# The profitability and production of a beef herd on transitional *Cymbopogon – Themeda* veld receiving three different levels of lick supplementation

**By**

**Liesel Ann Foster**

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**Promoter: Prof P.J. Fourie (D.Tech)**
**Co-promoter: Prof F.W.C. Neser (Ph.D)**

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# DECLARATION OF INDEPENDENT WORK

I hereby declare that this thesis submitted for the degree of DOCTOR TECHNOLOGIAE: AGRICULTURE is my original work and has not been submitted by me in respect of a degree to any other institution, and the views expressed are my own.

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# SUMMARY

## The profitability and production of a beef herd on transitional *Cymbopogon – Themeda* veld receiving three different levels of lick supplementation

A study was conducted over a three year period with 250 Drakensberger cows to identify a supplementation regimen that would bring about the most profit when offered to cows grazing transitional *Cymbopogon-Themeda* veld. Four production groups were identified namely: Young Heifers (YH) (wean to 22 months old); Heifers (H) (22 to 34 month old); First-calf-heifers (1CH); and Cows (C). Each production group was then randomly divided into one of three supplementation treatment groups. The supplementation treatments offered differed in crude protein (CP) content, percentage non-degradable protein (NDP), metabolisable energy (ME) content, and recommended daily intake. The level of supplementation was similar to the levels commonly recommended by animal nutritionists and typical of levels used under practical farming conditions. Treatment 1 of the YH (YH1) and the 1CH (1CH1) consisted of a winter production supplement and a summer production supplement. Treatment 2 of the YH (YH2) and the 1CH (1CH2) consisted of a cotton-oil-cake and urea based protein and mineral supplement in winter and a mineral supplement containing 15% CP in summer. Treatment 3 of the YH (YH3) and 1CH (1CH3) consisted of a urea based protein and mineral supplement in winter and a mineral supplement in summer. Treatment 1, Treatment 2 and Treatment 3 of the H (H1, H2 and H3) consisted of the same urea based protein and mineral supplement in winter and a mineral supplement in summer. Treatment 1 of the C (C1) consisted of a cotton-oil-cake and urea based protein and mineral supplement in winter and a mineral supplement containing 15% CP in summer. Treatment 2 of the C (C2) consisted of a urea and cotton-oil-cake based protein and mineral supplement in winter and a mineral supplement in summer. Treatment 3 of the C (C3) consisted of a urea based protein and mineral supplement in winter and a mineral supplement in summer. Significant differences ($P < 0.05$) in body weights and body condition scores (BCS) were measured between the YH treatment groups. All three YH treatment groups were, however, able to reach target breeding weight (60 to 65% of mature body weight) eight months prior to the breeding season. The cost incurred (R145/animal/year) in developing the YH3 treatment group



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was much lower than that of the YH1 treatment group (R466/animal/year) and the YH2 treatment group (R228/animal/year). No significant differences were measured in weight gain between the H supplementation treatment groups, however, in Year 2 the H2 had a lower final BCS (5.55 ± 0.52) than the H1 treatment group (6.11 ± 0.33) and the H3 treatment group (5.90 ± 0.57) and in Year 3 the H1 treatment group had a significantly ($P$ < 0.05) heavier final body weight (513 kg ± 41) than the H2 treatment group (497 kg ± 24) and the H3 treatment group (478 kg ± 33). Significant ($P$ < 0.05) differences in body weight and BCS were measured between the 1CH treatment groups in Year 2 and Year 3 however mean weaning weight between the 1CH treatment groups did not differ significantly ($P$ < 0.05). When looking at profitability, the production attained by the 1CH treatment group (mean weaning weight 227 kg, conception rate 87%) and the 1CH2 treatment group (mean weaning weight 222 kg, conception rate 97%) compared to that of the 1CH3 treatment group (mean weaning weight 218 kg, conception rate 89%) could not compensate for the higher supplementation costs of the 1CH1 (R1033/animal/year) and the 1CH2 (R466/animal/year) compared to the 1CH3 treatment group (R265/animal/year). Despite the fact that significant ($P$ < 0.05) differences in body weights and BCS were measured between the C supplementation treatment groups no significant differences were measured in the production attained (C1: mean weaning weight 224 kg, calving rate (CR) 91%, inter calving period (ICP) 387 days; C2: mean weaning weight 219 kg, CR 90%, ICP 378 days; C3: mean weaning weight 216 kg, CR 94%, ICP 387 days). The higher supplementation cost of the C1 treatment group (R540/animal/year) and the C2 treatment group (R395/animal/year) made the supplementation regimen of the C3 treatment group (R322/animal/year) the most profitable. The conclusion made is that the provision of a urea based protein and mineral supplement in winter and a mineral supplement in summer to an entire cow-calf production system grazing transitional *Cymbopogon - Themeda* veld which is in good condition realizes the most profit as it enables the animals to operate within their optimum weight range.



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# LIST OF ABBREVIATIONS

| | |
|---|---|
| 1CH1 | First-calf-heifer Supplementation Treatment 1 |
| 1CH2 | First-calf-heifer Supplementation Treatment 2 |
| 1CH3 | First-calf-heifer Supplementation Treatment 3 |
| AU | animal unit |
| C1 | Cow Supplementation Treatment 1 |
| C2 | Cow Supplementation Treatment 2 |
| C3 | Cow Supplementation Treatment 3 |
| CP | crude protein |
| °C | degrees Celsius |
| CR | conception rate |
| DE | digestible energy |
| DM | dry matter |
| Ha | hectare |
| H1 | Heifer Supplementation Treatment 1 |
| H2 | Heifer Supplementation Treatment 1 |
| H3 | Heifer Supplementation Treatment 1 |
| LSU | Large Stock Unit |
| ME | metabolizable energy |
| MJ | mega joules |
| mm | millimeters |
| N | nitrogen |
| NaCl | Salt |
| NPN | non-protein-nitrogen |



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| | |
|---|---|
| P | phosphorus |
| ICP | inter calving period |
| YH1 | Young Heifer Supplementation Treatment 1 |
| YH2 | Young Heifer Supplementation Treatment 2 |
| YH3 | Young Heifer Supplementation Treatment 3 |



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# CHAPTER 1

# GENERAL INTRODUCTION

Barely a day goes by without reference being made of the disadvantageous financial position of the South African farmer. Tougher economic conditions usually kindle a greater awareness in belt tightening and becoming more efficient, whether it be in the household or farm expenses (Lamb & Maddock, 2009).

Farmers are continually looking for means to increase production and profitability of their extensive livestock enterprises, often focusing on production measures and means to increase production, as production is the profit equation component directly affecting income from the enterprise. Farmers also need to focus on cost management, another factor in the profit equation. Ultimately, the primary focus should be the profitability of the cow-calf enterprise (Ramsey *et al.*, 2005). Lishman *et al.* (1984) indicated that it is by and large believed that reproduction rates in sheep and cattle reflect the level of management to which animals are exposed. The prime component of this management is believed to be the operating feeding conditions.

