterioration where veld is burnt regularly and followed immediately by heavy continuous grazing.

2) Sufficient grazing pressure

Sufficient grazing pressure must be applied to veld that has had a growing seasons rest. Should this not happen, a "type of selective grazing cum resting system" occurs (Acocks 1966).

3) Better regrowth of plants

Regrowth after severe defoliation was better than after lenient defoliation, speculating that plants heavily defoliated had a greater proportion of more efficient photosynthetic component (Barnes 1989a).

4) Effect of defoliation on unpalatable species

A grazing method which enables the degree of selective grazing to be controlled, may enable significant improvements in the vigour of the more palatable pasture components to be achieved (Earl & Jones 1996). Bailey & Mappledoram (1983) found that *Themeda triandra* had a considerable competitive advantage (greater vigour) over unpalatable *Elionurus muticus* and *Diheteropogon filifolius* when grazed repeatedly by sheep during early spring at the Thabamhlope Research Station in the Highland Sourveld. The reason being that *T. triandra* had greater energy reserves, started to grow later and also grew more rapidly.

5) Criticism of non selective grazing

O'Reagain & Mentis (1989) mention that certain veld management systems, embodying non-selective grazing, are seriously flawed in their basic grazing philosophy. In their research on old lands at the Dundee Research Station (Natal Sour Sandveld) they found resistance to grazing of avoided species, and commented that these species were unlikely to be grazed to any significant degree even under high stocking densities. Camps were burnt in early spring and grazing commenced in mid-November of 1988, when available dry matter was 500 kg ha^{-1}. The author has found that in the application of non-selective grazing where unpalatable species dominate, it is preferable to burn early (August), and then utilize the sward as soon as it reaches 100 mm in height.

2.6.2 High production grazing

High production grazing (HPG) is also referred to as controlled selective grazing, which in theory is used to rest undesirable plant species out, by inducing a moribund condition and eventual death. This maximizes the seasonal production from the desirable and more palatable plants. Sufficient leaf is left on the good plant to continue fast growth, even though the bad plant is never grazed. Where the undesirable plant is less susceptible to grazing than the desirable plant, the sward will improve until completely dominated by desirable plants (Booysen 1969). However, Scott (1967) stated that if grass rested for a full growing season or selectively grazed is not removed, it soon becomes moribund, and in the course of three or more seasons, commonly dies out in patches, with the resultant invasion by weeds and other undesirable plants. Controlled selective grazing is the recommended form of rotational grazing in many of the veld types of South Africa, based on the experience and findings obtained at the Soutpan Experimental Farm north of Pretoria (Trollope 1989). In the more arid regions, HPG might be expected to perform better than high utilization grazing. Under conditions of frequent fire and low grazing pressure, sourveld would have comprised communities dominated by *Themeda triandra* (Hardy 1994).

The proper use concept developed by Roberts & Opperman (1974) is a similar concept to HPG, as it refers to the degree to which key species may be defoliated without detrimental effects on herbage production. This necessitates the identification of local key species, and quantification of their proper use or non-use. It is suggested that in judging animal movement, animals be removed when 75% of the key species have been utilized by 50%. An acceptable height being five to six centimetres.

The use of HPG is considered to be similar to selective grazing. Selective grazing has a profound effect on species composition, and it encourages the encroachment of *Aristida junciformis*, a species almost totally rejected by animals at all stages of growth, and has caused greater veld deterioration than overstocking in tall grassveld in Natal (Tainton 1972). The efficiency of controlled selective grazing in improving the botanical composition of the grass sward depends on the response of undesirable grass species to grazing. It is ineffective when the undesirable grass species increase with under-grazing or selective grazing (Trollope 1989). Where selective grazing occurs, palatable species are grazed more closely and also more frequently, resulting in an increase in unpalatable plants (Barnes 1956). Barnes (1989b) found that light stocking favoured the vigour of *Trachypogon spicatus* and *Heteropogon contortus*, but did not prevent some loss of vigour in the themeda population, as grazing pressure on this palatable species was relatively high, even under light stocking.

2.6.3 Continuous grazing

Continuous grazing is that type of management in which grazing animals are placed in a camp when the forage is first ready to graze at the start of the growing season. They and their replacements are left in the camp for the entire grazing season (Edwards 1981). In the reclamation stage, when palatable climax species like themeda are scarce, light stocking will defoliate these species just as thoroughly as will intensive stocking (Acocks 1966).

Maximum profitability and conservative stocking rates are apparently not incompatible (Danckwerts 1989). Danckwerts (2000) found in sweetveld and thornveld of the Eastern Cape, that the highest production of meat per hectare over a ten year period was obtained by continuous grazing. This was achieved at a stocking rate 25% lower than the recommended stocking rate. The other treatments were a control with a rest, a rotation without a rest, a three-camp system, heavy utilization and continuous grazing with a rest (du Toit 2003). Vorster (1975) found that grazing of veld with sheep and cattle every year during late summer to autumn had an extremely detrimental effect on plant growth in the dry *Cymbopogon-Themeda* veld at Glen Agricultural Research Station.

2.6.4 Fixed grazing rotations

A fixed grazing system is one in which one camp is rested, and the herd of animals rotate in the remaining camps, grazing one camp at a time for a fixed period (eg 10 days). At Cedara, these conventional systems are referred to as "closed systems" of veld management (Venter & Drewes 1969). One of the better known is the four-camp system. One camp is given a season long rest, and the other three camps are grazed on a fixed rotation. This means a camp is used for three years before it is given a season long rest again. A major flaw of systems that are grazed for a third consecutive grazing season was identified by Peddie (1994). He found in the Highland Sourveld, that two consecutive grazing seasons were not problematic for *Themeda triandra*, however there was high mortality for the species, when grazed for a third consecutive season without rest.

Grazing trials that included all combinations of three periods of stay (2, 10 and 20 days) and three periods of absence (20, 40 and 60 days), were done in the Tall Grassveld at the Ukulinga Research Station. The shorter the period of stay, the greater number of camps required per herd. The most practical combination appeared to be 10 days in, and 60 days out, which would require nine camps, if two full seasons rest were included (Tainton *et al.* 1977a).

2.6.5 Multicamp rotational grazing systems

These systems have several camps per herd (in excess of 10 camps per herd). Multicamp systems have been found to be no better than systems with few camps for increasing grass productivity and maintaining grassland condition (Morris & Tainton 1996).

2.6.6 Flexible grazing rotations

The flexible system differs from the closed systems mainly in that the regrowth of grass, rather than time, is taken as the criterion in deciding whether a camp should be grazed or not (Venter & Drewes 1969). They reported on the practical implementation of the flexible or open system. One quarter of the veld was rested, and the animals would then first be placed in one camp, and moved to the next when this camp was grazed sufficiently. This would happen until the first grazed camp was ready for grazing again, at which time the animals were returned to it. The number of camps that the animals would graze consecutively, before they return to a previously grazed camp, would depend on weather conditions and the time of the year (Venter & Drewes 1969). Theron (1993) developed the flexible grazing concept further with the practical five cell system. Each cell was to have the same carrying capacity, and comprised any number of paddocks. The aim was to use large herds for short durations to control selective grazing in summer. The system required fewer camps than multicamp rotational grazing systems, as the livestock was grouped into as few herds as possible. Selective grazing was avoided by intense grazing after burning, and adequate season long rests to provide reasonable quality roughage for winter.

2.6.7 Holistic management

Holistic management is a form of short duration grazing, whose training practitioners and educators are resident in regions all over the world. They form small groups that meet regularly, and keep a focus on learning relying on approved regional coordinators. Worldwide operations are co-ordinated by The Allan Savory Centre for Holistic Management in Albuquerque, New Mexico.

Practitioners of Holistic management work to achieve their stated holistic goal. This includes the production of healthy grasslands with covered soil, biological diversity, effective mineral and water cycles and high energy flow (Savory & Butterfield 1999). Holistic management practice has evolved from interpretations of the apparent effects on soil and vegetation of large scale wild animal migrations in the Serengeti amongst others. The sealed soil surface had been left chipped and broken by the hooves of bunching and milling animals, and the seed being slightly buried. The soil was then compacted around the seed, and covered with mulch (Savory & Butterfield 1999). Animals are grouped in large herds, or even only one herd, which rotate through camps, spending periods of a few hours or a few days, until the desired utilization has been achieved. The author found no research data on the effectiveness of this system. The monitoring of the grass composition and production, would provide useful information on the long-term effects of the strategy in the different veld types.

2.7 General comments

In this chapter, a wide variety of components have been touched upon, that play a role in the decision of how to utilize sourveld. Sourveld is found mostly in the higher rainfall parts of southern Africa, and at high altitude. The importance of resting has been highlighted, as well as the necessity to supply nutritious grazing.

This chapter has indicated the complexity of the utilization of grassland, and important questions that need to be addressed in the formulation of a strategy. The different aspects have been included so that the best mix of components can be selected. The system selected will depend on the available sources of roughage. Assuming that the source of roughage will be the veld only, then the aim will be to have the highest quality possible for the longest period of time.

Winter utilization is different to summer utilization, and can be done selectively, as the grass is not growing actively at that time. The removal of accumulated foggage after resting and partial utilization are important decisions. This excess herbage needs to be removed by the animals, or by fire or has to be mown.

CHAPTER 3

STUDY SITE AND GENERAL PROCEDURE

3.1 Study site

The research was undertaken on the farm known as 'Stratherne' (30°17'E 28°17'S) in the Dundee district of Northern KwaZulu-Natal. The farm is 1 974 ha in extent and consists of the following portions; Stratherne 4134, North Hoek 4236, AB of George 1 5066, A of George 1 5749, A of George II 5750, Remainder of Up and Down 4962, Ongeluk 8448 and Meadow Bank 4130 (Map 2830 AD Helpmekaar). Camp (1995) classifies the area as Dry Highland Sourveld, which adjoins the Moist Tall Grassveld. The veld is also classified as Southern Tall Grassveld (Acocks 1988). The area falls into bioresource unit (BRU)[1] Vd3 of KwaZulu-Natal on the Helpmekaar plateau, south-east of Dundee. The average annual rainfall of this bioresource unit is 780 mm (Camp 1995). The average annual rainfall at 'Stratherne' over the past 31 years has been 804 mm (Table 3.1).

3.2 Climate

In this BRU, the frost period can extend from 30 March to 30 September, with frosts during March and September being light (Chapman 1997 pers. comm.). The mean temperatures are also lowest at this time varying from 10.4 °C to 15.6 °C, whereas from 1 September to 30 April, the mean varies from 14.9 °C to 19.5 °C. The median monthly rainfall varies from 0 mm to 7 mm from May to August, and from 26 mm to 131 mm in the period September to April (Table 3.1)

In this study, where some research is to be done over the summer (growing) period and other research over the winter (dormant) period, it will be assumed that the growing period is from 1 September to 30 April, and the dormant period is from 1 May to 31 August.

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[1] A demarcated area of land, throughout which there are recurring patterns of topography, soils, vegetation and climate.

Table 3.1 Climatic details for bioresource unit Vd3, with an altitude of 1 400 m to 1 800 m, and a mean annual rainfall of 780 mm (Camp 1995)

Month	BRU Vd3 Mean temperature (°C)	BRU Vd3 Median rainfall (mm)	BRU Vd3 Mean rainfall (mm)	'Stratherne' Mean rainfall (mm)
September	14.9	26	40	46
October	16.1	69	80	84
November	17.3	104	110	116
December	18.8	119	120	135
January	19.5	131	136	140
February	19.2	98	106	111
March	18.0	78	81	83
April	15.6	33	42	39
May	13.1	7	22	15
June	10.4	0	12	10
July	10.5	0	12	9
August	12.5	4	19	16
TOTAL			780	804

3.3 Geology

The elevation of the area varies from 1 240 to 1 596 metres. Soils encountered are shales and mudstones of the Volksrust formation, Ecca group with intrusive dolerite. Due to the nature of the underlying geology and prevailing climatic conditions, soils tend to be high in clay. Soil forms most commonly found on 'Stratherne' are Avalon, Bonheim, Estcourt, Glenrosa, Katspruit, Kroonstad, Longlands, Rensburg and Sepane. Gordon (1997) also identified soils in two profile pits, one with an easterly aspect and the other with a westerly aspect. The easterly one was of the soil form Longlands with a Westleigh phase, Ermelo soil family with a moisture impediment. The westerly one was on a drier slope, Bonheim soil form, of Golela soil family. This pit had a Melanic A horizon, Pedocutanic B horizon and unspecified material (weathering dolerite) for the C horizon.

3.4 Dry Highland Sourveld

The Dry Highland Sourveld is less productive than the Moist Highland Sourveld, as it receives lower rainfall. Sedimentary derived soils tend to be shallow and dry or poorly drained. On dolerite soils, as in large sections of 'Stratherne', both veld condition and palatability are much higher than on the poorer soils, with a higher abundance of *Themeda triandra* and *Heteropogon contortus* (Table 2.1). These sites also have a higher resistance to grazing pressure. On the cool, moist, south-facing slopes, the grass is generally taller and less palatable and patches of *Cymbopogon* species occur. On north facing aspects, the grass is short and palatable. Rested veld has been used successfully to carry stock through the winter using suitable licks (Camp 1997).

CHAPTER 4

THE EFFECT OF WINTER UTILIZATION OF RESTED VELD ON GRASS PRODUCTION AND SPECIES COMPOSITION THE FOLLOWING SEASON

Grazing animals are reliant for continued well being and production, on an adequate supply of roughage during the winter period. The provision of rested veld is a cheap source of this roughage, and can be utilized to maintain animals during the dry winter season with appropriate protein supplementation (Kirkman & Moore 1995). Some research has shown that herbage which accumulates during the growing season, has a low feed value in winter (Hardy 1994), and does not sustain growing livestock. Partial utilization of rested veld after a full growing season's rest, will reduce fire intensity, especially where burning is carried out in late winter before rain. It is therefore important to determine whether the use of rested veld has any detrimental effect on veld production or species composition during the following season. If not, then such veld could be used as a low cost substitute for hay, as well as a means of reducing fuel loads and so lessen fire intensity. A critical factor in the safe use of fire as a management tool.

The effect of grazing on vigour can be determined by measuring regrowth during the season following grazing and comparing treatments with an undefoliated control. Differences in vigour may reflect a change in tuft area as well as amount of growth per unit tuft area. Techniques are available for the measurement of regrowth of all species present using quadrats, in the dry-weight-rank method (Kirkman & Moore 1995). This method was tested in the highveld of the Eastern Transvaal and was found to be an efficient and precise means of determining the botanical composition of veld (Barnes *et al.* 1982). The dry-weight-rank (DWR) method of botanical analysis was developed in 1963 by t'Mannetje & Haydock, and modified in 1979 by Jones & Hargreaves. In dry-weight-rank analysis, quadrats are placed in a manner that gives a satisfactory sample of the vegetation. For each quadrat the observer estimates which species comprise the greatest, second greatest and the third greatest amounts of herbage within the quadrat on a dry mass basis. Ranks 1,2 and 3 are allocated to these species. The proportionate values for ranks 1,2 and 3 are multiplied by emperically derived 'percentage' multipliers 70.19, 21.68 and 8.73 respectively (Barnes *et al.* 1982).