Approximately 65% of South Africa's grasslands are classified as arid to semi-arid as they receive less than 500 mm of rain per annum (Snyman, 1998; Smit, 1999). In these drier areas, grassland is frequently subjected to seasonal droughts, high ambient temperatures, and low soil fertility causing the greater part of the so-called beef-producing areas in the country to have a marginal agricultural potential (Meaker, 1984; Van Niekerk, 1996). This has resulted in a beef industry that is heavily dependent on natural pasture (veld) and therefore the most practical method of production in these areas is the extensive grazing of beef cattle.

A large variation in dry matter (DM) yield of this natural pasture, primarily due to differences in annual rainfall as well as its distribution, occurs at any specific site between years and is often reflected in animal performance. The grazing ruminant therefore exists in an extremely dynamic state where performance in terms of growth, milk and wool production, is determined not only

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by changes in nutrient requirements, but also by the physical environment as well as quantity and quality of available pasture (Reid & Jung, 1982). An important additional constraint on animal production from these pastures remains an insufficient intake of digestible nutrients (Hacker, 1982; Hodgson, 1982; Read *et al.*, 1986b; De Waal, 1990 and Van Niekerk, 1996) and may be compounded by deficiencies of specific nutrients, like salt (Louw, 1979), phosphorus (Read *et al.***,** 1986b; De Waal *et al.*, 1996 and Van Niekerk, 1996) and protein (Read *et al.***,** 1986b; Van Niekerk, 1996).

Livestock farming under these circumstances often necessitates the use of supplementary feeding as it may increase nutrient intake of the grazing ruminant and correct deficiencies in pastures (De Waal, 1990). Many reports have been published on the marked effect of supplementary feeding on animal reproduction and growth under extensive grazing conditions in certain areas and as a result supplementary feeding has become a general practice in the South African livestock farming industry (Lishman *et al.*, 1984; Read *et al.*, 1986a; Read *et al.*, 1986b; De Brouwer *et al.*, 1993; De Waal *et al.*, 1996; Van Niekerk, 1996 and De Brouwer *et al.*, 2000). The provision of feed to animals is, however, a major cost input in almost any animal production system (Herd *et al.*, 2003; Van der Westhuizen *et al*., 2004 and Lamb & Maddock, 2009). This has long been recognized by the pig and poultry industries, in which one can easily put a value to the cost of feed. Roughly 55 to 75% of the total costs related to beef cattle production are feed costs (Arthur *et al*., 2001 and Basarab *et al.*, 2002). Although the cost of providing feed to extensive grazing cattle is more complex to quantify, it still remains a major input (Herd *et al*., 2003).

The basic aim of supplementary feeding should be to supplement the nutrients that have been identified to limit production under any specific set of circumstances and to supplement only that nutrient. The limiting nutrient in any particular area is largely influenced by season, while the quantative requirements for the limiting nutrient will depend on the kind and productive state of the animals involved (Van Niekerk, 1996). Although it might be theoretically possible to have a perfectly balanced diet for animals, this ideal is seldom realized in practice. If this is the case under carefully controlled intensive farming conditions, then the problem is, for obvious reasons, greatly magnified where animals are kept on natural pasture (Van Niekerk, 1996). De Waal



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(1990) describes animal response to supplementation at best as unpredictable and far less than might be expected from feeding standards.
Supplementary feeding of ruminants is largely based on the direct extrapolation of principles established by means of conventional, stall-based feed intake and digestibility trials (De Waal, 1990). Likewise, results concerning the reaction of grazing ruminants to supplementary feeding in one area cannot summarily be re-assigned to another area where different environmental conditions prevail.

Earlier studies concerning the nutritive value of veld in South Africa were based on chemical analysis of hand-cut herbage samples (De Waal, 1990). In a survey done by Du Toit *et al.* (1940) data was collected for use in the mapping out South Africa into areas according to the phosphorus and protein content of the pasture. The methods adopted included the analysis of (a) the soil from the selected areas, (b) grasses growing on that soil, and (c) blood of cattle grazing on that pasture. However, in a review by Holecheck *et al.* (1982) on the methods for determining the nutritive quality of range ruminant diets, it was concluded that the collection of samples from fistulated animals gave the most accurate representation of the animals diet and showed that grazing animals consistently selected forage higher in quality than compared to hand-cut samples. The actual feed consumed, therefore, had a higher nutritive value than was previously believed, and upon which many of the supplementation guides are based (De Brouwer *et al.* 1993).

Supplementation has been shown to increase nutrient intake of grazing beef cattle, as well as correct deficiencies of pastures for animal production. However, the general outcome of supplementation is unpredictable (Winks & Laing, 1972; Van Niekerk & Jacobs, 1985; Read *et al.*, 1986a; Read *et al.*, 1986b; De Waal, 1990; De Waal *et al.*,1996; Van Niekerk, 1996 and De Brouwer *et al.*, 2000). Therefore the nutritive value of veld and, moreover, its ability to support animal production, as well as the role of supplementary feeding in promoting animal production, should be studied under realistic and practical grazing conditions (De Waal, 1990). Needless to say, any input regarding supplementation should be positively reflected in animal performance and the increase in output must be economically justifiable. Many erroneous conclusions based on analytical data regarding the need for supplementary feeding have been made in the past and



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continue to be made at present (Van Niekerk, 1996). Supplementary feeding recommendations should, where ever possible, be based on results of statistically sound, controlled supplementary feeding experiments conducted with the relevant animal species on veld grazing.

The main objective of this study is to make a contribution to the South African beef cattle industry by identifying a supplementation regimen that would increase the economic returns of the extensive cow/calf production systems of the south-eastern Free State.

The specific objectives of the study are to:

i) Identify a cost effective supplementation regimen to develop replacement heifers from weaning to two years of age without adversely affecting heifer growth performance;

ii) Identify a cost effective supplementation regimen to offer to two year old heifers without adversely affecting their reproductive performance;

iii) Identify a cost effective supplementation regimen to offer to first-calf-heifers without adversely affecting their reproduction performance and profitability;

iv) Identify a cost effective supplementation regimen to offer to a cows that would bring about the highest economic return by not adversely affecting the production and reproduction performance of the cow herd;

v) To do a questionnaire-based survey amongst commercial beef cattle farmers in the Zastron district to provide data of their farming systems so that recommendations can be made so they can improve the profitability of their extensive beef cow/calf production systems.



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# CHAPTER 2

# RANGELAND DESCRIPTION AND MANAGEMENT

## 2.1 INTRODUCTION

Rangeland management involves optimizing both short-term and long-term forage production and quality. In the short-term, forage production and quality is strongly influenced, *inter alia* by temporal climatic variability (rainfall and temperature), stocking rate, grazing system, fire, animal type and spatial variability. On the other hand, long-term optimization requires prevention of rangeland deterioration (Dankwerts & Tainton, 1996).

The main livestock management decisions made by commercial cattle farmers are concerned with livestock type, animal numbers, and the seasonal pattern of movement. The pattern of movement of livestock is determined by the grazing system in operation. Vegetation management for sustainable animal production is concerned with decisions on resting, fire regime, and the interaction between fire and grazing (O'Connor *et al.,* 2010). The expected impact of grazing management variables rest strongly upon season, while grazing effects are expected to be dependent on body size, stocking rate and interaction with fire.