A spreadsheet-based computer programme has been developed to process dry-weight-rank (DWR) data (Kirkman 1996, pers. comm.). This programme comprises a template with a data entry section (DWRDE), a data transformation section (DWRDT), a data storage section (DWRDAT) and a data processing section (DWRDP). The programme files convert raw data into proportional species composition by mass and on a percentage basis as well as species mass per unit area (Kirkman *et al.* 1996). This proved the ideal programme to use as it could detect any changes in the total mass of herbage produced as well as any changes in species composition.

Hypothesis 1 Winter utilization of rested veld does not influence the production or the species composition of that veld.

4.1 Experimental site

The farm 'Stratherne' has an independant five camp (K30, K31, K35, K36 and K37) flexible grazing system on the southern section of the property. This area was used for the research to test hypothesis one (Figure 4.1). In Northern KwaZulu-Natal, a significant area of veld has been previously ploughed. Where the climate or soil has proved unsuitable for cropping, many of these areas have been left to revert to secondary veld. This has also happened on a small area at 'Stratherne', where no ploughing or cropping has taken place in the last forty years, but the sward has remained dominated by tall grass species such as *Hyparrhenia hirta*.

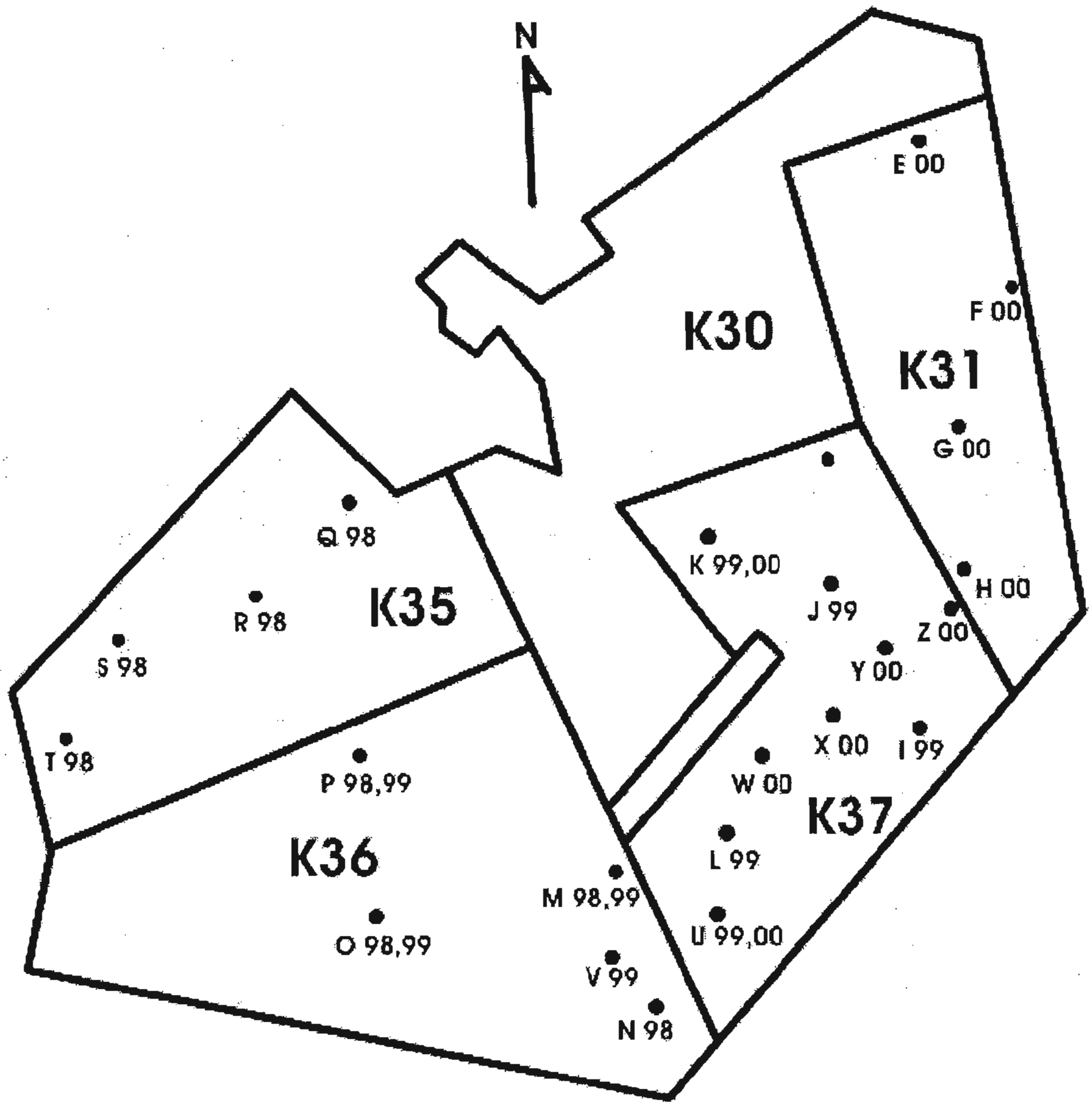

Figure 4.1. Experimental area showing exclosure positions in camps K30, K31, K37, K36 and K35 on 'Stratherne' Dundee district.

4.2 Experimental procedure

Every year, 40% of the veld is rested for a full growing season, in accordance with the rotational utilization programme. The research was carried out for three consecutive seasons, from 1996/1997 to 1998/1999, on the area rested for each season. Grass production and species composition were measured the following January (January 1998, January 1999 and January 2000). Each exclosure has been identified by a letter of the alphabet, followed by G for the section of the exclosure grazed during the winter, or R for the section of the exclosure rested during the winter. The year when the grass production was measured (98, 99 or 00) then follows the G or R.

Camps K35 and K36 were rested during the 96/97 growing season. Eight sites were randomly selected in the camps (M, N, O, P, Q, R, S and T), in areas free of excessive rocks. Each exclosure was 20 metres by 10 metres, consisting of two similar sections. Creosoted poles were placed securely at each corner and in the middle of the longer sides of the exclosure. Half of each exclosure was securely fenced, so that in the winter there was no grass utilization in that half of 10 metres by 10metres. The other half of the site was grazed by the cattle. During August the entire area was burnt, and the second section of the exclosure (grazed area) was also securely fenced, so that the cattle had no access to the entire exclosure (grazed and non-grazed sections). The rest of the area was then grazed during the growing season. The dry-weight-rank (DWR) method of botanical analysis was used to determine the production and species composition separately for grazed and ungrazed areas of each exclosure, this being done in the following January.

One hundred 300 mm by 300 mm quadrats were assessed per exclosure, fifty from the area that was grazed during the winter, and fifty from the area where no winter utilization took place. All material rooted in every fifth quadrat was harvested 15 mm above the ground. The grass was placed in marked paper packets (Quadrat number) and dried by forced draft at the Dundee Agricultural Research Station at 70 °C for 72 hours. The mass of each packet was then recorded, and details captured in the computer programme.

The dry-weight-rank method of botanical analysis extrapolates the total herbage (grass) production as well as the individual species composition of that production. Abbreviations were used in the recording of the different species in the tables and spreadsheets (Table 4.1)

Table 4.1 Names of the thirty grass species identified in the exclosures on 'Stratherne' Dundee district

Abbreviation	Species	Abbreviation	Species
Allsem	*Alloteropsis semialata*	Erarac	*Eragrostis racemosa*
Andapp	*Andropogon appendiculatus*	Eulvil	*Eulalia villosa*
Aricon	*Aristida congesta*	Heltur	*Helictotrichon turgidulum*
Arijun	*Aristida junciformis*	Hetcon	*Heteropogon contortus*
Braser	*Brachiaria serrata*	Hypdre	*Hyparrhenia dregeana*
Cymexc	*Cymbopogon excavatus*	Hyphir	*Hyparrhenia hirta*
Digmon	*Digitaria monodactyla*	Melrep	*Melinis repens*
Digter	*Digitaria ternata*	Miccaf	*Microchloa caffra*
Digtri	*Digitaria tricholaenoides*	Moncer	*Monocymbium ceresiiforme*
Dihamp	*Diheteropogon amplectens*	Pannat	*Panicum natalense*
Elimut	*Elionurus muticus*	Pasdil	*Paspalum dilatatum*
Eracap	*Eragrostis capensis*	Setnig	*Setaria nigrirostris*
Erachl	*Eragrostis chloromelas*	Spoafr	*Sporobolus africanus*
Eracur	*Eragrostis curvula*	Thetri	*Themeda triandra*
Erapla	*Eragrostis plana*	Trileu	*Tristachya leucothrix*

The spreadsheet based programme calculates the mass and species composition of grazed and ungrazed proportions of each exclosure separately.

* MG98 refers to the winter grazed section of exclosure M, recorded in January 1998.

**MR98 refers to the non-grazed (rested) section of exclosure M (Table 4.2).

The same procedure was followed for the next two growing seasons. Camps K36 and K37 were rested during the 97/98 season, having nine sites randomly selected (I, J, K, L, M, O, P, U and V). Results recorded in Table 4.3. Camps K31 and K37 were rested during the 98/99 season, having eleven randomly selected sites (E, F, G, H, J2, K, U, W, X, Y and Z). Results recorded in Table 4.4.

Table 4.2 Total grass production and species composition of exclosures determined by dry-weight-rank method - January 1998

Exclosure Species	MG98* (%)	MR98** (%)	NG98 (%)	NR98 (%)	OG98 (%)	OR98 (%)	PG98 (%)	PR98 (%)	QG98 (%)	QR98 (%)	RG98 (%)	RR98 (%)	SG98 (%)	SR98 (%)	TG98 (%)	TR98 (%)	GrazeAv (%)	RestAv (%)
Allsem																		
Andapp																		
Aricon																		
Arijun						0.58				0.43					1.45	1.33	0.18	0.29
Braser																		
Cymexc	17.13	16.36	7.71	24.34	4.35		28.79	18.89	20.33	32.33	12.49	20.25	13.99	9.97	11.86	13.40	14.58	16.94
Digmon																		
Digter																		
Digtri		1.76	0.18	0.45									0.50				0.09	0.28
Dihamp			1.85	0.54			0.46				0.07	2.24			16.80	8.47	2.40	1.41
Elimut	3.32	1.32	2.02	2.87	0.56	0.26	3.65	2.90	0.38	0.44					0.08		1.25	0.97
Eracap						2.55	0.46			0.35							0.06	0.36
Erachl	1.52	1.06	0.66	0.13	0.45	1.06	0.70		2.70	1.39	4.15	9.39					1.27	1.63
Eracur	2.47	2.92	4.15	2.36	6.67	2.87	2.45	6.38	0.09	0.58	4.17	6.55	3.06	3.68	2.30	2.14	3.17	3.44
Erapla	4.97	1.07	1.63	3.79	1.63	0.83	1.53	6.92	8.70	5.06	2.30	5.49	1.35	2.04	2.04	1.23	3.02	3.30
Erarac	1.97	0.62	0.92	1.01	0.90	1.19	2.82	3.97		0.84	6.09	2.87		0.39	3.50	4.22	2.03	1.89
Eulvil																		
Heltur	0.35		2.72	2.12			4.61	2.08	0.23	1.78			1.67	3.28	3.00	12.64	1.57	2.74
Hetcon	2.55	0.20			2.12		6.37	0.85		0.44	21.60	18.13			2.28	0.42	4.37	2.51
Hypdre																		
Hyphir	38.58	38.83	1.97	1.08	52.52	78.97	12.54	13.56	47.00	24.05	14.09	22.57	18.50	15.14	7.12	4.99	24.04	24.90
Melrep							1.15											
Miccaf			0.34		0.62	0.37	1.20	0.91		0.35	1.40	0.05					0.45	0.21
Moncer																		
Pannat																		
Pasdil	0.21		1.89	1.75	16.49	2.73			13.36	1.35			3.36	2.18		0.23	4.41	1.03
Setnig	8.00	13.85	8.18	5.42			0.17	1.39					2.61	3.57	5.99	0.70	3.12	3.12
Spoafr	1.98	0.50	1.42	3.66	13.67	8.59	1.59	1.56	6.02	4.62	2.44		0.34	0.39	0.21		3.46	2.42
Thetri	16.83	21.44	57.63	40.38			31.51	40.59	0.86	25.99	31.20	12.45	52.69	59.00	42.16	48.53	29.11	31.05
Trileu	0.11	0.06	6.74	10.12					0.33				1.93	0.33	1.22	1.70	1.29	1.53
TOTAL	99.99	99.99	100.01	100.02	99.98	100.00	100.00	100.00	100.00	100.00	100.00	99.99	100.00	99.97	100.01	100.00	99.86	100.00
MASS (kg)	4840	5534	4037	3770	1990	1607	2739	3034	2171	2372	1989	1878	4321	4198	4381	4527	3309	3365

Table 4.3 Total grass production and species composition of exclosures determined by dry-weight-rank method - January 1999

Exclosure Species	IG99 (%)	IR99 (%)	JG99 (%)	JR99 (%)	KG99 (%)	KR99 (%)	LG99 (%)	LR99 (%)	MG99 (%)	MR99 (%)	OG99 (%)	OR99 (%)	PG99 (%)	PR99 (%)	UG99 (%)	UR99 (%)	VG99 (%)	VR99 (%)	GrazeAv (%)	RestAv (%)
Allsem			6.75	1.16															0.75	0.13
Andapp																			0	0
Aricon																			0.00	0
Arijun			1.48	2.23		0.29					0.57	2.25				0.08			0.23	0.54
Braser																			0.00	0
Cymexc	19.04	13.91	10.90	44.91	4.23		17.08	16.15	12.08	8.36	3.76		20.49	16.97	11 24	10.08	5.85	3.00	11.63	12.6
Digmon								0.09					2.19	0.71					0.24	0.09
Digter																			0.00	0
Digtri	0.12																		0.01	0
Dihamp							18.10	22.23		0.51					11.27	31.41	16.29	13.62	5.07	7.53
Elimut	0.09						0 62	0.82	0.91	0.09	1.78	1.73	1.17	0.58			1.24	2.63	0.65	0.65
Eracap	0.93	0.72	2 01	7.10	2.11	1.88	0.17		0.20			1.68	5.48	3.36	0.09		1.63	2.15	1.40	1.88
Erachl		0.27	0.30	0.56	1.54	0.77	0.10			0.47	1.80	0.15	0.07						0.42	0.25
Eracur	6.57	3.55	6.58	10 51	4.70	2.75		0.49	1.54	0.69	0.42	1.07	0.11	1.95	1.10	0.60	1.94		2 55	2.4
Erapla	3.33	1.09	15.48	14.94	1.92	3.61	2.43	1.48	2.77	1.95	0.91	0.40	1.69	4.64			0.40	0.33	3.21	3.16
Erarac	2.87	3.18	0.25		0.32		4.36	1.04	0.91		0.51		1.76	4.49	0.72	2.47	0.80	1.22	1.39	1.38
Eulvil																	0.08		0.01	0
Heltur					0.80	0.19	0.52		0.19				0.12				2.52	0.20	0.46	0.04
Helcon							0.35		11.38	3.02	4 89	0.25	6.15	0 84	18.42	12.93	7.10	6.53	5.37	2.62
Hypdre							0.28												0.03	0
Hyphir	11.01	21.91	53.32	18.43	72.35	82.99	24.30	7.33	48.37	62.40	76.59	81.64	13.15	4.54	14.20	3.18	8.96	5.54	35.81	32
Melrep																			0.00	0
Miccal							0.17				0.30	0.73	3.02	1.93				0.20	0.39	0 32
Moncer																		0.08	0.00	0.01
Pannat											0.23								0.03	0
Pasdil			1.15		0.6	0.58					2.05	1.78					0.11		0.43	0.26
Setnig	3.03	5.88			0.82		0.22		0.86	0.60	0.54	4.55			4.71	1.65	1.47	5.08	1.29	1.97
Spoafr	9.31	5.56	1.80	0.15	10.62	6.94	2.93	2.97	1.50	0.95	5.64	3.78	0.86	2.23	0.09	0.42	0.43	0.11	3.69	2.57
Thetri	43.60	43.92					28.40	47.40	19.29	20.96			43.72	57.76	37.39	31.35	51.01	59.30	24.82	28.97
Trileu	0.10														0.77	5.84	0.17		0.12	0.65
TOTAL	100.00	99.99	100.00	100.01	100.01	100.00	100.01	100.00	100.00	100.00	99.99	100.01	99.98	100.00	100.00	100.01	100.00	99.99	100.00	100
MASS (kg)	3635	3635	2538	2881	2629	2312	3734	3746	3799	3935	1885	1733	2349	2419	3865	3725	4220	4235	3184	3180

Table 4.4 Total grass production and species composition of exclosures determined by dry-weight-rank method - January 2000

Exclosure Species	EG00 (%)	ER00 (%)	FG00 (%)	FR00 (%)	GG00 (%)	GR00 (%)	HG00 (%)	HR00 (%)	J2G00 (%)	J2R00 (%)	KG00 (%)	KR00 (%)	UG00 (%)	UR00 (%)	WG00 (%)	WR00 (%)	XG00 (%)	XR00 (%)	YG00 (%)	YR00 (%)	ZG00 (%)	ZR00 (%)	GrazeAv (%)	RestAv (%)
Allsem																							0.00	0.00
Andapp	18.41	8.20																					1.67	0.75
Aricon	0.31																						0.03	0.00
Arijun			0.08						0.73	4.15	0.31				0.17								0.12	0.38
Braser							0.13			2.17			0.31							0.19			0.04	0.21
Cymexc	6.56	15.14	6.45	2.64	7.24	13.84	8.68	6.30	5.43	19.99	2.87		4.41	2.64	11.68	13.94	4.23	6.38	10.33	7.36	10.55	18.16	7.13	9.67
Digmon			2.47	10.09	3.14	2.10	1.76	0.30	0.55		1.58		1.38	0.06			1.29	0.37	0.18	0.42			1.12	1.21
Digter			2.93	1.58																		8.27	0.27	0.90
Digtri	12.19	8.17	42.22	32.62		0.08	4.64	1.78	7.67	11.17	3.76	0.82	1.50		2.39	2.07					3.57		7.09	5.16
Dihamp	1.77						12.54	15.98		3.14	12.48	0.72	9.54	14.62	11.97	16.73	11.35	16.32	0.16	2.39	0.24		5.46	6.35
Elimut	0.79		1.22	2.44		0.20	0.72	0.18	1.99	3.86	0.11	0.47	0.21	1.06	0.14	0.39	0.43	0.48	0.02	0.08	1.79	0.71	0.67	0.90
Eracap	0.23	0.61	0.11	0.09	1.42			0.31			4.53	0.87	0.54	0.34	0.07	0.25	0.09	0.22					0.64	0.24
Erachl					0.42	0.12	0.08	0.28			1.97	0.38	0.40	0.28	0.36								0.29	0.10
Eracur	2.53	3.32	0.68	2.23	8.61	6.12	5.78	1.31	2.73	2.92	2.54	1.94	1.10	0.06	5.30	2.90	0.77	2.04	2.90	2.30	3.88	3.92	3.35	2.64
Erapla	0.80		0.50		16.01	10.96	0.53	0.43	6.90	0.58	3.16	1.79			3.29	0.16		0.93	0.30	0.12	1.84	1.11	3.03	1.46
Erarac	1.04	4.65	3.33	2.53	1.17	0.66	0.18		2.16	4.98	0.14	0.52	0.74	0.81	2.19	2.22	1.77	1.21	0.08	0.12	0.87	0.37	1.24	1.64
Eulvil	3.39	12.83																					0.31	1.17
Heltur																							0.00	0.00
Hetcon	1.25	17.90	28.35	34.47	8.59	3.11	7.61		0.33	2.17			2.45	3.61	1.43	0.90	3.33	2.01	1.26	1.92			4.96	6.01
Hypdre													1.65						0.53	0.94			0.20	0.09
Hyphir	12.34	15.42	11.22	7.41	18.29	45.60	15.05	29.34	20.82	1.93	62.59	88.44	9.29	17.54	7.74	5.69	1.93	2.19	33.89	30.93	4.44	7.31	17.96	22.89
Melrep																							0.00	0.00
Miccaf	0.72					0.20	0.10	0.22	0.07				0.19		0.50						0.52	0.34	0.19	0.07
Moncer			0.03	0.22										3.12									0.00	0.30
Pannat																							0.00	0.00
Pasdil	0.38	0.20							0.19		0.25												0.07	0.02
Setnig	17.89	2.24				0.28			0.52						0.47	2.45	0.26		0.33	0.17	2.26	0.17	1.98	0.48
Spoafr	4.30	3.56	0.40		10.78	8.20	0.54		0.19		3.71	4.05	0.09	0.06	0.17	0.61	0.34	0.28	0.79	0.23	0.13		1.95	1.54
Thetri	15.09	7.74		3.67	24.34	8.53	40.92	43.19	49.72	42.47			63.40	48.20	51.12	50.52	74.04	64.17	48.18	50.34	69.64	59.48	39.68	34.39
Trileu							0.73	0.39		0.48			2.80	7.59	1.01	1.18	0.17	3.41	1.06	2.50	0.28	0.17	0.55	1.43
TOTAL	99.99	99.98	99.99	99.99	100.01	100.00	99.99	100.01	100.00	100.01	100.00	100.00	100.00	99.99	100.00	100.01	100.00	100.01	100.01	100.01	100.01	100.01	100.00	100.00
MASS (kg)	3040	2360	2225	2862	2428	2405	3068	4063	3046	2437	2693	2557	5232	4389	3634	3829	3838	4166	5735	4802	3388	3335	3484	3364

Exclosures J, K and O (Figure 4.1) had been previously ploughed in excess of forty years ago. It is of interest that each of these exclosures was dominated by *Hyparrhenia hirta*, with not even a single *Themeda triandra* plant identified in any of them (Tables 4.2, 4.3 & 4.4).

4.2.1 Total production from winter grazed and rested areas

The biomass produced every year from each winter grazed and the winter rested section of each exclosure was subjected to a paired t-test. This was done to determine if there was any difference in the total production between the two treatments (Table 4.5).

Table 4.5 Results of a t-test comparing the total production of herbage the following season from exclosures grazed during winter and exclosures rested (not grazed)

Year	Graze (kg ha^{-1})	Rest (kg ha^{-1})	t-value	P value
1998	3 308.5	3 365.0	-0.45853	0.66047(ns)
1999	3 183.8	3 180.1	0.05833	0.95491(ns)
2000	3 484.3	3 364.1	0.66396	0.52173(ns)

There was a non-significant ($P>0.05$) difference in the total production (kg ha^{-1}) for each of the three years for the grazed and rested exclosures (Table 4.5).

4.2.2 The effect of winter utilization on frequently occurring grass species

Thirty different grass species were identified in the exclosures over the period. Nine species occurred in over two-thirds of all the exclosures over the period, representing over 88% of all the grass plants. The occurrence of each of these nine species was subjected to a t-test to detect any changes in the frequency of their occurrence between winter grazed and winter rested veld (Table 4.6).

Table 4.6 Results of a t-test on species that occurred in over 66.67% of all the exclosures

Species	winter graze (%)	winter rest (%)	t-value	P value
Cymbopogon excavatus	10.70	12.69	1.16488	0.25426(ns)
Elionurus muticus	4.64	5.40	0.84898	0.40336(ns)
Eragrostis curvula	3.04	2.79	-0.64448	0.52470(ns)
Eragrostis plana	3.09	2.53	-1.18486	0.24640(ns)
Eragrostis racemosa	1.51	1.63	0.40590	0.68802(ns)
Heteropogon contortus	4.92	3.92	-1.13837	0.26496(ns)
Hyparrhenia hirta	25.43	26.39	0.35313	0.72673(ns)
Sporobolus africanus	2.94	2.12	-2.74755	0.01056
Themeda triandra	31.89	31.69	-0.09704	0.92341(ns)
% of all grass species	88.16	89.16		

Key:(ns) non significant, as P > 0.05 (5%).

Eight of the frequently occurring species showed a non-significant difference in percentage of occurrence over the three years. *Sporobolus africanus* was the only species which had a significant increase in occurrence, but was only 2.94% of the total species composition.

4.3 Correspondence Analysis of species data

Correspondence Analysis (CA) is a form of indirect gradient analysis that extracts independent theoretical vectors that best explain the species data. This is based on the assumption that species show bell-shaped response curves to environmental gradients. The output of ordination, by correspondence analysis, indicates the species positions in relation to the axes (Figure 4.2), which represent particular gradients that require interpretation (Jongman *et al.* 1987).

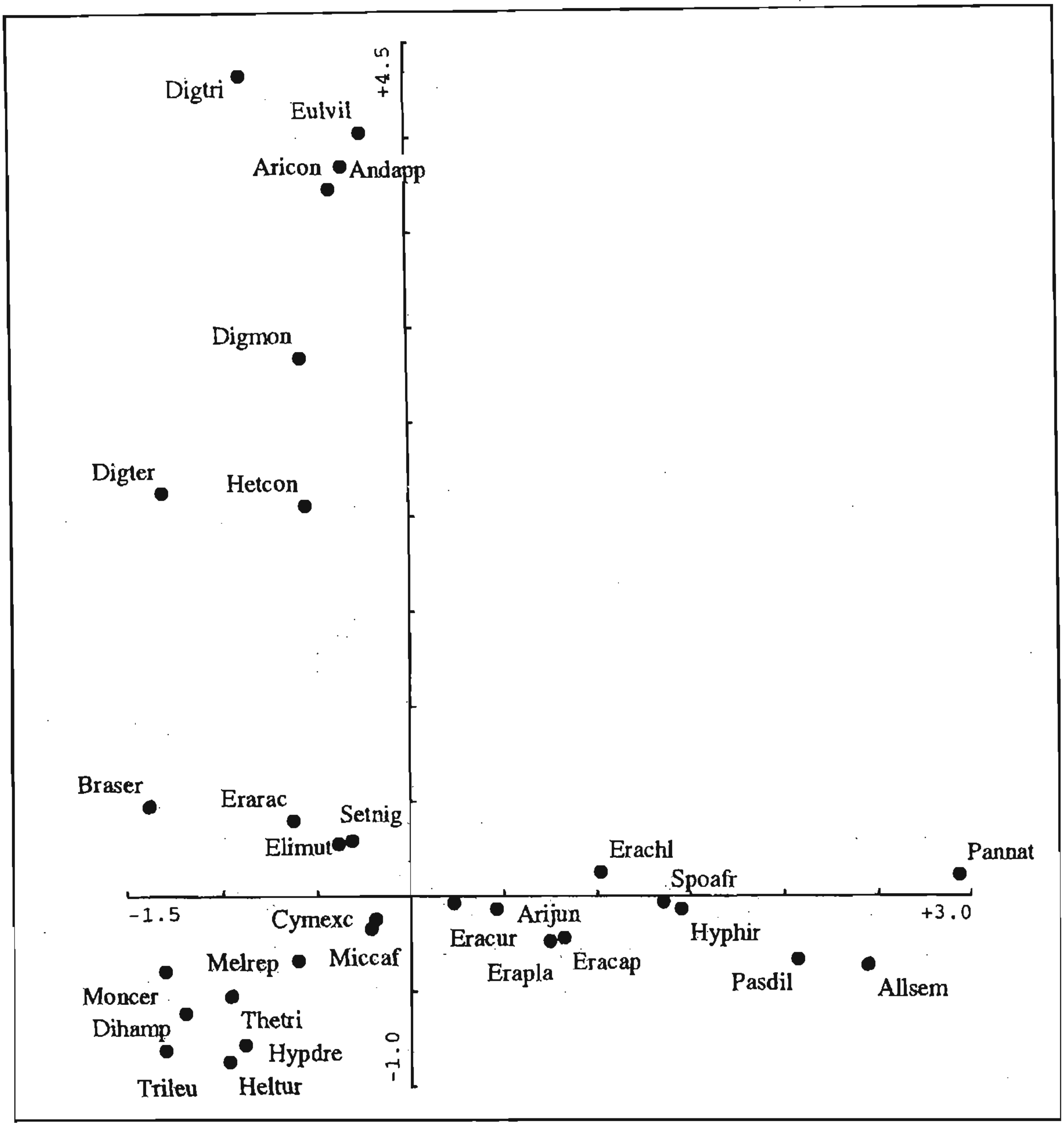

Figure 4.2. A plot of 30 species positions along the first two axes of a correspondence analysis of species composition data collected over three years from winter grazed and rested exclosures. Eigenvalues for axes one and two are 0.417 and 0.363 respectively, representing cumulatively 41.7% of the total species variance (for species names see Table 4.1).

Productivity declines from left to right along the first axis (Figure 4.2). Frequently occurring species with lower productivity are strongly correlated to this axis. These included *Eragrostis curvula, Eragrostis plana, Hyparrhenia hirta* and *Sporobolus africanus.* Frequently occurring species with higher production that were negatively correlated to the first axis included *Cymbopogon excavatus* and *Themeda triandra.*

Species positively correlated to the second axis were *Digitaria tricholaenoides* and *Eulalia villosa.* Negatively correlated species being *Hyparrhenia dregeana, Helictotrichon turgidulum, Tristachya leucothrix.* and *Diheteropogon amplectens.* The site data have also been graphed to identify the sites that had lower productivty and the species associated with these sites (Figure 4.3).