Profitable livestock production from forage depends largely on the quantity and quality of the pasture produced; the animal's capabilities to harvest and utilize that forage efficiently and on the livestock producer's ability to manage the recourses at his disposal. The greater the control the livestock producer exercises over forage production and consumption, matching animal requirement to seasonal forage production cycles, the better the likelihood that the operation will be profitable (Forbes, 1988). However, producers often manage livestock in order to achieve production objectives and not to maintain biodiversity (O'Connor *et al.*, 2010) and sustainable animal production.



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## 2.2 RANGELAND DESCRIPTION AND MANAGEMENT

### 2.2.1 Vegetation type

There has been a recently inconsistent description by researchers of the vegetation type in which the study site is located. According to Acocks (1988), the study site contains variations of the *Themeda-Cymbopogon* veld type located on sandy soils, while Mostert *et al.* (1971) described it as the *Themeda-Cymbopogon* sourveld of the south-eastern Free State, and Bredenkamp *et al.* (1996) described it as part of the Moist Cold Highveld Grassland biome. Most recently the area has been classified as the *Elionurus* sour grassland of the south-eastern Free State (Van der Westhuizen, 2003 and Van der Westhuizen 2014a).

### 2.2.2 Veld condition

There are many techniques that can be used to determine rangeland condition or the health of the vegetation. Certain techniques are however reserved for specific vegetation types. Veld condition assessment is a widely employed and simple technique (Hardy *et al.*, 1999) which involves the comparison of vegetation between a site and that of a benchmark within the same veld type or relative homogeneous plant community. After determining the botanical composition, in most techniques each grass species is then scored whether it decreases or increases with under-, over-, or selective utilization. These techniques are subjective since they are only based on the ecological aspects of plant species. The rangeland condition assessment technique of Van der Westhuizen *et al.* (2013) that was used in this study is of the few techniques that are fully objective. It is based on real degradation gradients where, regardless of plant ecological aspects, agronomical values (both production and nutrient value) are also allocated to individual plant species.

The rangeland condition was determined on two sites representing two different terrain morphological units, namely: the crest and the foot slope of the escarpment (Van der Westhuizen *et al.*, 2013; Table 2.1). The species composition of the herbaceous layer was determined based on the frequency of occurrence, using the wheel point apparatus (Tidmarsh & Havenga, 1955). The nearest plant to the wheel point was recorded and 200 observations were recorded per site. Rangeland condition was objectively determined, along a degradation gradient, using indicator and dominant species curves (Van der Westhuizen, 2003 and Van der Westhuizen *et al.*, 2005).



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The rangeland condition for the footslope and crest as determined by the technique of Van der Westhuizen *et al.* (2005) is presented in Table 2.1.

The rangeland was classified as being in an excellent condition (> 80%; Table 2.1). On the basis of topographical and soil variation of the rangeland, differences in the species composition of the midslope of hills could be distinguished. *Cymbopogon pospischilii* (Turpentine Grass) was the dominant grass species on these areas, while the relative prevalence of *Elionurus muticus* (Wire Grass), *Themeda triandra* (Red Grass), *Hyparrhenia hirta* (Common Thatching Grass) and *Aristida diffusa* (Iron Grass) was also high. Trees such as *Olea europaea* subsp. *Africana* (Wild Olive) and Celtis africana (Witstinkhout), and shrubs like *Searsia erosa* (Besembos), *S. undulate* (Taaibos), *S. dentate* (Nanabessie), *S. pyroides* (Gewone Taaibos), *Diospyros lycioides* (Bloubos), *D. austro-africana* (Jakkalsbos) were encountered, while a few individuals of *Rhamnus prinoides* (Blinkblaar) and *Pittosporum viridiflorum* (Kasuur) also occurred. In certain areas Karoo encroachment was obvious, especially at the foot of hills and on heavy clay soils where species such as *Euryops empetrifolius* (Harpuisbos), *Pentzia globosa* (Vaalkaroo), *Chrysocoma ciliate* (Bitterbos), *Lycium* spp. and *Felicia filifolius* (Bloudraaibos) occurred. No plant surveys were done on this terrain type but the rangeland condition was subjectively determined by experienced researchers as in an excellent condition (Van der Westhuizen *et al*., 2013).

On the crests, the proportional occurrence of the increaser *Seriphum plumosum* was however relatively high (12.7%). *Seriphium plumosum* (Slangbos/vaalbos/bankrupt bush) encroachment can convert extensive areas of grassland into less productive shrubland-grassland and is playing a major role in the threat to sustainable agriculture especially for this vegetation type. The effective control of *S. plumosum* must therefore be one of the long term objectives in this area (Snyman, 2010, 2011, 2012a, 2012b).

On the foot slopes the proportional species composition was dominated by *E. muticus* which was indicative of the onset of selective grazing (Van der Westhuizen *et al.*, 2013). With degradation due to selective grazing, the unpalatable *E. muticus* will increases at the expense of species such as *C. pospischilii* and *T. triandra*. *Cymbopogon pospischilii* is still the dominant species of a rangeland in good condition for the studied area, but species such as *Eragrostis chloromelas*



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(Narrow Curly Leaf), *Heteropogon contortus* (Spear Grass), *Digitaria eriantha* (Common Finger Grass), *Brachiaria serrata* (Velvet Signal Grass), *Eragrostis capensis* (Heart-seed Love Grass) and *Andropogon appendiculatus* (Vlei Bluestem) increase at the expense of *C. pospischilii*, *T. triandra*, *E. muticus*, *Harpochloa falx* (Caterpillar Grass), *Helictotrichon turgidulum* (Small Oats Grass) and *Eragrostis lehmanniana* (Lehmann's Love Grass). Unpalatable species such as *Aristida congesta* (Tassel Three-awn), *A. diffusa* (Iron Grass), *Microchloa caffra* (Pincushion Grass), *Triraphis andropogonoides* (Broom Needle Grass) and *Eragrostis gummiflua* (Gum Grass) also increase in this condition class, as well as palatable pioneer species such as *Setaria pallide-fusca* (Garden Bristle Grass), *Cytisus hirsutus* (Hairy Broom) and *Eragrostis nindensis* (Wether Love Grass). Shrubs such as *Walafrida saxatilis* (Witaarbos) and *Helichrysum dregeanum* (Bergankerkaroo) as well as annual herbs can also increase, while few individuals of *Felicia muricata* (Bloublommetjie) and *Cyperus* species can also occur in this condition class. The species composition of the studied site is presented in Table 2.1.