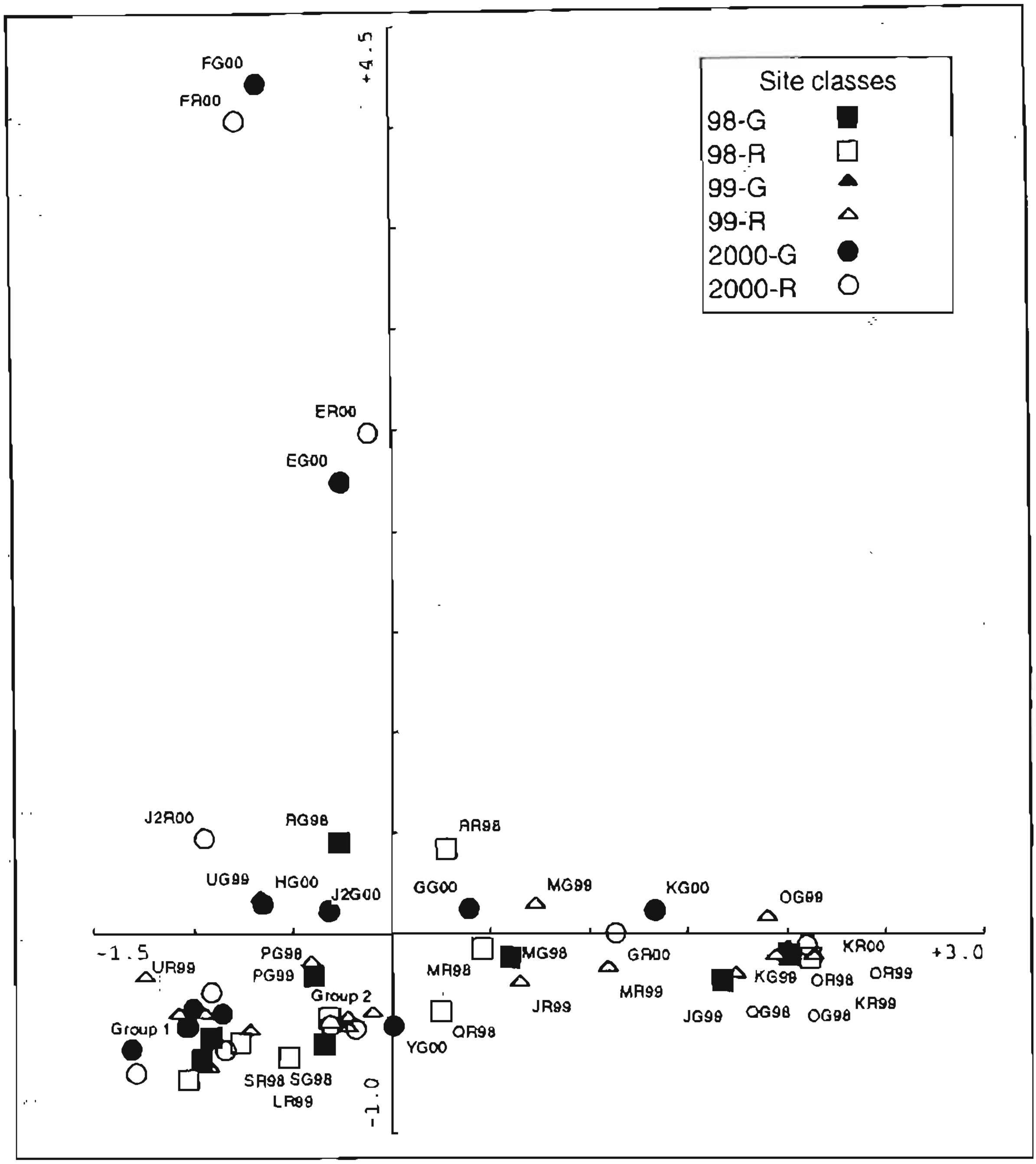

Figure 4.3 A plot of 56 exclosure site positions along the first two axes of a correspondence analysis of site data collected over three years from winter grazed and rested exclosures. Eigenvalues for axes one and two are 0.417 and 0.363 respectively, representing cumulatively 41.7% of the total species variance.

The fifty-six exclosure sites included in the correspondence analysis of data are; MG98, MR98, NG98, NR98, OG98, OR98, PG98, PR98, QG98, QR98, RG98, RR98, SG98, SR98, TG98, TR98, IG99, IR99, JG99, JR99, KG99, KR99, LG99, LR99, MG99, MR99,

OG99, OR99, PG99, PR99, UG99, UR99, VG99, VR99, EG00, ER00, FG00, FR00, GG00, GR00, HG00, HR00, J2G00, J2R00, KG00, KR00, UG00, UR00, WG00, WR00, XG00, XR00, YG00, YR00, ZG00 and ZR00.

The similar positioning of several sites necessitated the removal of the site names, and forming two groups of sites (group 1 and group 2 in Figure 4.3). The following sites formed group 1 ; NG98, NR98, TG98, TR98, PR99, VG99, VR99, UG00, UR00, WG00, WR00, XG00, XR00, ZG00, ZR00. Sites in group 2 are PR98, IG99, IR99, LG99, HR00, YR00. Sites with lower production are positively correlated to axis one. These sites include OG98, OR98, OG99, OR99, QG98, KG99, KR99, KG00 and KR00. Higher production sites are negatively correlated to axis one, and are included in the group 1 and group 2 sites. The sites EG00 and ER00 as well as FG00 and FR00 are outlyers, being strongly correlated to the second axis (Figure 4.3).

The positioning of the grazed and rested sections of several exclosures in close proximity on the axes, indicated that production had not been affected in those exclosures that were grazed in the winter. This applies to the following exclosures that are closely grouped together;
Positively correlated to axis one; MG98 & MR98, KG99 & KR99, OG99 & OR99, KG00 & KR00. Negatively correlated to axis one were the group 1 sites; group 2 sites; and sites UG99 and UR99. There are two sets of outlyers FG00 & FR00, and EG00 & ER00 that are positively correlated to the second axis.

There was a marked decline in productivity along the first axis of the correspondence analysis from left to right, representing a halving of the production over the range of sites (Figure 4.4).

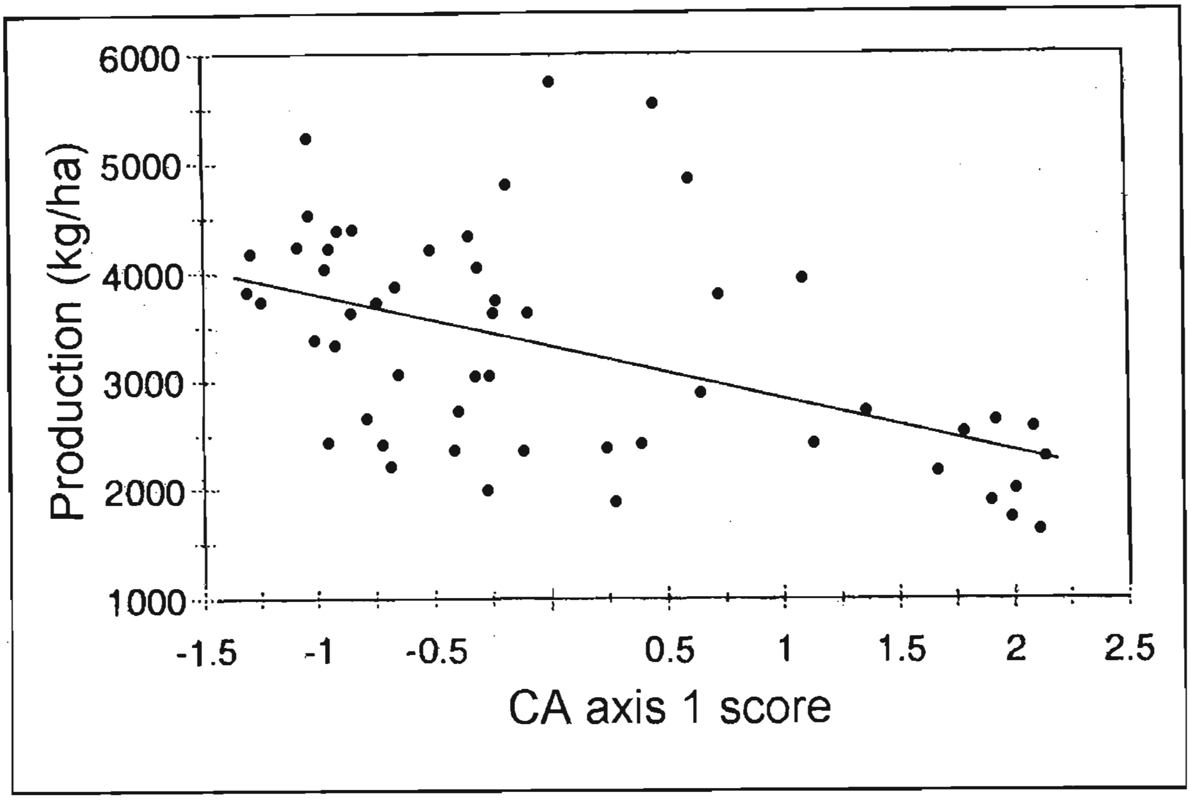

Figure 4.4 Decline of the productivity gradient along the first axis of the correspondence analysis, showing the scatter of the exclosure sites. Correlation ($r=0.505$, $P<0.001$).

4.4 Discussion and conclusions

Two aspects concerning the winter utilization of veld were investigated in the research. The first of these concerned the influence of winter grazing on total production. The average production difference was less than one percent, and non-significant in the t-test of all the data. It can be concluded that winter grazing of rested veld did not affect the subsequent production in the seasons of this study.

The second aspect addressed the question of the influence of winter grazing of rested veld on the species composition of that veld. The nine most frequently occurring species; *Cymbopogon excavatus, Elionurus muticus, Eragrostis curvula, Eragrostis plana, Eragrostis racemosa, Heteropogon contortus, Hyparrhenia hirta, Sporobolus africanus* and *Themeda triandra*, representing over 88% of all the species present in the exclosures were subjected to a t-test and correspondence analysis. Only one species, *Sporobolus africanus*, representing 2.94% of the total species had a significant P value in the t-test. In the correspondence analysis, the winter grazed and winter rested exclosures were positioned similarly along the axes, showing no difference in species composition.

The research supports the hypothesis that winter utilization of rested veld does not influence the production or species composition of that veld in the Dundee area.

CHAPTER 5

THE EFFECT OF A CHANGE FROM A FIXED PERIOD ROTATIONAL GRAZING SYSTEM TO A FLEXIBLE NON-SELECTIVE GRAZING SYSTEM ON GRASS COMPOSITION

The second aspect that has been researched, has been the effect of the suggested strategies on grass composition on the farm 'Stratherne' in the Dundee district over an eight year period. This period is from January 1994 to January 2002.

A four camp fixed period rotational grazing system was applied on the farm 'Stratherne' for the period 1965 to 1990. This system was based on allocating four camps for each herd, three to be used rotationally during the growing season and the other camp rested for the winter. Camps were grazed for two weeks and then rested for four weeks before the herd returned to the camp. The target stocking rate for each four camp system was 130 to140 kg ha^{-1}. A problem was encountered that there was insufficient grass to burn after winter, as only 25% of the farm was rested to supply roughage for the winter.

In 1990, plans were made to change the utilization from a fixed period rotational system to a flexible non-selective grazing system. The system was changed and adapted, so that the new system was fully operational from 1 September 1993. The new system of utilization would be based on combining herds into fewer larger groups. The grazing available would be monitored, and groups would be moved from camps as soon as the herbage had been eaten down. The rested area for winter provision was simultaneously increased to 40% .

5.1 Grass species composition of transects

In January 1994, the author requested personnel from the Dundee Agricultural Research Station to do veld assessments on his farm. The assumption has been made that the species composition at that time (January 1994) resulted from the application of the four camp system in operation from 1965 to the early 1990's. Abbreviations of the 28 different grass species that were recorded in the four transects and used in the charts (Table 5.1).

Table 5.1 Names of thirty grass species identified in the transects analysed on 'Stratherne' Dundee district in 1994 and again in 2002

Abbreviation	Species	Abbreviation	Species
Allsem	*Alloteropsis semialata*	Erarac	*Eragrostis racemosa*
Andapp	*Andropogon appendiculatus*	Eulvil	*Eulalia villosa*
Aricon	*Aristida congesta*	Hetcon	*Heteropogon contortus*
Arijun	*Aristida junciformis*	Hypdre	*Hyparrhenia dregeana*
Braser	*Brachiaria serrata*	Hyphir	*Hyparrhenia hirta*
Cymexc	*Cymbopogon excavatus*	Miccaf	*Microchloa caffra*
Digmon	*Digitaria monodactyla*	Moncer	*Monocymbium ceresiiforme*
Digtri	*Digitaria tricholaenoides*	Pasdil	*Paspalum dilatatum*
Dihamp	*Diheteropogon amplectens*	Passco	*Paspalum scrobiculatum*
Dihfil	*Diheteropogon filifolius*	Setnig	*Setaria nigrirostris*
Elimut	*Elionurus muticus*	Setsph	*Setaria sphacelata*
Eracap	*Eragrostis capensis*	Spoafr	*Sporobolus africanus*
Erachl	*Eragrostis chloromelas*	Thetri	*Themeda triandra*
Eracur	*Eragrostis curvula*	Traspi	*Trachypogon spicatus*
Erapla	*Eragrostis plana*	Trileu	*Tristachya leucothrix*

The different camps on the farm have all been named by the employees. Four different ls camps on the farm were selected, and a transect was marked in each of the camps. The names of the camps selected were Cele, FGM, Geza and Hill. A transect site was randomly selected in each camp. Each transect was marked with iron standards set 200 m apart.

The 1994 transects had revealed a grassland dominated by *Hyparrhenia hirta*. Other prominent species were *Cymbopogon excavatus, Heteropogon contortus* and *Themeda triandra*. Since the introduction of the flexible grazing management system, with increased frequency of resting and burning, there appeared to have been changes in the grass composition. In February 2002, a decision was made to record the species composition of the original four transects, so these could be compared to species recorded on the same transects in 1994. This was done by personnel of the Department of Agriculture and the University of Natal in February 2002. A further three transects were also recorded, which will form part of ongoing monitoring of grass composition (Table 5.4).

There has been a change in the method of recording species composition of transects since the original transects were recorded in 1994. When the species were recorded in 1994, the nearest plant to the point of impact of the marker was recorded. The recording of the plants included forbs and sedges. It is now customary to record 200 readings of the nearest grass plant, and record the forbs and sedges separately. An acceptable method had to be found to make the comparison between the two sets of data. In effect, as some of the readings taken in 1994 were forbs and sedges, fewer grass plants were actually recorded. The most accurate method to compare the results of the transects, would be to first remove the total number of forbs and sedges encountered on a transect in 1994. The example of the Hill transect in 1994 is given with 169 grass species, 28 forbs and three sedges were recorded, giving a total of 200 plant species across these data. The actual number of each species of grass has been multiplied by 200/169, to bring the total number of grass plants to 200. The monitoring of transects every eight years is one of the recommendations going forward. It was felt that recording should be done on the same basis, two hundred grass plants per transect, in the future. The numbers of 1994 have been adjusted proportionally so that the grass plants also total 100% (Table 5.2).