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**Table 2.1** Proportional species composition (%) and rangeland condition (%) of the study site. I = ecological index values (negative rangeland condition indicating selective grazing) (Van der Westhuizen *et al*., 2013).

| **Site** | | **Footslope** | **Crest** |
|---|---|---|---|
| Species | I | | |
| *Cymbopogon pospischilii* | 10 | 10.6 | 23.5 |
| *Helictotrichon turgidulum* | | 1.9 | 0.0 |
| *Sporobolus fimbriatus* | | 1.9 | 2.0 |
| Sub total | | 14.4 | 25.5 |
| *Harpochloa falx* | 9 | 9.6 | 10.8 |
| *Themeda triandra* | | 3.8 | 6.9 |
| Sub total | | 13.4 | 17.7 |
| *Triraphis andropogonoides* | 8 | 1.0 | 0.0 |
| Sub total | | 1.0 | 0.0 |
| *Aristida diffusa* | 7 | 4.8 | 0.0 |
| *Heteropogon contortus* | | 5.8 | 0.0 |
| *Walafrida saxatilis* | | 0.0 | 1.0 |
| Sub total | | 10.6 | 1.0 |
| *Brachiaria serrata* | 6 | 6.7 | 1.0 |
| *Elionurus muticus* | | 23.1 | 20.3 |
| *Microchloa caffra* | | 0.0 | 1.0 |
| Sub total | | 29.8 | 22.3 |
| *Digitaria eriantha* | 5 | 1.9 | 0.0 |
| *Helichrysum dregeanum* | | 1.9 | 0.0 |
| Annual herbs | | 1.0 | 1.0 |
| Sub total | | 4.8 | 1.0 |
| *Eragrostis plana* | 4 | 5.8 | 0.0 |
| *Setaria pallide-fusca* | 3 | 7.7 | 2.0 |
| *Eragrostis gummiflua* | 2 | 4.8 | 0.0 |
| *Eragrostis chloromelas* | 0 | 2.9 | 6.9 |
| Other species | | | |
| *Helichrysum lucilioides* | | 2.9 | 7.8 |
| *Seriphium plumosum* | | 1.0 | 12.7 |
| *Tragus koelerioides* | | 1.0 | 0.0 |
| *Tristachya leucothrix* | | 0.0 | 2.9 |
| Sub total | | 100 | 100 |
| Rangeland condition | | -88 | 87 |



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### 2.2.3 Grazing capacity

According to Meissner (1996) the term grazing capacity (carrying capacity) has different meanings for different people and this is one of the reasons why veld management programmes have not always been successful. Dankwerts (1989) defined grazing capacity as the area of land required to maintain an animal unit in order to achieve maximum profit in the short-term, while maintaining the condition of the vegetation and soil in such a way as to be able to fulfill the needs and aspirations of future land users. Meissner (1996) defines grazing capacity simplistically as the dynamic equilibrium between forage supply and ungulate requirements (herbivory). Both elements have characteristics which adjust the input-output relationship or have influencing or associative factors that do not contribute directly to the equilibrium. Forage supply is determined by forage production which is a function of climate, soil, water, fire and vegetation composition. Ungulate herbivory is a function of nutrient and energy requirements, and of food preference and availability. Ungulate herbivory is, however, tailored by ungulate density which is only partially explained by food requirements. These factors modify the simplistically defined equilibrium resulting more often in lower grazing capacities than anticipated, but rarely also higher grazing capacities (e.g. ungulates grazing new growth on burnt areas) (Meissner, 1996).

Various attempts have been made to find a scientifically based method to estimate grazing capacity in southern Africa (Tainton *et al*., 1980; Du Toit *et al*., 1981; Danckwerts, 1982; Vorster, 1982; Kruger, 1983 and Fourie *et al*., 1985). Long-term grazing capacity trials give good results but are time-consuming and expensive and have to be repeated under different soil conditions. Researchers agree that rangeland condition forms the best basis for determining grazing capacity (Kruger, 1983; De Waal, 1990; Van der Westhuizen, 1994 and Van der Westhuizen *et al.*, 1999). In southern Africa the main approach in determining rangeland condition is ecological (Van der Westhuizen, 1994), while less attention is given to the agronomical values (productivity, forage value and perenniality) (Van der Westhuizen *et al*., 1999). According to Snyman (1998) the contributions of Van der Westhuizen (1994) and Du Toit *et al.* (1995) to this knowledge of arid and semi-arid areas of southern Africa deserves mentioning. These were the first studies where agronomical values on the basis of both production and forage values were allocated to individual plant species.



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Currently a correlation between rangeland condition (ecological) and grazing capacity (utilizable dry matter production) determined by Van der Westhuizen (2003) is used for this vegetation type. In this correlation the preference utilization ratio for forage species was determined by using a microhistological technique to determine the botanical composition of diet samples selected by oesophageal fistulated sheep and cattle. To determine grazing capacity the utilizable dry matter production along a degradation gradient was determined by linking dry matter production with the percentage preference utilization ratio of each species (Van der Westhuizen, 2003 and Van der Westhuizen & Snyman, 2011).

The grazing capacity of the study site (see Table 2.2) determined by Van der Westhuizen *et al.* (2013) varied mainly due to differences in topography as well the availability of soil moisture which is dependent on differences in soil type and soil depth. The dominant soil form on the crest on the northern side of the study site (landtype Ca 104) was Estcourt which has an effective depth of 300-750 mm. Grazing capacity as determined from rangeland condition was calculated at 5 ha/LSU for that area. The dominant soil form at the footslope of the southern part of the study site (landtype Db 194) was Sterkspruit which has an effective depth of 200-400 mm. Grazing capacity as determined from rangeland condition was calculated at 5 to 6 ha/LSU for this area. Rock dominated the midslope of the hills in the center as well as the eastern side of the study site (landtype Fb 449) and grazing capacity was calculated at 7 ha/LSU for that area.

**Table 2.2** Grazing capacity of the study site according to topography and soil moisture availability

| | Crest – northern side of study site | Footslope – southern side of study site | Midslope of hills and eastern side of study site |
|---|---|---|---|
| Landtype | Ca 104 | Db 194 | Fb 449 |
| Dominant soil form | Estcourt | Sterkspruit | - |
| Effective depth | 300-750 mm | 200-400 mm | - |
| Grazing capacity | 5 ha/LSU | 5 to 6 ha/LSU | 7 ha/LSU |



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### 2.2.4 Conversion of animal numbers into Large Stock Units (LSU)

Sustainable use of rangeland for livestock production depends on the knowledge of fodder requirements (for a specified level of production) of each class and type of animal using the fodder resource (Hardy, 1996). In South Africa the detailed tables of Meissner *et al.* (1983) or the rough, but practical conversion: mass$^{0.75}$ developed by Mentis (1981) is used to estimate fodder requirements for animals of the same species but of different weight, or for different animal species. Both these methods are based on intake of metabolizible energy (MJ ME kg$^{-1}$ DM) while the conversion tables of Meissner *et al.* (1983) also consider species, maturity type, and physiological and reproductive state of each animal.

A LSU was defined by Meissner *et al.* (1983) as the equivalent of a growing ox with a weight of 450 kg which gains 500 g per day in weight on grass pasture with a mean digestible energy (DE) concentration of 55%. The energy requirement of such an animal is ± 75 MJ ME/day. This implies that any other class, type or species of animal may be equated to a LSU by calculating their expected intake of ME (Hardy, 1996).