Table 5.2. The percentage of the different grass species in four different transects (Cele, FGM, Geza and Hill) recorded in 1994 and in 2002 on 'Stratherne' Dundee district

Grass comp	Cele 1994	Cele 2002	FGM 1994	FGM 2002	Geza 1994	Geza 2002	Hill 1994	Hill 2002	Ave 1994	Ave 2002
Allsem	2.1			0.5					0.5	0.1
Andapp	2.6								0.6	
Aricon	0.5		1.8				1.2		0.9	
Braser	1.1	0.5					0.6		0.4	0.1
Cymexc	5.3	4.5	3.7	11.5	8.5	6.0	13.0	14.5	7.6	9.1
Digmon					1.1				0.3	
Digtri	1.6	0.5						0.5	0.4	0.2
Dihamp	1.6		0.6	5.0					0.5	1.2

Grass comp	Cele 1994	Cele 2002	FGM 1994	FGM 2002	Geza 1994	Geza 2002	Hill 1994	Hill 2002	Ave 1994	Ave 2002
Dihfil							0.6		0.1	
Elimut	2.6		0.6	0.5			5.3	3.5	2.1	1.0
Eracap	4.3	2.5	3.1	3.0	1.1	3.0	1.2	11.0	2.4	4.9
Erachl		2.0	3.7	2.5	3.7		3.5		2.7	1.1
Eracur	1.1	2.5	6.1	2.5	4.8	8.0	7.1	0.5	4.8	3.4
Erapla	3.2	3.5	0.6	2.5	3.2	4.5	1.2	5.5	2.0	4.0
Erarac	4.3	5.5	4.9	3.0	2.1	4.0	9.5	4.0	5.2	4.1
Eulvil	3.6	2.0						0.5	0.9	0.6
Hetcon	3.7	8.0	12.9	4.0	12.2	3.5	12.4	9.0	10.3	6.1
Hypdre	1.6		9.8		5.9	0.5	1.2		4.6	0.1
Hyphir	29.8	21.0	30.7	4.0	47.3	22.0	27.8	13.0	33.9	15.0
Miccaf	4.3	8.5		8.5	0.5				1.2	4.2
Moncer			1.2	2.5					0.3	0.6
Pasdil		0.5		0.5				0.5		0.4
Setnig	4.3	10.0	1.2	1.5		2.5		3.5	1.4	4.4
Setsph	5.3	7.0	2.5	1.5	2.7	1.0	5.3	11.0	4.0	5.1
Spoafr	1.1	8.5	2.5	9.0	3.2	8.0	3.0	5.0	2.4	7.6
Thetri	11.7	10.5	12.9	31.0	3.7	34.5	6.5	10.0	8.7	21.5
Traspi		0.5		1.5		1.0				0.7
Trileu	4.3	2.0	1.2	5.0		1.5	0.6	8.0	1.5	4.1
Grasses	100	100	100	100	100	100	100	100	99.7	99.6
Forbs	4.2	6.0	17.5	5.5	6.0	16.5	14.0	11.5	10.4	9.9
Sedges	2.1	1.0	1.0	1.5	0	0	1.5	1.0	1.1	0.9
Total	106	107	118	107	106	116	115	112	111	110

Hypothesis 2. The grass species will change when a flexible non- selective grazing system is applied instead of a fixed period rotational system.

5.2 Analysis of changes in species composition

The composition of the transects in 2002 has been compared with the composition in 1994. The assumption is made that the changes in grass composition are as a result of the changes in the method of utilization, as a consequence of the changed management strategy for using the vegetation as grazing for cattle.

5.2.1 t-test on species data

The sixteen species identified in over 50% of the transects, have been subjected to a t-test, to determine whether there has been a significant change or not (ns), in species composition (Table 5.3).

Table 5.3 Results of a t-test on the occurrence of sixteen frequently occurring species in transects recorded in 1994 and 2002 on 'Stratherne' Dundee district

Species	1994	2002	t-value	P value
Cymbopogon excavatus	7.625	9.125	0.66541	0.55338(ns)
Elionurus muticus	2.125	1.000	-1.75207	0.17805(ns)
Eragrostis capensis	2.425	4.875	0.95553	0.40980 (ns)
Eragrostis chloromelas	2.725	1.125	1.20547	0.31443(ns)
Eragrostis curvula	4.775	3.375	0.62156	0.57827(ns)
Eragrostis plana	2.050	4.000	-2.29412	0.10557(ns)
Eragrostis racemosa	5.200	4.125	0.63596	0.57000(ns)
Heteropogon contortus	10.300	6.125	-1.34731	0.27060(ns)
Hyparrhenia dregeana	4.625	0.125	-2.24533	0.11041(ns)
Hyparrhenia hirta	33.900	15.000	-4.40788	0.02166
Microchloa caffra	1.200	4.250	1.45224	0.24237(ns)
Setaria nigrirostris	1.375	4.375	-2.67615	0.07529(ns)

Species	1994	2002	t-value	P value
Setaria sphacelata	3.950	5.125	-0.70066	0.53397(ns)
Sporobolus africanus	2.450	7.625	4.35717	0.02234
Themeda triandra	8.700	21.500	1.76018	0.17660(ns)
Tristachya leucothrix	1.525	4.125	1.27757	0.29130 (ns)
% of all grass species	94.950%	95.875%		

Key: (ns) non significant, as P>0.05 (5%)

The t-test indicated a significant increase in the occurrence of *Sporobolus africanus* and a significant decrease in the occurrence of *Hyparrhenia hirta*. There was also an two and half fold increase in the occurrence of *Themeda triandra*. Had a larger number of transects been available, it is likely that this may have calculated as significant. Of particular note in these data, is that most of the species that have increased in relative abundance are those selected as palatable by cattle.

5.2.2 Principal components analysis

The grass species composition has been subjected to ordination to determine the direction of any compositional change. Principal Components Analysis (PCA) is a technique that analyzes quantitative data from the species alone. It assumes a linear response of species along the gradient, instead of a unimodal response (Figure 5.1).

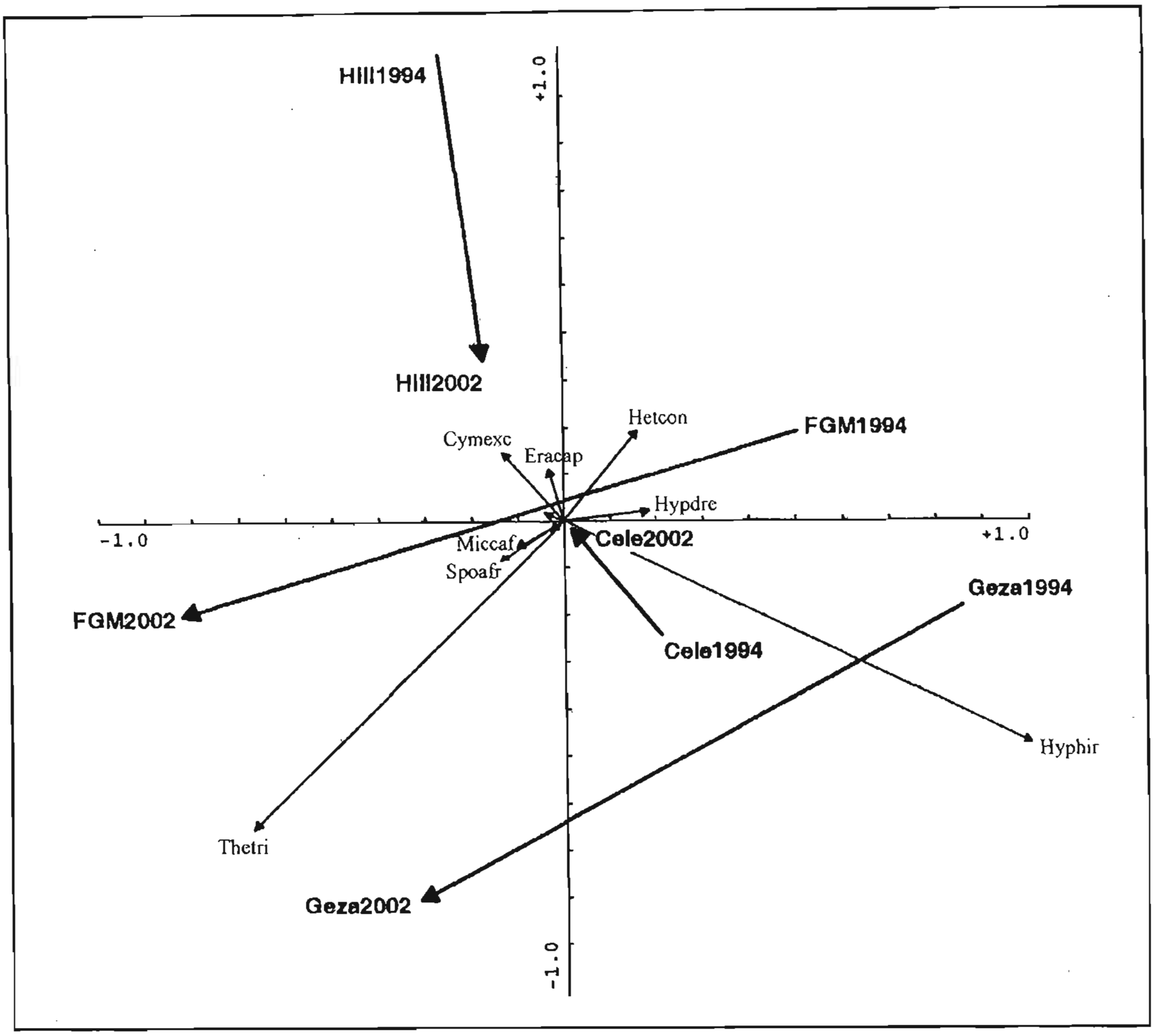

Figure 5.1. A plot of species (arrows from the origin) and sites (joined by arrows) from 1994 to 2002, along the first two axes of a principle components analysis (PCA). Eigenvalues for axes one and two are 0.569 and 0.275 respectively, representing cumulatively 84.4% of total species variance. Key: Cymexc = *Cymbopogon excavatus*; Eracap = *Eragrostis capensis*; Hetcon= *Heteropogon contortus*; Hyphir = *Hyparrhenia hirta*; Hypdre = *Hyparrhenia dregeana*; Miccaf= *Microchloa caffra*; Spoafr = *Sporobolus africanus*; Thetri = *Themeda triandra.*

The arrows in bold indicate the magnitude and degree of species change in the different sites. There was a small change in species composition for both the Hill and Cele camp. The greater species change occurred in Geza and FGM camps. In the PCA plot, the trajectories of change (arrows) show the changes of movement in species composition over the eight year period. Changes occurred in the four sites and in the proportion of the species, over the period 1994 to 2002. The arrows representing species change all start at the origin. The longer arrows indicate the greater change in *Themeda triandra* (increase) and *Hyparrhenia hirta* (decrease).

The changes in species composition can also be quantified by calculating the euclidean distance between the site positions at the two dates (Figure 5.2). The camps FGM and Geza had changed significantly from 1994 to 2002, as they were both above the 95% confidence limit (dashed line).

There was a slower turnover of species on the Cele and Hill sites (Figure 5.2), indicating the influence of aspect, soil type and depth, slope and grazing preferences of the animals across all sites.

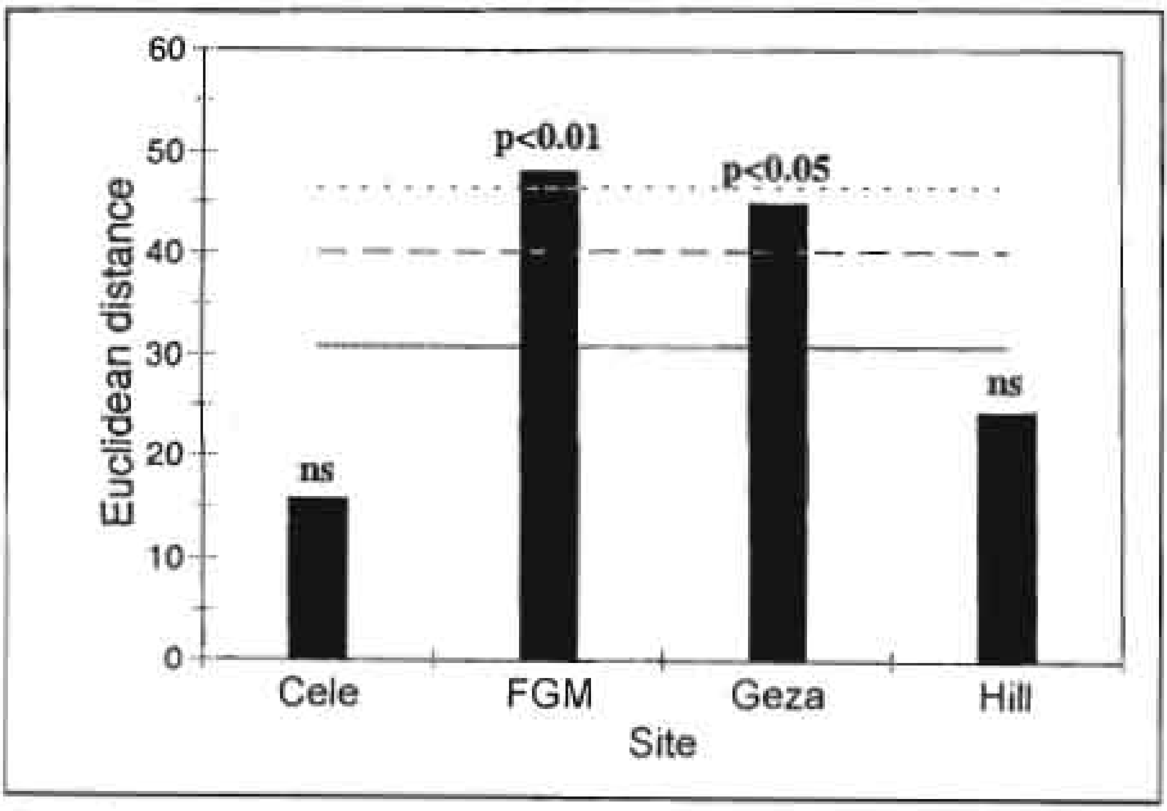

Figure 5.2. Measures of dissimilarity (Euclidean distance) in proportional species composition at sites on 'Stratherne' Dundee district from 1994 and 2002. Key: (ns) non significant.

The research indicated that aspect and soil played a role in what changes took place. The transect sites that had not changed, Cele and Hill were cooler sites. Cele has a south-westerly slope on a blue dolerite soil. Hill also has a south-westerly slope, on a shallow dolerite based soil. Again FGM and Geza changed significantly, as conditions on these two predominantly north facing slopes on deeper soil were more suitable to *Themeda triandra*.

5.3 Discussion and conclusions

The question posed was that if a utilization strategy is changed, will there be a change in the species composition of the veld? The strategy of grass utilization on 'Stratherne' Farm was changed to include greater use of fire, resting and non-selective grazing. Changes in the utilization strategy appear to have resulted in changes in species composition and veld condition. However, there are insufficient transects from which to draw a definitive conclusion. In addition, there has not been a marked change in composition in the two south facing slopes (Cele and Hill). It was only after observing the changes that appeared to be occurring, that it was decided to record the composition of the original four transects as well as a further three transects. Despite the relatively sparse data it is clear that the general trend has been for sites to move from a *Hyparrhenia* species dominated state to one associated with *Themeda triandra* (Figure 5.1). This 'result' concurs with the findings of Zacharias (1994) where he concluded that veld moved to a more productive (in terms of forage production) state in response to a change in defoliation and resting under the management proposed here (Chapter 7).

The recording of changes in grass species composition is an important indicator of the effects of utilization. It is advisable for all persons reliant on the use of veld, to set up transects, which can be monitored on a medium term basis. It will be interesting to monitor the changes in composition in the year 2010 from seven sites. The composition of the three additional transects (Beith, Geza 1 and Hilltop) was also recorded in 2002 (table 5.4). The transect 'Hilltop' has been placed on top of the highest hill on 'Stratherne' (1 580m a.s.l.). It has been observed that few cattle graze on the top of the hill, and that there is less grazing pressure there as a result. 'Hilltop' also had the highest proportion of *Hyparrhenia hirta* (37%) of the seven transects in 2002.

Table 5.4. The 2002 species composition of three additional transects on 'Stratherne' Dundee district

Species	Beith	Geza 1	Hilltop	Species	Beith	Geza 1	Hilltop
Aricon		0.5		Hyphir	36.5	26.5	37.0
Arijun	1.0		1.5	Miccaf	1.5	0.5	
Cymexc	5.0	7.0		Moncer		0.5	
Dihamp	0.5			Pasdil			0.5
Digtri	0.5		5.0	Passco		0.5	
Elimut			1.5	Setnig	1.5	3.0	5.0
Eracap	0.5		0.5	Setsph	3.0	1.5	9.5
Erachl	0.5			Spoafr	6.5	7.0	4.0
Eracur	3.0	4.5	6.5	Thetri	25.0	33.0	16.5
Erapla	5.5	2.0	3.5	Trileu	1.5	1.0	4.5
Erarac	4.5	3.0		Grass sp	100.0	100.0	100.0
Hetcon	3.5	9.5	4.5	Forbs	4.5	9.0	10.0
Hypdre				Sedges	0.5	0.5	2.5

Names of species (Table 5.1)

CHAPTER 6

LIVESTOCK MARKETING AND ECONOMIC CONSIDERATIONS

The objective of livestock farming should be to optimally use and improve the resources available over the long term under a philosophy of sustainable use. This can only be achieved if there is a match between the vegetation type, feed available, breed or type of beef animal selected and the aims of the manager. In a production system based primarily on production from the veld, without resorting to pastures or hay, the selection of early or medium maturity type of animals is important. This applies in sourveld, but not in sweetveld.

6.1 The effect of cattle breeds and maturity type

The livestock producer must fit the correct maturity type into the production system selected for the enterprise. The important point is that the maturity type should be in balance with the feed supply. 'Big animals are late maturing and small animals are early maturing' (Paterson 1990). Early maturing cattle breeds include Angus and Africander, medium maturity include Sussex, Bonsmara and Brahman and late maturing types include Simmentaler and Charolais (Paterson 1990).

Meaker (1991) conducted research over a five year period at Eversley farm, Glencoe which has a similar vegetation type to 'Stratherne'. The aim of the research was to determine what breeds of animals could finish off grass (Grades Super A, A1, Prime B and B1), and be market ready at 30 months of age. The equivalent grades at present are Classes A2, A3, AB2 and AB3 (SAMIC 2001). He found that only 39% of 315 locally purchased steers of ten different breed types, were ready to market before and up to the age of 30 months (Meaker 1991). He found 93% of the Africander (early maturing), 38% of the Bonsmara (medium maturity) and 0% of the Simmentaler (late maturing) reached market readiness off the veld. The larger framed, later maturing European breeds are more suited to intensive feedlot finishing than veld finishing.

6.2 Beef production systems and age of marketing

Production systems available to the beef producer can be found on a continuum from intensive to extensive (Figure 6.1). Intensive production systems rely on the faster turnover of finished product by use of grains and pastures, so as to get animals into marketable condition at a younger age. Often such high growth or fattening systems rely on growth promoting hormones. This results in a higher output in kilograms of beef per hectare but a lower economic return per animal unit owing to the extra feed and cost of disease control. Veld production systems by their nature, have lower feed costs, and can supply weaners and long yearlings to the intensive operations or other extensive systems. Alternatively the animals can be kept and sold off the veld as two or three year olds.

The slaughter value of beef cattle depends primarily on the age and fatness (finish) of the animals, as these are the primary factors setting the carcass grade (SAMIC 2001) and so the price. In most grading systems, premiums are paid for younger animals in good condition. An effective grass utilization system will allow beef animals to gain mass more rapidly, and so reach marketable condition as two-tooth animals, at which stage they will command a premium price. This premium price can only be achieved if the producer meets the requirements of niche markets, such as 'Country Reared' beef as there is now a world-wide trend for so called 'organically' produced food items. Identification of animals and traceability are important factors when supplying these niche markets, with inspections taking place to ensure compliance with regulations. In addition, a declaration form that no animal by-products, growth stimulants, hormones or similar products have been used, is required with each batch of animals supplied. At present, a certain large supermarket chain is marketing all the carcasses supplied in the 'Country Reared' beef programme, and does not accept pure Brahman cattle (Evans 2003).

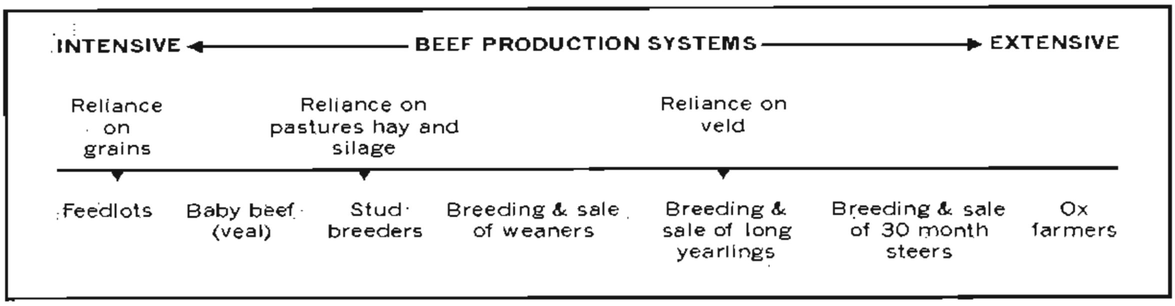

Figure 6.1 A basic graphic model illustrating the continuum of beef production systems from intensive to extensive after Buntting (1988).

"Intensive farming may be regarded as a production line in its extreme form, as output can be predicted from input. Extensive cattle farming on the otherhand may be regarded as veld farming in its most extreme form, since condition of the veld is a major determinant of profitability" (Meyer 1986). This statement reinforces the necessity to improve veld condition so as to be able to improve profitability of a veld farming enterprise. In systems reliant on veld, the younger the age of marketing, the higher the percentage of breeding cows in the herd due to the turnover and rapid removal of the animal to the market (Table 6.1).

Table 6.1 . Cows as a percentage of the total mature livestock units in different production systems (Harwin 1989)

System	Cows as a percentage of total mature units
Selling weaners	80%
Selling at 18 months	65%
Selling at two and a half years	55%
Selling at three and a half years	45%

6.3 The relative profitability of the different systems

In the beef industry, there is a cyclical expansion and contraction of the national beef herd. This cycle is the only real determinant of long term beef prices (Meyer 1986). The demand is fairly inelastic, so when supply is reduced, the price increases rapidly by following normal supply and demand patterns. The supply of animals cannot easily be increased, because of the length of time it takes to grow out the animals to reach the slaughter stage. In addition, producers may withhold numbers, especially breeding stock, creating shortages and pushing prices up further at the markets. The changes in the average price of beef carcasses over thirty-four years support the proposal that there has historically been a seven-year beef price cycle (Table 6.2). Beef prices are relatively constant for a period of five years (for example from March 1967 to March 1972 there was only an increase of 2.6%), before rising sharply over a period of two years (in the period March 1972 to September 1974, there was a 128.6% increase in prices).

Table 6.2. Average auction price for all grades of beef carcasses over the price cycles (1967-2001)

Period	Carcass Auction (c/kg)	Percent increase (decrease)	Period (Years)	Total cycle period (years)
March 1967	42.2*			
March 1972	43.3	2.6	5.0	
Sept 1974	99.0	128.6	2.5	7.5
March 1979	90.7	-8.4	4.5	
March 1981	217.0	139.2	2.0	6.5
March 1986	249.4	14.9	5.0	
March 1988	456.0	82.8	2.0	7.0
Year 1993	521.9**	14.5	5.0	
Year 1995	746.8	43.1	2.0	7.0
Year 2001	923.6	8.8	1.0	

*South African Reserve Bank Quarterly Bulletin, June 1988,S106

** SAMIC (S.A. Meat Industry Company) July 2002. SA Meat 5(9):28

Weaner production is the most profitable system for two years of the cycle, just after the beef price has peaked. It is, however, usually the least profitable of the systems in the two years before the beef price starts rising. In general, the same amount of beef is produced per hectare in all the extensive systems. The value of that beef is highest for weaner production, but this also goes with the highest production cost (Paterson 1992).

6.4 Beef production norms

It is useful to have norms that are realistic for producers using sourveld throughout the year. du Toit *et al.* (1995) gave the mean values derived from all breeds participating in the National Beef Cattle Performance Testing Scheme (1980-1985). These figures (Table 6.3) provide a norm that could be used, with minor changes. The final mass of two tooth animals finished on veld, instead of a phase C growth test, for example could be reduced to 440kg.

Table 6.3. Mean values of different characteristics from National Beef Performance Testing Scheme (du Toit *et al.* 1995)

Percentage cows calved	79.4
Age at first calving	36 months
Average cow weight	460kg
Average weaning age	7 months
Average weaning weight	201kg
540 day mass of heifers	310kg
Average of final mass of Phase C growth test	487kg
Eight month steer weight	221kg

There is general consensus that the calving percentage (number of live calves per 100 cows mated) is a major determinant of profitability. Danckwerts (2001a) emphasises this point, in stating that the calving percentage is not the most important factor influencing productivity, it is the only one! Lishman *et al.* (1984) found that at calving rates below 75%, insufficient heifer replacements become available to replace non-pregnant cows. However, when the calving rate rises above 75%, then regardless of the stage or avenue of sale, the gross margin improves. They also stated that in sourveld areas it would probably not be profitable to improve calving rates by additional short term feeding during winter (Lishman *et al.* 1984).

6.5 Calving season

Profitability can be improved by selecting the correct time for cows to calve down. This is the time when additional feed need not be purchased to supplement the cows. It is important that the majority of cows calve down within the first month of the selected calving season. As a rule of thumb, the calving season should commence a month prior to the onset of normal spring / summer rains. This is to meet the nutrient requirements of a lactating beef cow, which are approximately 80% more than the prepartum cow (Meaker 1984). In a three- year study involving 345 cows he found the average weighted reconception rate was highest (94.9%) for those cows that calved in the first 30 days, and lowest (61.5%) for those calving in the last 30 days of a three-month calving season. Sound veld management practices can provide conditions under which animals have optimum mass gains in summer, that lead to higher conception rates. Research by MacGregor & Swanepoel (1992) indicates that body mass (condition) at the end of the mating period is the critical factor that influences conception rate and hence fertility.

6.6 Economic considerations

The simplest and most commonly stated breeding objective is to maximize profit. According to Roux (1992), the profit rate for a meat production enterprise can be divided into the unit price for meat and herd efficiency. Herd efficiency depends on reproductive efficiency (reproduction and replacement rates, early fertility and degree of fertility at first mating) and growth efficiency. The correct long-term objective should be to optimise profits, as there could be environmental and other costs associated with the maximization of profits. The emphasis should again be placed on the correct utilization of the veld throughout the year.

Based on an assumption of an average price differential per kilogram of 19% between 18 month old cattle and cull cows, and a 34% differential between 8 and 18 month market animals, a 18/18 month production system (steers and heifers sold at 18 months) is more efficient than a 8/18 month system (steers sold at 8 months and surplus heifers at 18 months). An increase in the replacement rate of cull cows has a positive effect on biological efficiency and economic efficiency of the beef herd. This is so when cull cows are worth more on a per animal basis, than 8 or 18 month old females. A 20% replacement rate of cows is assumed as a norm for South Africa (du Toit *et al.* 1995), and this is advocated as an appropriate rate of replacement. The higher the average age of cows in a production herd, the less efficient the system becomes (Stewart & Martin 1981; Taylor *et al.* 1985 as cited by du Toit *et al.* 1995).

In KwaZulu-Natal there are different small groups of farmers that participate in economic study groups in an attempt to improve the efficiency of their operations. These groups meet on a regular basis to discuss topics that are likely to improve their economic results. At the end of each season, statistics are published on the average financial results of the group. Each individual participant can then compare the results of their enterprise to the group average. In this way weaknesses in any aspects of the enterprise can be identified, and corrective action taken. Examples of the two sets of statistics published about study groups in the late nineties follow. The Estcourt beef study group had ten beef farmers as members in 1999. The average area of veld on these farms was 2 272 out of 2 404 ha, carrying 630 mature livestock units (MLU) of beef. The gross margin per animal unit was R516.00 (R143.00 ha^{-1}). The average net profit after interest was R32.14 ha^{-1}. However, it was R73.20 for the top third of these farmers. The calving rate for the group was 80.86%, with a weaning rate of 77.23% (Norval 1999). Similar results were published by Whitehead (1998) who found that in the results of the study groups he analysed, the top third of farmers gross margin per animal unit averaged R672.00, whereas the bottom third only averaged R239.00 AU^{-1}. The difference being attributed to differences in management capabilities and strategies.

In conclusion, managerial skill and veld utilization strategies will play a defining role in the profitability of an enterprise. Veld is the cheapest source of feed, which has the advantage that it can be consumed where it is produced. In the growing season (summer), the provision of adequate quantities of short green growing grass will result in optimum mass gains for the livestock. At the same time an additional area of veld must be rested for the full growing season to provide for the grass plants need to rest after utilization of the previous summer. This area will then provide the roughage required for the winter, where the aim will be to restrict mass loss to a minimum. The practical application of a strategy that caters for the needs of the veld and the needs of the animals, will be required to optimise beef production.

CHAPTER 7

UTILIZATION STRATEGY

The quest for a new utilization strategy was triggered by dissatisfaction with the previous system of grass utilization on the property under study. In the seventies and eighties, a four-camp fixed rotation system was applied. The farm consisted of 36 camps, with nine sets of four-camps spread over the property. One camp of the group of four was rested for the full growing season. The camps being utilized were grazed for a fixed period of fourteen days, and were being selectively grazed. The grass composition as a result had a predominance of thatch grass (*Hyparrhenia hirta*), with an increase in the density of thorn trees (*Acacia karroo*). Most camps were seldom burnt in early spring and this had undoubtedly lead to an increase in *A. karroo*. It was not possible to get the two and a half year old steers into a marketable condition until late in the growing season. Approximately thirty percent of the group were kept over, and marketed as three year olds. The tall and stemmy sward structure of the grass resulted in low rates of intake for the weaners resulting in excessive mass loss in winter. A change in utilization strategy was required, and in the early nineties, the four-camp fixed rotation was replaced with a five-cell flexible grazing system.

The five-cell flexible grazing system introduced the concept of dividing the unit into at least five cells, each cell having approximately the same carrying capacity and comprised of any number of paddocks. Herd sizes were increased so that a larger proportion of the herbage in a camp could be grazed for shorter durations resulting in reduced selective grazing (Theron 1993). The Theron system was a great improvement on the four-camp system, as selective grazing was greatly reduced. The grazing cells were grazed for three years in succession, which was followed by a year as the reserve cell and then a full season's rest. Cells that had been rested were burnt, so that burning took place every fifth year (Table 7.1)

Table 7.1. The Theron veld management programme for twelve month utilization of sourveld on 'Stratherne' Dundee district from 1993 to 1997

Years	Cell 1	Cell 2	Cell 3	Cell 4	Cell 5
Year 1	Graze	Graze	Graze	Reserve	*Rest (B)
Year 2	Graze	Graze	Reserve	Rest (B)	Graze
Year 3	Graze	Reserve	Rest (B)	Graze	Graze
Year 4	Reserve	Rest (B)	Graze	Graze	Graze
Year 5	Rest (B)	Graze	Graze	Graze	Reserve

* Rest(B) Rest for a full growing season. Burn in spring

7.1 Strategic changes to optimize summer utilization

Research has been published that high mortality of *Themeda triandra* can result where more than two consecutive years of summer utilization take place, especially when utilized by sheep grazing (Peddie 1994). This meant that the utilization needed to change, so that there were never more than two years of utilization in succession. At the same time, research by Zacharias (1994) showed a major financial advantage of early stocking and frequent burning for red meat production systems using sheep. Burning was being carried out every fifth year on 'Stratherne', so that only twenty percent of the area was being burnt each year. A second burn after resting could double the area being burnt each year, which could be utilized soon after burning by applying the recommendations of Zacharias (1994, 1995) to production system using cattle. This would mean that grazing animals would be grazing on higher quality burnt grass for at least two-thirds of the summer. The implementation of this production system changes in emphasis from 'strategic grazing' to 'optimal resting' of the sward. This strategy focuses on the production needs of the plants and not the animals with a view to a more sustainable production system.