Many veld ecologists are of the opinion that the animal unit (AU) concept (commonly referred to as a LSU in southern Africa) has not achieved what it was intended for and should therefore be replaced by something else. The AU was developed as a norm to estimate grazing capacity in an effort to synchronize the requirements or intake of the animals with the supply of fodder from the veld to the mutual benefit of both (Meissner, 1996). De Waal (1990) and Meissner (1996) state that one reason for the failure of the AU concept to effectively simulate grazing capacity, is the rigid application and recommendations by officials without considering veld condition, rainfall, animal species involved, management procedures and objectives. Meissner (1996) concludes that the AU concept remains a useful point of reference and that it is a unit with which the farmer can associate with.

The average number of LSU grazing the study site for the duration of the study was calculated as 495 using the conversion tables composed by Meissner (1983).



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### 2.2.5 Stocking rate

Stocking rate can be defined as the area of land in the system of management which the manager has allocated to each animal unit in the system, and is expressed per length of the grazeable period of the year (hectares/large stock unit). Selecting the correct stocking rate is the most important of all grazing management decisions and is based on sustainable use of vegetation, livestock production, and economic return (Kirkman & Moore, 1995 and Van der Westhuizen *et al.*, 2005). It is therefore important to apply stocking rates based on estimated grazing capacity, which will allow for the sustainable utilization of the grassland ecosystem as stocking rate is the most important factor influencing rangeland condition, available grazing material, sensitivity to drought periods, animal performance and gross income (Snyman, 1998).

The average number of LSU grazing the study site (3 559 ha) during the course of the study was 495 which equates to a stocking rate of 7.2 ha/LSU. The stocking rate did not exceed the grazing capacity of the study area which ensured the sustainability of the grazing ecosystem and prevented rangeland degradation.

### 2.2.6 Veld management systems in South Africa

Veld management is the process whereby graziers examine the probable consequences of different management actions, and select those which, in their opinion, have the highest chance of attaining their objectives (Dankwerts & Tainton, 1996). Much has been written, recommended and published on aspects of rangeland management in southern Africa.

According to Snyman (2014) and Snyman (2015), each of the rangeland management strategies that have been advocated since 1925 have been successfully implemented somewhere in South Africa – being it correct or incorrect. Unfortunately there is no rangeland management system that is best suited to all regions. Although researches are of the opinion that rotational grazing has a diminished detrimental effect on grazing than continuous grazing, they acknowledge that management and/or stocking rate plays an even greater role in rangeland degradation than the management system itself. An excellent rangeland management system is not a guarantee against vegetation degradation (Snyman, 2012a and Snyman, 2015). Overgrazing for long periods, continuous grazing, too long grazing periods, repeated grazing during the same time of



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the year, livestock breeds or game that are not adapted to the veld type and the long-term and injudicious provision of licks and supplementary feeding are the most important harmful rangeland management practices. The implementation of a correct rangeland management approach, based on correct scientific principles, is the only method whereby sustainable animal production can be guaranteed for the future (De Waal, 1990; O'Connor *et al*., 2010; Snyman, 2014 and Snyman, 2015).

Many researchers have recently showed renewed interest in the periodic full growing season rests approach which enables preferred plants to regain vigour after a season or seasons of defoliation and thus provide for sustainable production of preferred feed, as well as maintenance or improvement of rangeland condition (Dankwerts & Teague, 1989; Kirkman, 1995, Peddie, 1995; Van Pletzen *et al.*, 1995; Moore, 2014; Van der Westhuizen, 2014b; Snyman, 2015). Provision is also being made for satisfactory animal performance and improved fodder flow (on an economic basis). The recommendations are also based on easily understood principles which are non-capital intensive and easy to implement (Kirkman & Moore, 1995).

Another advantage of a season-long recovery period is that it ensures that grasses are rested during all the key pulses of N mineralization over the growing season, whereas these pulses can be missed by shorter intra-seasonal recovery periods, reducing or nullifying the efficacy of the recovery period. Finally, a season-long recovery period will probably aid maximum seed production for establishment of new tufts. This season-long grazing and resting is anticipated to have two likely influences: 1) increase grass production during the year of grazing, and 2) prevent grassland growing out and losing quality (facilitation of grazing) (Fynn, 2012). The combination of these two factors will facilitate maximum nutrient and energy flow to livestock, thereby increasing the productivity of the farm (Kirkman & Moore, 1995).

The "full growing season rest" approach of Dankwerts & Teague (1989); Kirkman (1995); Kirkman & Moore (1995); Peddie (1995); Van Pletzen *et al.* (1995); Zacharias (1995); Moore (2014); Snyman (2014) and Van der Westhuizen (2014b) and as well as the three-camp-*Elionurus*-cattle grazing system developed by Van der Westhuizen (2014b) was used in developing a grazing system for the study site, which was first implemented in 2011 (Table 2.3).



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Camps were divided into three blocks of similar size and grazing capacity. Long controlled rest periods were the basis of this grazing system in which a third of the farm was rested from the beginning of spring until the first frost occurred. The blocks which were being grazed were managed in a manner flexible enough to take advantage of seasonal fluctuations in production, and in a manner that facilitated good animal performance. Certain camps (indicator camps) within a block that was being grazed were well grazed in the growing season while other camps within the block were only grazed when necessary. Animals were returned to indicator camps as soon as they were ready for grazing again. In this way, quality was maintained in the indicator camps by keeping them short and leafy.

Some camps in a grazing block may only be grazed at a low frequency in years of good rainfall, resulting in more than the recommended area being rested. In years of poor rainfall, if all feed in the grazing block has been used, it may be necessary to move stock into a block designated for resting, resulting in a smaller area being rested than recommended. This serves as a timely warning that there will be a shortage of winter feed, and decisions regarding stock numbers or alternative feeding strategies can be taken timeously. If the stocking rate is correct, the correct amount of rangeland will be rested in the long-term.

**Table 2.3** Three-camp-*Elionurus*-cattle grazing system (Van der Westhuizen, 2014b)

| Grazing year | Sep. | Oct. Nov. Dec | Jan. Feb. Mar. Apr | May | Jun. Jul. Aug. |
|---|---|---|---|---|---|
| 1 | A | B | C | B | A |
| 2 | B | C | A | C | B |
| 3 | C | A | B | A | C |

In the first grazing year camps in grazing block A were rested for a full growing season (October to May) to ensure that preferred plants regained vigour after a season of defoliation. The camps were subsequently grazed the following winter (June, July and August). Camps in grazing block B were grazed in the early summer (October to December) and rested in the late summer and camps in grazing block C were rested in the early summer and subsequently grazed in late summer (January to April).



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# CHAPTER 3

# SUPPLEMENTATION OF EXTENSIVE BEEF COW/CALF PRODUCTION SYSTEMS – A REVIEW

## 3.1 INTRODUCTION

Livestock farming on veld has two major limitations, namely veld production (quantity) and a variation in quality (nutritive value) (Van Niekerk & Jacobs, 1985; De Brouwer *et al.*, 1993; Van Niekerk, 1996; Van Pletzen, 2009). This problem is often exacerbated by erratic and highly seasonal rainfall, with long-term droughts being experienced on a recurring basis. Livestock farming under these circumstances often necessitates the use of supplementary feeds.

The basic aim of supplementary feeding should be to identify the nutrient which is limiting production under any specific set of circumstances and only to supplement that nutrient. The limiting nutrient in any particular area is largely influenced by season, while the quantative requirements for the limiting nutrient will depend on the kind and productive state of the animals involved. Feeding more than the first limiting nutrient is often precluded by economic realities (Van Niekerk, 1996).