Optimizing the utilization system was achieved by adjusting the utilization schedule and the introduction of a second full-season rest (Table 7.2). After each rest, the veld was utilized in the winter, followed by burning and relatively early utilization. A further change introduced was that no block has the same treatment in successive years, as the combination of early post-burn grazing and frequent use of fire could have severe consequences (Tainton 1999).

It is practical to consider each year as consisting of a growing season of eight months (roughly 1 September to 30 April), and a dormant period of four months (roughly 1 May to 31August). The suggested rotation over five years provides for two full growing season rests, two growing seasons of non-selective grazing (NSG), and one growing season where controlled selective grazing (CSG) takes place. This is the period when that area is used as a reserve. In the reserve period, a utilization level of no more than 50% is sought. In seasons of below average rainfall, if more than fifty percent of the reserve area is being utilized in summer, then animal numbers should be reduced, while animals are in good condition. The opposite applies in wetter seasons, where there is less than fifty percent of the reserve area being utilized. Then livestock numbers can be increased. These adjustments to the stocking rate where necessary, give the system the flexibility to optimize profits in the context of the long-term sustainability of the strategy. Each block of land consists of a number of camps, in excess of the number of cattle herds. The animals are placed in the camps of one block. When the grass in any camp has been utilized, the animals are moved to another ungrazed camp in the block. When all the camps in a block are effectively utilized, the cattle are placed in camps of the next block. This process is repeated, until the grass is ready in the first block.

Table 7.2. Programme for optimal utilization of sourveld throughout the year

	Block 1	Block 2	Block 3	Block 4	Block 5
Year 1	REST[1]	NSG[2]	REST	NSG	RESERVE[3]
Year 2	NSG	REST	NSG	RESERVE	REST
Year 3	REST	NSG	RESERVE	REST	NSG
Year 4	NSG	RESERVE	REST	NSG	REST
Year 5	RESERVE	REST	NSG	REST	NSG

[1]REST. Rest for growing season, selectively graze in dormant period, burn in August.

[2]NSG. Non-selective grazing using a quick rotation for the growing season.

[3]RESERVE. Reserve block. Aim for < 50 % utilization.

7.2 Winter utilization

In the period May to the end of August, the rested veld should be lightly stocked. This lighter stocking gives the grazing animals the opportunity to select their diet, and so reduce the amount of winter mass loss. All material left after utilization should be burnt, so as to provide nutritious grazing the following summer (Zacharias 1994).

7.3 Provision for calves during the summer

The increased production by intensive utilization of short green growing grass over the summer has resulted in higher milk production by cows. Young calves in larger herds tend to be more susceptible to parasites and the normal tick-borne diseases plus calf paratyphoid and bovine viral diarrhoea. As a consequence there is a need for superior veterinary management.

7.4 Provision for calves during the winter

Weaner calves are better able to maintain their mass over winter when grazing shorter grass. This need (shorter grass) can easily be catered for by closing a section of one of the blocks being grazed non-selectively (or the entire block) in mid-February. The veld growth in the area withdrawn from utilization at this time, will be more suitable for the weaners during winter.

7.5 Drought strategies

Under severe drought conditions (frequency of one in twenty years), utilization strategies may need to change. Animal numbers should be reduced in the herds to allow animals to stay for longer periods in the different camps. Longer recovery periods will also be required between successive periods of utilization. It may also be necessary to reduce animal numbers on the property, and to spread the remaining animals over the entire area that is being utilized.

7.6 Monitoring and management

This utilization system has brought about several beneficial changes. The most important is in the observed species composition over the entire farm (See chapter five). A decade ago, the farm was basically a typical hyparrhenia tall grassveld, whereas the dominant grass in most areas at present is rooigras (*Themeda triandra*). The grass composition of seven transects in different parts of the farm were recorded in 1992, and will be monitored on an ongoing basis to establish the trend in grass species composition over time. Ground cover appears to have improved, although this has not been quantified. The extra use of fire has reduced the incidence of bush and shrub encroachment, with distinct fence-line effects with neighbouring farms that have not yet changed to similar utilization systems. There will always be a need to observe and monitor changes that occur in the veld, and to make adjustments to utilization strategies when these are necessary.

The perfect system of management is a figment of the imagination. There are flaws in all systems, and the best laid plans can be upset by changes in conditions. Stuart-Hill (1989) described the system of adaptive management which accepts that there must be monitoring, constant learning and adaptations. The basic concept is that the performance of the animals and the condition of the veld needs constant monitoring. The process involves learning from past successes and mistakes, obtaining the best advice available and making adaptations to incorporate what has been learnt. Recording of the environmental conditions that occur and management actions taken, assists to build up a data base to be used in future decisions.

CHAPTER 8

LIVESTOCK PRODUCTION ON 'STRATHERNE' DUNDEE DISTRICT

The system used at 'Stratherne' is based on the use of early to medium maturity types. The animals used have been Bonsmara type, originally Africander cross Shorthorn and Africander cross Sussex.

Records have been kept over the years to monitor the growth of the animals on the natural veld at 'Stratherne'. These analyses that follow, provide an opportunity to examine the consequences of the changed stocking strategy on the animal production system.

8.1 Growth of steers on sourveld from weaning to marketing age

In sourveld systems based on utilization of the natural veld, beef animals can be expected to lose mass over winter. The objective is to restrict this winter mass loss, and to make optimum use of summer mass gains.

Decisions on the most suitable marketing option for a particular enterprise will depend on the mass and the price obtainable at the different stages. In the period 1995 to 2000, various groups of calves were randomly selected and tagged to get an indication of changes in mass from birth to marketing age. The changes in mass from weaning to various marketing ages has been recorded (Tables 8.1 to 8.6). Cattle used in the research have been born in spring from 1 September to 30 November. Each group is identified by the year of birth, so for example, the 1995 group refers to calves born 1 September to 30 November 1995. Recording of the initial and final masses has been done after each group has been penned overnight without food and water, and this has been referred to as the dry mass.

8.1.1 Mass at weaning

Weaning of calves at 'Stratherne' takes place when calves are between five and a half and seven months. Calves born 1 September to 15 October, are weaned 1 April. Calves born

16 October to 30 November are weaned 15 May. A sample of 60 male weaners (Table 8.1) were tagged in each of three successive years (1998, 1999 and 2000).

Table 8.1. Dry weaning mass of a sample of sixty weaners on 'Stratherne' Dundee district for three different years

Group	Number	Mass Date	Average mass
1997	60	01-06-1998	217.38kg
1998	60	01-06-1999	196.10kg
1999	60	01-06-2000	200.22kg

The average mass of the three groups of weaners was 204.57 kg.

8.1.2 Mass loss of weaners over winter

Two of the above groups were mass recorded monthly over the winter, with the final mass recording on the 1st September (Table 8.2).

Table 8.2. Monthly changes in mass of weaners on 'Stratherne' Dundee district over the winter

Group	Number	1st June	1st July	1stAug	1st Sept	Mass loss	% loss
1997	60	217.38	225.82	212.82	205.12	12.26	5.64%
1998	60	196.10	202.88	203.82	190.23	5.87	3.00%
Average		206.74	214.35	208.32	196.67	9.07	4.39%

The average mass loss over the period amounted to 4.39%, which is comparable to other recorded losses. Elliott & O'Donovan (1971) working at Henderson Research Station, Zimbabwe found that without any supplementation Hereford X Africander weaners lost 12.7% of their livemass over winter.

8.1.3 Summer growth of yearling steers

The monthly summer growth of a sample of 60 yearling steers for each of three summer seasons (96/97, 97/98 and 98/99) was recorded (Table 8.3).

Table 8.3 Monthly changes in the mass of yearling steers on 'Stratherne' Dundee district over the summer

Group	1 st Sept	1 st Oct	1 st Nov	1 st Dec	1 st Jan	1 st Feb	1 st Mar	1 st Aprl	1 st May	Gain
1995	198	194	228.6	254.7	296.3	315	332	346	345	147
1996	194	213	241.5	265.1	288.6	314	323	349	350	156
1997	205	213	232.8	261.3	300.7	314	334	359	344	139
Ave	199	206	234.3	260.3	295.2	314	330	351	346	147

The average mass gain of the yearlings over the summer will depend on the breed, veld type, stocking rate and management. The gain at 'Stratherne' in the Dry Highland Sourveld compares favourably with mass gains on sourveld, but being lower than the gains obtained in the Lowveld with lower stocking rates (Table 8.4).

Table 8.4. Mass gains of yearling steers on 'Stratherne' Dundee district compared to mass gains on various veld types (Gammon 1992)

Veld type	Gain (kg)	Stocking rate (kg ha^{-1})
'Stratherne' (Table 8.3)	147	171
Highland sourveld	121	225-300
Highland sourveld	112	180
Tall grassveld	133	129-180
Sour sandveld	109	129
Lowveld	194	90

8.1.4 Monthly mass loss of yearlings over the second winter

A group of twenty from the 1995 group and thirty-seven from the 1996 group were sent to the Wondervale custom feedlot operated by Stock Owners Co-operative, which has since been sold. This earlier marketing resulted in only forty of the 1995 group and twenty-three of the 1996 group remaining. The objective was to determine if there would be a financial benefit in pursuing this marketing option. In drought circumstances custom feedloting could ease grazing pressure, but if there is veld available, it is more profitable to grow the steers out on the veld.

Table 8.5. Monthly changes in mass of yearlings over winter on 'Stratherne' Dundee district

Group	Number	1 st May	1 st Jun	1 st Jul	1 st Aug	1 st Sep	Mass loss
1995	40	347.80	348.73	343.70	333.80	317.85	29.95
1996	23	367.91	379.78	360.96	353.17	334.52	33.39
1997	60	343.83	349.70	352.37	343.85	307.37	36.46
Ave	123	349.63	355.00	351.16	342.32	315.85	33.78

The average mass loss of the 123 yearlings was 9.7% in the four month period. This was similar to losses reported in research done in Moist Tall Grassveld and Highland Sourveld (Table 8.6).

Table 8.6. Mass loss of yearling steers over winter on 'Stratherne' Dundee district compared to other reported mass losses

Veld type	Loss	Source
Dry Highland Sourveld	9.70%	'Stratherne'
Highland Sourveld	9.35%	Lyle *et al.*(1975)
Moist Tall Grassveld	10.0%	Günther (1986)
Moist Tall Grassveld	10.4%	O'Donovan (1997)
Average loss	9.86%	

8.1.5 Mass gains of two-year old to two and half year old steers

The optimum mass of two and a half year old steers is reached after the mass gains of the summer. Marketing takes place from February to June of each year. The combined average mass has been determined for each month based on the forty born in 1995 and the twenty-three born in 1996 (Table 8.7).

Table 8.7. Monthly mass gains of two-year old to two and half year old steers on 'Stratherne' Dundee district over the second summer to time of marketing

Group	1 Sep	1 Oct	1 Nov	1 Dec	1 Jan	1 Feb	1 Mar	Mass gain
1995	317.8	341.0	379.1	402.6	427.9	454.7	468.4	150.5
1996	334.5	324.4	366.3	406.1	428.3	456.7	463.2	128.7
Ave	323.9	334.9	374.4	403.9	428.0	455.4	467.5	143.6

The rapid gain in mass over the summer allows the Bonsmara type steers to reach market readiness before winter. This is a good example of the benefit of the mass gains obtained from the nutritious grazing after burning. This contrasts with the 38% of Bonsmara steers that reached market readiness off the veld at 30 months (Meaker 1991).

8.2 Annual cattle livemass production on sourveld for period March to February for four consecutive years

Table 8.8. Livemass production off the 1 974 ha 'Stratherne' Dundee district

Financial year	Livemass production (kg)	kg ha^{-1}
01-03-1999 to 29-02-2000	103 847	52.6
01-03-2000 to 28-02-2001	98 712	50.0
01-03-2001 to 28-02-2002	111 602	56.5
01-03-2002 to 28-02-2003	103 464	52.4
4 Year average	104 406	51.2

Determination of livemass production off a farm will give an indication of the efficiency of the system. Systems based on the production and sale of weaners can produce up to 60 kg ha^{-1} (Danckwerts 2001b).

8.3 Stocking rate (Total mass)

Table 8.9. The total mass of beef cattle on 'Stratherne' Dundee district recorded on a quarterly basis

Date	Number	Total Mass	Average Mass	kg ha^{-1}
31 Aug 2000	796	276 252	355.08	139.95
30 Nov 2000	1047	325 057	310.47	164.67
28 Feb 2001	1003	342 782	341.76	173.65
31 May 2001	924	328 669	355.70	166.50
31 Aug 2001	858	296 242	345.27	150.07
30 Nov 2001	1118	334 398	299.10	169.40
28 Feb 2002	1039	351 458	338.27	178.04
31 May 2002	944	319 636	338.60	161.92
31 Aug 2002	923	289 709	313.88	146.76
30 Nov 2002	1202	319 670	265.95	161.94
28 Feb 2003	1109	358 245	323.03	181.48
Average		322 011		163.13

The average annual stocking rate was 163 kg ha^{-1}, with a summer average stocking rate of 172 kg ha^{-1} and a winter stocking rate of 153 kg ha^{-1}. The stocking rate should be adjusted during the season according to the fodder usage. In dry seasons, with lower veld production in the rested areas, cattle numbers should be reduced before winter, to avoid the risk of not having sufficient roughage. Gammon (1992) is of the opinion that the stocking rate affects animal performance more than does any other factor, and as the stocking rate increases, individual animal gains decrease linearly. The author found that the mass recording of all the animals on the farm every quarter, was time consuming and would not recommend a producer to do this. What would be more effective is to ear-tag about five percent of the animals, and record the masses of these each month. This would give a good indication if mass gains were unacceptable, and managerial actions could be taken to rectify the cause of poor performance.

8.4 Pregnancy diagnosis

Conception rate is probably the most important factor affecting profitability. Monitoring of the conception rates will give an indication to management of what corrective action should be taken.

Table 8.10. Conception rates on 'Stratherne' Dundee district over the season's 1996/1997 to 2002/2003

Year	Total cows and heifers in calf	Total cows and heifers bulled	Percentage in calf	Seasonal rainfall at 'Stratherne'
1996/1997	291	312	93.3	839 mm
1997/1998	309	344	89.8	960 mm
1998/1999	282	343	82.2	565 mm
1999/2000	234	317	73.8	1000 mm
2000/2001	335	377	88.9	781 mm
2001/2002	340	408	83.3	663 mm
2002/2003	239	421	56.8	676 mm
Average	290	360	80.6	

The amount and distribution of rain per season will influence the production of the veld. The total number of cows and heifers bulled should be reduced during seasons of lower rainfall. The effect of the lower rainfall in one breeding season often results in a lower conception rate the following season, unless there has been a sufficient reduction in the stocking rate. Lower conception rates were recorded the season after the two driest seasons (1998/1999 and 2001/2002). After the 1998/1999 season, the number of cows and heifers bulled the following season had been reduced. There were also good rains that season, so conception only decreased by nine percent. However, after the dry 2001/2002 season, the number of cows and heifers bulled was increased. This happened in another dry season, where certain monitoring did not take place, that would have resulted in earlier destocking. The result was very low conception rates, exacerbated as a result of the drought.