De Waal (1990) and Van Niekerk (1996) conclude by stating that many erroneous conclusions based on analytical data, regarding the need for supplementary feeding have been made in the past and continue to be made at present. Supplementary feeding recommendations should, where possible, be studied under realistic and practical grazing conditions with the relevant animal species. Needless to say, any input regarding supplementation must be positively reflected in animal performance and the increase in output must be economically justifiable (De Waal, 1990; Van Niekerk, 1996).



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## 3.2 PHOSPHORUS SUPPLEMENTATION

Parent material low in phosphorus is the source of many of the world's soils (Cohen, 1980). These soils support early maturing, grass-dominant pastures, that have a lengthy period of senescence and a short summer growth period. Such pastures are common in Africa, America and Australia. Du Toit *et al.* (1940) did an extensive study of the mineral content of the natural pastures located in South Africa and found that the P content of the grazing in many areas of South Africa was insufficient to support productive cattle. As a result the supplementation of phosphorus has become general practice in South Africa.

Fortunately South Africa has a long history of research into phosphorus (P) supplementary feeding, dating back to the legendary work done by Theiler, Green and Du Toit in 1927. Many reports have been published since on phosphorus (P) supplementation in South Africa (Van Niekerk & Jacobs, 1985; Groenewald, 1986; Read *et al.*, 1986a; Read *et al.*, 1986b; De Waal, 1990; De Brouwer *et al.*, 1993; De Waal *et al.*, 1996; Van Niekerk, 1996; De Brouwer *et al.*, 2000). However, it is important to note that responses to P supplementation vary substantially from one area to the next, indicating that some areas are clearly P deficient and other areas are evidently not and in turn has prompted further studies (De Brouwer *et al.*, 2000).

### 3.2.1 Responses to P supplementation

The pioneering work of Sir Arnold Theiler in the 1920's, and more recently by Read *et al.* (1986a), has identified P as a major limiting nutrient of beef cattle at Armoedsvlakte, in the North West province of South Africa. The consequences of a P deficiency were once again characterized by Groenewald (1986) and Read *et al.* (1986a). Possibly the most serious effect of the deficiency was a depression of feed intake, especially during late lactation and early pregnancy, resulting in stunted growth, high mortality rates and a very poor reproductive performance. Cattle not receiving supplementary P weighed 121 kg less compared to cows receiving supplementary P and their reproductive performance was also severely impaired. In addition, the calves of the dams not receiving supplementary P averaged 9.8% lighter at birth (34.0 *vs.* 37.7 kg) and were 21.6 % lighter at weaning (181,8 *vs.* 231.8 kg) (Read *et al.*, 1986a).



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Results by De Waal *et al.*, (1996) at Armoedsvlakte suggest that P reserves may only be depleted to a certain limit, after which reproduction is impaired. Over four calving seasons, the reproductive performance of cows receiving even the lowest level of supplementary P, was slightly better than that of cows receiving no P supplement. The reproductive performance improved with increasing levels of supplementary P. However, within individual calving seasons, the average birth and weaning weight of the calves differed little between treatments, suggesting that in times of nutrient deficiencies, the cow sacrificed her own body tissues to shield the calf from such deficiencies. Nevertheless it is suggested that there is a limit to which the body reserves of the dam can be utilized before having an effect on milk yield and the calf (De Waal *et al.*, 1996). According to De Waal *et al.* (1996) the best financial return on investment in P supplementation to reproducing beef cows at Armoedsvlakte was gained by providing a supplement which provided 16 g P day $^{-1}$ during late gestation to late lactation (September to February) and 9 g P day $^{-1}$ during the remainder of the year. The supplementation of P only during the 'reproduction' period (September – February) was insufficient for the general well-being of the cows as cows receiving a P supplement for only six months of the year had an average body weight of 472 ± 9.39 kg, compared to the average of 505 ± 9.05 kg observed for the cows which were supplemented all year round.

The research that Read *et al.* (1986a) did at Armoedsvlakte on P supplementation was done concurrently with research on P supplementation at Glen, which is situated in the central Free State province of South Africa and which was suspected to have P-deficient pastures. The acuteness of the P deficiency differed vastly between the two sites. At Glen, no advantage was realized in any aspect of animal performance of supplemented *vs.* unsupplemented cattle, which was indicative of pastures sufficient in P. Rib-bone samples that were taken also ruled out a sub-clinical P deficiency at Glen. The only advantage of P supplementation at Glen was maintenance of higher bone mineral reserves during late lactation, especially in young heifers (Read *et al.*, 1986b). According to Van Niekerk (1996) possible reasons for the lack of response to supplementary P feeding at Glen could have been the use of well-conserved veld and light stocking rates (7.3 ha/LSU) by Read *et al.* (1986a). Van Niekerk (1996) questions the extent to which the results by Read *et al.* (1986a) could be replicated under conditions of over-grazing, which are often applied in practice.



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Research was also done on P supplementation on *Cymbopogon-Themeda* veld near Potchefstroom in the North West province of South Africa by De Brouwer *et al.* (2000). Cows received three different levels of P supplementation (8 g P/cow/day, 4 g P/cow/day and 0 g P/cow/day) in the summer and in winter a maintenance supplement containing protein, energy and minerals. Cows receiving no P supplementation in summer had a lower ($P < 0.01$) autumn condition score and a lower ($P < 0.01$) body weight than cows receiving a P supplementation in summer (De Brouwer *et al.*, 2000). The results were similar to those of Read *et al.* (1986a) at Glen in that different levels of P supplementation during the summer did not influence reproductive performance. The results could possibly be ascribed to a maternal buffering effect, as the dam may have mobilized skeletal P from reserves in order to maintain milk production. However, contrary to the results at Glen, when bone P levels were examined, it was evident, that despite annual winter replenishment of P reserves, cows unsupplemented with P in summer were not able to avoid a deficiency developing when relying on summer veld to replenish P reserves. It was concluded that reproducing cows in the Potchefstroom area should be supplemented with 8.3-9.1 g P/cow/day throughout the year and that P-supplementation during the winter, should be accompanied by protein supplementation. Research has also shown that where phosphorus is given as the only dry season supplement, it may accelerate the rate of live mass loss (Winks & Laing, 1972; Louw, 1979; Van Niekerk & Jacobs, 1985).

De Brouwer *et al.* (1993) also attempted to determine whether a rumen-stimulating lick, containing approximately 26% crude protein was economically and biologically feasible when compared to a P-lick on *Cymbopogon-Themeda* veld in summer (January – April). The results indicated that cows reacted positively to the provision of a rumen-stimulating-lick compared to a P-lick in terms of weight gain ($P < 0.05$) and condition score ($P < 0.05$). However, the positive effects experienced by receiving a rumen-stimulating-lick did not have an effect on the conception rate. Cows receiving the rumen-stimulating-lick weaned slightly heavier ($P < 0.05$) calves, however, the difference in weaning weight was not sufficient to make the practice economically justifiable (De Brouwer *et al.*, 1993). The conclusion by De Brouwer *et al.* (1993) was that on well-managed *Cypbopogon-Themeda* veld, where sufficient roughage of a good quality was available during the summer, the supplementation of breeding beef cows with a P-lick gave comparable results to a rumen-stimulating lick at much reduced costs. The cows



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receiving the rumen-stimulating-lick would have to perform considerably better than cows receiving the P-lick due to the high intake of the rumen-stimulating lick as compared to the P-lick to cover expenses, which was not found in the trial. On the other hand results by McCosker *et al.* (1991) indicated that wet season supplementation with non-protein nitrogen/protein and minerals had the potential to substantially increase herd productivity in the monsoonal tallgrass region of Australia.