In most herds there is an 8% loss from conception to calving made up of 2% abortions, 2% do not calve although certified in calf, 2% stillbirths and 2% to cow deaths (Paterson 2001). It is recommended that the number of pregnant cows and heifers be recorded at the start of the calving season. This will give an accurate figure of the actual percentage of calves born, which can be compared to the percentage certified in calf.

8.5 Carcass grades of milk-tooth (unshed) and two-tooth steers at graded abattoirs

The management system applied on 'Stratherne' complies with the requirements to market natural beef or 'country reared' beef. The 'country reared' beef system is designed to supply consumers at selected stores with quality beef raised off grass, which commands a premium price. Animals to be supplied through the system must be registered with 'country reared' beef. A declaration must be made with each consignment of the breed of animals, that no animal by-products, growth stimulants, hormones or similar products have been used. There is no restriction on the use of urea (non-protein Nitrogen). Traceability is extremely important, and details such as the supplier are bar coded onto packages, so that inspections can be done to ensure compliance with the regulations.

The statistics obtained from the use of the suggested grazing strategy can be compared to statistics obtained using different production systems. Such comparisons would highlight any benefits derived from the use of a system. In the research on breeds of animals that can be finished off the veld it was found that only 38% of Bonsmara's could finish off the veld (Meaker 1991). In the system at 'Stratherne', with sufficient monitoring 97% of the Bonsmara's are finishing off the veld at two to two and a half years. Animals that have cut four teeth have been marketed at the auction in Dundee.

The grading results of all the consignments sent directly off the veld, without any additional supplementary feeding other than licks are included (Table 8.11). 'Country reared' beef requires suppliers to also supply at times when animals need limited feeding, such as in winter. Consignment results of these batches are not included, as the extra feed would distort the results.

Table 8.11 Carcass grades of unfed steers (classes A and AB) produced on 'Stratherne' Dundee district

Date	Abattoir	Class A2	Class AB1	Class AB2	Class AB3	Cold mass
24-05-2001	SANB [1]	3		19	2	218.77
29-01-2002	SANB	3		23		210.07
26-04-2002	SANB		1	23		225.16
24-02-2003	H Zaal [2]			12		215.62
27-02-2003	H Zaal		1	11		206.23
06-05-2003	Country [3]		1	29		211.39
Total		6	3	117	2	

SANB [1] South African Natural Beef Abattoir, Boksburg

H Zaal [2] Roadside Abattoir, Dannhauser

Country [3] 'Country reared' beef, Huntersvlei Abattoir, Viljoenskroon

8.6 Comments

The mass of the cattle at different stages has been included to give an idea of what level of production can be achieved with the suggested utilization strategy. With the author away from 'Stratherne' on a regular basis owing to commitments outside farming, there are times when the application of corrective actions was delayed. With the application of adaptive management and enthusiasm, similar and improved livestock performance should be easily achieved. The utilization system applied at 'Stratherne' has proved that animal performance on sourveld can match the performance on other veld types. The nutritious grazing in the summer months and light stocking in winter ensure satisfactory performance is achieved, and of importance is the fact that all the two and a half year old steers can reach finish off the veld.

CHAPTER 9

DISCUSSION AND CONCLUSIONS

The quest that led eventually to this research was undertaken out of economic necessity and an inkling that production of quality slaughter cattle off sourveld had been achieved by other farmers in the past, and could somehow be done again. The question to be answered was why the cattle were not finishing off the veld? They did not grade well, and amongst others the weaners took several weeks after winter to regain condition.

On consultation with the production division of Stock Owners Co-operative, I was told that the problem lay with the grass and its utilization. The problems identified were the type of grazing (hyparrhenia dominated with a little themeda), selective grazing, insufficient rested areas for the winter, lack of burning (seldom burnt or burnt late) and the late utilization of any burnt areas. This combination resulted in lower mass gains of livestock and the inability to reach market readiness until late in the veld growing season.

All the practical research has been done on a 1 974 ha farm 'Stratherne' in the Dundee district in Dry Highland Sourveld adjoining Southern Tall Grassveld. The original objectives were firstly to improve the veld composition and management and to research the effects of winter utilization on the grasses. Secondly, to improve animal performance and the ability to fatten steers on the veld. The research and the utilization system suggested is as a result of practically applying the research results and ideas of Theron, Zacharias, Kirkman and others on a farm scale. The theoretical underpinning is from the work of Acocks (1996), Zacharias (1994, 1995), Peddie (1994), Kirkman & Moore (1995) and Kirkman (2001).

The practice of having certain areas or farms only for summer, and other areas or farms only for winter, results in damage to the grass composition. The grass plant needs both periods of utilization and periods of resting. Exclusion of either will result in lowered production. The virtual elimination of *Themeda triandra* from grassland where fire and defoliation by livestock is removed for an extensive period is a case in point (Titshall *et al.*

2001). The programme for optimal utilization (Table 7.2) is repeated for the convenience of the reader as Table 9.1. The recommendations of Zacharias (1994, 1995) about nutritious grazing following burns, and Peddie (1994) on the mortality of *Themeda triandra*, if utilized for more than two years in succession, resulted in the changes to the utilization strategy as suggested in this study. Optimizing the utilization system was achieved by adjusting the utilization schedule and the introduction of a second full-season rest (Table 9.1). The extra resting meant that there was more conserved fodder for the winter. An extremely important change, especially in the drought conditions in the winter and spring season of 2003. A further change introduced was that no block has the same treatment in successive years, as the combination of early post-burn grazing and frequent use of fire could have severe consequences (Tainton 1999).

Table 9.1. Programme for optimal utilization of sourveld throughout the year repeated for the convenience of the reader (Table 7.2)

	Block 1	Block 2	Block 3	Block 4	Block 5
Year 1	REST[1]	NSG[2]	REST	NSG	RESERVE[3]
Year 2	NSG	REST	NSG	RESERVE	REST
Year 3	REST	NSG	RESERVE	REST	NSG
Year 4	NSG	RESERVE	REST	NSG	REST
Year 5	RESERVE	REST	NSG	REST	NSG

[1]REST. Rest for growing season, selectively graze in dormant period, burn in August.

[2]NSG. Non-selective grazing using quick rotation for the growing season.

[3]RESERVE. Reserve block. Aim for < 50 % utilization.

The key elements of the utilization strategy suggested (resting, winter utilization, burning of the rested veld, summer utilization, marketing and a reserve) can be summarised as follows;

Resting The proposed utilization strategy recommends that 40% of the total area is given a full growing season rest every year, providing opportunity for the grasses to recover from utilization in two out of every five years. Any system that does not rest at least 40% of the total area, will have insufficient roughage for the animals over the winter. The area rested is rotated, so that the same area never has two full rests in successive years. The strategy, however, sees the 'rest' and 'reserve' status follow the non-selective grazing (NSG) periods to minimise the impact of the higher density of stocking under NSG.

Winter utilization In the utilization of veld during winter, livestock producers should ensure that it is only lightly stocked. Grazing animals can then select their diet, and so reduce the amount of winter mass loss. All material left after utilization should be burnt, so as to provide nutritious grazing the following summer (Zacharias 1994). In winter, animals on the veld require supplementation with non-protein nitrogen licks.

Burning of the rested veld It must be accepted that burning large tracts of land is dangerous at any time. Provided extra caution is taken, and burning is started on a calm day, dry burns can be efficiently undertaken. Starting of back-fires on fire breaks is recommended in these circumstances. No burning should take place in windy conditions, or when a fire warning has been given.

Burning should be done in August while the grass is still dormant if possible, as late burning causes damage to *Themeda triandra* (Everson *et al.* 1985). The aim of the burning is to provide nutritious grazing (Zacharias 1994, 1995) from vegetation that has been rested in preparation for the burn and the grazing that follows under this system.

Summer utilization Summer utilization needs to start as early as is possible, in order to exploit the rapid growth of quality forage. Utilization at this time is based on larger herds that graze the herbage non-selectively. Sourveld is species rich, with grasses which vary in palatability. Early utilization of burnt grass at the start of spring, enables the animals to consume all species, and particularly unpalatable species at a early stage. Full use should be made of the 'nutrient wave' (Danckwerts 2001a), by making the maximum use of the nutritious grazing. This is the ability of animals grazing burnt grass early to gain mass rapidly. The seasonal production of veld varies with rainfall, and it is therefore important to have a flexible stocking strategy, to optimise returns. A reserve must be built into the system. This approach differs from a rotational stocking system, with its emphasis on the movement of animals. Only a flexible grazing strategy can cope with the variation in veld production from season to season. Utilization of the grasses during the growing season never exceeds two years in succession, so as not to excessively deplete the reserves of the desirable species such as *Themeda triandra*. Veld that is only utilized in winter, will lose desirable species such as *Themeda triandra* that will be shaded out and dominated by taller grass species such as *Hyparrhenia hirta* and *H. dregeana*. Beef cattle on sourveld require a salt-phosphate lick provided *ad lib* during the summer.

Marketing The growing season is the critical time, to allow grazing animals to maximise mass gains, and improve in condition. There are generally shortages of classes A2, A3, AB2 and AB3 (Appendix A) beef cattle early in the marketing season, when demand outstrips supply. Price premiums are obtained by producers able to market at this time. Providing high quality forage as early as possible will allow producers to exploit this niche market.

Reserve A reserve must be built into the system. This reserve is to cater for the variability of rain early in the growing season, as well as dry periods later during the season. Only 50% of the block where controlled selective grazing takes place should be utilized to provide for the reserve veld required each season. The rested area acting as an emergency reserve. If, however, it becomes used routinely this will be an indication that the number of stock on the property is too high and a permanent reduction is warranted. The expectation, therefore, is that the reserve camp provides a barometer to guide managers in determining the position of their stocking rate in relation to both economic and ecological carrying capacity.

Results Changes in the utilization strategy on 'Stratherne' appear to have resulted in changes in species composition and veld condition. However, at the outset there were insufficient transects from which to draw a definitive conclusion. In addition, there has not been a marked change in composition in the two south facing transects (Cele and Hill). Despite the relatively sparse data, it is clear that the general trend has been for sites to move from a hyparrhenia species dominated state to one associated with species such as themeda. This 'result' concurs with the findings of Zacharias (1994) where he concluded that veld moved to a more productive (in terms of forage production) state in response to an increase in defoliation following resting under the management system proposed here (Chapter 7).

The recommended utilization system relies on the resting of veld, and its utilization in the winter. It was necessary to determine what the effect of the winter grazing on total production and species composition of veld would be. This was researched over three seasons (Chapter 4). The average production difference between winter rested and winter utilized veld was less than one percent, so it was concluded that the winter grazing of the rested veld did not affect the subsequent production in the three seasons of this study on 'Stratherne'. It can be concluded that the species composition was also not affected by the winter utilization, as only one species (*Sporobolus africanus*), of the nine most frequently occurring species tested, had a significant P value in the t-test. The research supports the hypothesis that winter utilization of rested veld does not influence the production or species composition of that veld at 'Stratherne' in the Dundee area.

Livestock production The rates of growth of the cattle tested during the summer have been higher than the other research reported. The ability of animals to reach market readiness as two-year old to two and half year old steers (97%) is far superior to the 38% of the other quoted research using Bonsmara type steers (Meaker 1991). The mass losses over winter for each group were similar to the other research quoted (<10%).

At 'Stratherne', the average weaning mass at an age of approx. 6.25 months was 204 kg. During the first winter calves lost typically four percent of their livemass, ending up with an average of 196 kg at the beginning of September. Summer growth added a further 147 kg, bringing the average mass prior to the second winter of approx. 345 kg. A further mass loss of approx. ten percent over winter, resulted in an average mass of approx. 323 kg at the start of summer. This average mass increased until the time of marketing, which was from December to June for the different groups (420 to 470 kg).

Monitoring Any medium to long term project on the utilization of veld should start off with the establishment of transects so that the the initial composition can be recorded. It creates an extra interest in the project, and makes the researcher realise that the success ultimately depends on the vigour and quality of the veld herbage. Monitoring of the transects every four years will give the trends in species composition over the medium term. This information will be valuable so that timely interventions can take place if required. Monitoring of animal performance is important to ensure adjustments can be made timeously to livestock numbers. The encroachment of shrubs and trees should be monitored.

Application of adaptive management The principles of adaptive management will build a data base to ensure long-term success. Stuart-Hill (1989) described the system of adaptive management which accepts that there must be monitoring, constant learning and adaptations. Recording of the environmental conditions that occur and management actions taken, assists to build up a data base to be used in future decisions.

Drought strategies Under severe drought conditions (frequency of one in twenty years), utilization strategies may need to change. Animal numbers should be reduced in the herds to allow animals to stay for longer periods in the different camps. If the drought persists, it may also be necessary to spread the remaining animals over the entire area that is being utilized.

The farm 'Stratherne' has had two years of below average (82% and 84% of MAP) rainfall, followed by the driest spring in 72 years in 2003 (Günther 2003). This has resulted in the utilization system being severely tested, as the rested blocks had been burnt in August and September. All the animals on the farm were separated into small groups, and placed into all the camps on the farm. A decision was taken on 15 October 2003, to supplement the lick for cows with small calves, to ensure that the cows did not loose condition, and give calves the maximum opportunity for growth. A hominy chop and molasses mixture (1 kg AU^{-1} day^{-1}) has been given to only this group. The first spring rain in excess of 10mm (11mm) fell on 29 October 2003, which has been followed up by a further 33 mm during the week. A rapid response in forage production is expected. As a consequence, the supplementation is to stop as soon as growth occurs on the burns, in approx. 14 days after the rain. This is in contrast to several other properties in the district, where a lack of fodder reserves has resulted in movement of livestock to other areas.

General This system for utilization of sourveld hinges on three interlocked principles; resting, early burning and non-selective grazing. These principles in correct sequence are essential. The factor of flexibility lies in their application according to variable conditions, particularly the influence on the veld of varied rainfall and specific climatic and seasonal changes. The system is, after all, subject to the climate variations common in large parts of Africa. The fundamental shift in emphasis underpinning this strategy is that it concentrates on resting. Specifically this is applied as a rotational resting strategy. The focus, therefore, is on the requirements of the plants and not on the animals which was the emphasis in all previous grazing plans.

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APPENDIX A

Classification of Red Meat in South Africa

Organisation South African Meat Industry Company (SAMIC)
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Beef, lamb, sheep and goat meat are classified according to age, fatness, conformation, damage and sex. The age and fatness classifications being the most important, with information on conformation, damage and sex also stamped on the carcass. Information on the sex of the animal is only stamped on bull and ram carcasses in the AB, B and C age groups (table A.1).

Table A.1 Classification of red meat in South Africa

Age	Class	Fatness	Class	Conformation	Class	Damage	Class
0 teeth	A	No fat	0	Very flat	1	Slight	1
1-2 teeth	AB	Very lean	1	Flat	2	Moderate	2
3-6 teeth	B	Lean	2	Medium	3	Severe	3
7-8 teeth	C	Medium	3	Round	4		
		Fat	4	Very round	5		
		Overfat	5				
		Excess. overfat	6				

Information supplied by SAMIC (2001)