## 3.3 PROTEIN SUPPLEMENTATION

While diet quality is important, production by the grazing ruminant is more dependent on the total intake of digestible nutrients (Hodgson & Rodriguez, 1971). The quantity of the herbage ingested by grazing ruminants depends on the availability of suitable herbage, the physical and chemical composition of the veld and the nutrient requirements as well as the ability of the animals to ingest the herbage (Minson, 1982).

There is however a general consensus amongst animal nutritionists that a protein deficiency is by far the most important cause of winter weight loss in cattle maintained on low-quality (winter) veld as protein supplementation had a marked stimulating effect on forage intake and greatly reduced the rate of weight loss (Louw, 1979; Hennessy, 1983; Van Niekerk & Jacobs, 1985; De Waal, 1986; Groenewald, 1986; Krysl & Hess, 1993 and Van Niekerk, 1996). The poor digestibility of winter veld has often been implicated as a major cause of the decrease in forage intake. Results by De Waal (1986) using the artificial fibre-bag technique, showed that the rate at which herbage was fermented in the rumen of grazing ewes during winter was considerably slower than in summer. This extension in the retention time within the reticulo-rumen appeared to be caused by seasonal changes in the composition of structural carbohydrates of the herbage (i.e. cellulose, hemicelluloses and lignin) which were relatively resistant to microbial breakdown. Thus the initial step in any supplementation programme should be to increase the efficiency of microbial fermentation in the rumen by supplying sources of readily fermentable nitrogen or combinations of fermentable nitrogen and carbohydrate (Cronje, 1990).

The provision of supplementary N to animals on a diet of poor quality roughage improves microbial activity, increases the rate of fermentation and the rate of passage of ingesta through



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the digestive tract and thereby enhances voluntary intake of herbage and the energy status of the grazing animal. The enhanced voluntary intake of herbage during autumn and onwards was confirmed by measurements of an increased faecal output in groups receiving urea supplementation (Winks & Laing, 1972). Gilchrist & Schwartz (1972) report an increase in the daily intake of sheep of up to 40% when a nitrogen limitation in the rumen was removed.

### 3.3.1 Responses to protein supplementation

Protein supplementation of roughage-fed ruminants has been found to decrease live weight loss considerably, however, the best improvement that can be expected is the prevention of live weight loss, or at best a slight gain in live weight (Reyneke, 1971; Winks & Laing, 1972; Hennessy, 1983; Van Niekerk & Jacobs, 1985; Groenewald, 1986; McCosker *et al*., 1991; De Brouwer *et al.*, 1993 and Van Niekerk, 1996).

### 3.3.2 Urea as protein source

It has long been acknowledged that urea, and other non-protein nitrogenous compounds, can replace a portion of dietary protein for ruminants. When urea is fed to ruminants it is rapidly hydrolysed to ammonia and carbon dioxide by the action of microbial urease in the reticulo-rumen. The ammonia-N is subsequently released in combination with alpha-keto acids to synthesize amino acids, which are then converted to microbial protein and then digested by enzyme action further down the digestive tract (Tillman, 1967).

The cost of protein supplements in feeds is high in South Africa, so supplementation is only beneficial if there are improvements in terms of production and reproductive rates (Webb *et al.*, 2010). With this in mind, it is of vital importance to evaluate alternative and inexpensive protein sources such as urea which will relieve greater quantities of the conventional protein sources for use in monogastric diets (Kargaard & Van Niekerk, 1977). ). Urea is frequently used as a ‘cheap’ source of N to supplement the diet of livestock on poor quality roughage and there is no doubt that urea has an important role to play in this regard, particularly as oilcake meals become more costly (Reyneke, 1971; Winks & Laing, 1972; Kargaard & Van Niekerk, 1977; Grant, 1979; Cronje, 1990; Brand & Van der Merwe, 1993; Webb *et al.*, 2010).



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## 3.4 ENERGY SUPPLEMENTATION

It is important for the farmer to ensure that the primary protein deficiency is first alleviated before any attempt is made to supply further nutrients (Van Niekerk, 1996). Because protein supplements stimulate pasture intake, thereby tending to reduce the secondary energy deficiency, it may not be necessary to give further supplements. However, droughts and/or overgrazing cause a lack of roughage and under these circumstances, energy intake is the main limiting nutrient, followed by protein (Cronje, 1990; De Waal, 1990; Van Niekerk, 1996). Under such circumstances, it is necessary to feed additional sources of energy if animal growth and reproduction are to be optimized. This is evident from the work of Reyneke (1971), Meaker (1976) and Meaker *et al.*, (1979).

Contrary to expectation, Lishman *et al.* (1984) found that the energy supplementation (2.8 kg maize meal) of first-calf cows from the time of parturition until the end of the breeding period did not consistently improve either maintenance of body weight or reconception and thus the practice of providing an energy concentrate during early lactation was not recommended. The findings of Van Niekerk & Jacobs (1985) that energy supplementation had a relatively minor influence on roughage intake and in preventing mass loss is in agreement with results published by Lishman *et al.*, (1984). Less favorable results with energy supplementation were also obtained by Reyneke (1976). In researching the supplementation of energy and/or protein to steers grazing summer veld Reyneke (1976) found that the greatest response to strategic supplementation in respect of average daily weigh gains was obtained with 1.36 kg of high protein concentrate and the poorest response was with 1.36 kg of maize meal.

The lack of response or even negative reaction that energy supplements have when given as the only supplement on protein deficient forage can be attributed to the fact that such supplements cause a proliferation of fast growing sugar or starch digesting micro-organisms which deprive the slower growing cellulolytic organisms of what little nitrogen is available in the rumen. The net effect is a lowering of digestibility, rate of passage, and voluntary intake of roughage (Gilchrist & Schwartz, 1972).



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## 3.5 SALT SUPPLEMENTATION

Severe doubts about the possible ill effects of excessive levels of dietary salt (NaCl) have been raised by De Waal *et al.*, (1989a), De Waal *et al.*, (1989b) and De Waal (1994). Excessive salt intake did not only tend to counteract the positive effects of protein, energy and mineral supplements but it was also shown to have a more prolonged harmful effect on animal production, even after excessive levels of salt ingestion had ceased (De Waal, 1994). The excessive quantities of salt water dosed by De Waal to the postulated animals were, however, way beyond levels which free range animals would consume voluntarily (Groenewald, 2015).

Despite a high intake of salt observed by Spangenberg *et al.* (1997) or De Brouwer *et al.* (2000) none of the toxicity symptoms described by De Waal (1994) were observed. De Brouwer *et al.* (2000) found that cattle receiving 0g P/cow/day in summer on *Cymbopogon-Themeda* veld in the western Highveld region of South Africa consumed large quantities of salt of up to 250 g/cow/day without any negative effects on production.

Van Niekerk (1996) suggests that the ability of salt to limit feed intake was likely due to post-ingestive effects rather than to its palatability.

## 3.6 GENERAL SUPPLEMENTATION PRINCIPLES OF EXTENSIVE BEEF COW/CALF PRODUCTION SYSTEMS

In areas where big differences in the nutritional value of summer and winter veld occur and where moderate to acute deficiencies in phosphorus develop Cronje (1990); Van Pletzen (2009); Ferreira (2015) and KK Animal Nutrition (2015) recommend a three-phase supplementation programme for a cow-calf production system to ensure that the cow herd’s condition and nutritional status is adequate during critical stages of the production year. The three-phase supplementation programme is also meant to ensure high weaning percentages and acceptable weaning weights for any particular region.



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The three-phase supplementation programme of Cronje (1990), Van Pletzen (2009), Ferreira (2015) and KK Animal Nutrition (2015) entails the following :

- A wet season or summer supplementation period: Starts after good rain when there is abundant green veld which is high in protein, highly digestible and palatable. Phosphate and trace elements are the most limited nutrients on green natural veld. Phosphate is essential to maximise reproduction and growth.
- Early dry season or winter supplementation period: This period starts in autumn when temperatures start dropping and frost sets in. Protein is the most important limiting nutrient in the early dry season/winter. Protein supplementation is important to maintain body mass and –condition during the dry season by increasing roughage intake and digestibility.
- Late dry season supplementation period: Veld is characterized by a low protein and energy content. Cows start calving in this period and to maintain the condition of lactating cows and to ensure good conception rates protein and energy is supplemented in this period.



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# CHAPTER 4

# A SURVEY OF SUPPLEMENTATION AND MANAGEMENT PRACTICES OF COMMERCIAL BEEF FARMERS IN THE ZASTRON DISTRICT

## 4.1 INTRODUCTION

There is probably no other agricultural sector where there is such a broad diversity of opinions and perspectives as in the beef industry in South Africa. These differences are often on the subject of breed, production systems, breeding, supplementation, management, marketing and all sorts of other sentimentality (Mentz, 2002).

Reproductive performance is the single most important economic trait in a beef cow herd (Melton, 1995; Walker & Perry, 2007; Du Plessis *et al.*, 2006). As most components of fertility that influence calving and subsequent reproductive performance are not highly heritable, it is logical to assume that the majority of factors related to reproductive performance in cattle are influenced entirely by management (Patterson, 2002). The prime component of this management is believed to be the operating feeding conditions as body condition score at parturition has been implicated as the single most important factor affecting postpartum interval to estrus and pregnancy (Lishman *et al.*, 1984; Paisley & Chichester, 2005; Walker & Perry, 2007).

Livestock farming under extensive conditions often necessitates the use of supplementary feeding as it may increase nutrient intake of the grazing ruminant and correct deficiencies in pastures (De Waal, 1990). Many reports have been published on the marked effect of supplementary feeding on animal reproduction and growth under extensive grazing conditions in certain areas and as a result supplementary feeding has become a general practice in the South African livestock farming industry (Lishman *et al.*, 1984; Read *et al.*, 1986a; Read *et al.*, 1986b; De Brouwer *et al.*, 1993; De Waal *et al.*, 1996; Van Niekerk, 1996 and De Brouwer *et al.*, 2000. The provision of feed to animals is however a major cost input in almost any animal production system (Herd *et al.*, 2003; Lamb & Maddock, 2009). The aim of this survey was to establish the



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level of supplementation by commercial beef cattle farmers in the Zastron district and to use the results to formulate the supplementation regimens that are to be used in the study.

## 4.2 MATERIALS AND METHODS

Forty-eight *bona fide* commercial farmers from the Zastron district were selected for this study out of a prospective of 60 farmers. Respondents were also members of Free State Agriculture. The interviews were conducted at the farmer's house by the author with the assistance of two aides. The survey collected personal information about the farmer, the cattle production system in operation as well as general supplementation practices related to the cattle production system.

The study area is undulating, varying between 1460 m and 1790 m above sea level. The mean annual precipitation varies between 524 mm in the northern lower lying areas and 685 mm in the higher lying south-eastern parts. Precipitation occurs mainly in summer (65%) with March being the month in which the majority of the precipitation (15%) occurs.

## 4.3 STATISTICAL METHODS

The data were analysed using SAS Version 9.2. Descriptive statistics namely frequencies and percentages were calculated for categorical data.

## 4.4 RESULTS AND DISCUSSION

The average age of the farmers was 52 years ± 12 (n = 48) of which 15 (31.1%) had a secondary education, one (2.1%) had a tertiary certificate, 15 (31.3%) had a tertiary diploma, 14 (29.2%) had a tertiary degree and three (6.3%) had a tertiary masters qualification. The average farm size was 2 769 ha ± 2 425 and the median 2 000 ha. The Bonsmara (31.3%, $n$ = 15), Drakensberger (18.8%, $n$ = 9) and Simbra (18.8%, $n$ = 9) were the most prominent breeds.

Preventative vaccination was common practice as only one farmer did not vaccinate any of his cattle ($n$ = 48). The most prevalent diseases against which farmers vaccinated were Black Quarter ($n$ = 40, 85%), Anthrax ($n$ = 38, 80.9%) and Lumpy Skin ($n$ = 30, 63.9%). A concerning trend was that only 22 (46.8%) of the farmers vaccinated their heifers against Brucellosis. Brucellosis is an important disease as it is zoonotic and a controlled disease which means that



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suspected cases must be reported to the government veterinary services as there are specific control schemes for this disease (Olivier, 2013). External parasitic control was done by 45 (93.8%) respondents and internal parasitic control by 35 (72.9%) respondents.

The custom of commercial farmers (not stud breeders) breeding their own breeding bulls was commonplace ($n$ = 15, 31.3%) with only 28 farmers (58.3%) testing bulls for fertility and 30 farmers (62.3%) testing for venereal diseases. Farmers breeding their own bulls was in alignment with the findings of Ramsey *et al.* (2005) who found that investment in breeding livestock significantly increased per-unit costs but also increased production, however breeding-stock investment did not significantly affect cow-herd profitability.

The farmers reported the following calving percentage ranges (Figure 4.1): one farmer (2.1%) between 50 and 59%, three (6.3%) farmers between 60 and 69%, 19 farmers (39.6%) between 70 and 79%, 22 (45.8%) farmers between 80 and 89% and three (6.3%) farmers between 90 and 99%. The accuracy of calving percentages reported are however questioned as only 38 (79.2%) farmers had a set breeding season, 34 (70.8%) farmers had pregnancy tests done and 28 (58.3%) farmers had an identification system (tags) for individual animals. Length of the breeding season is an indicator of management skills and intensity and longer breeding seasons have been found to increase cost and decrease production (Ramsey *et al.*, 2005).

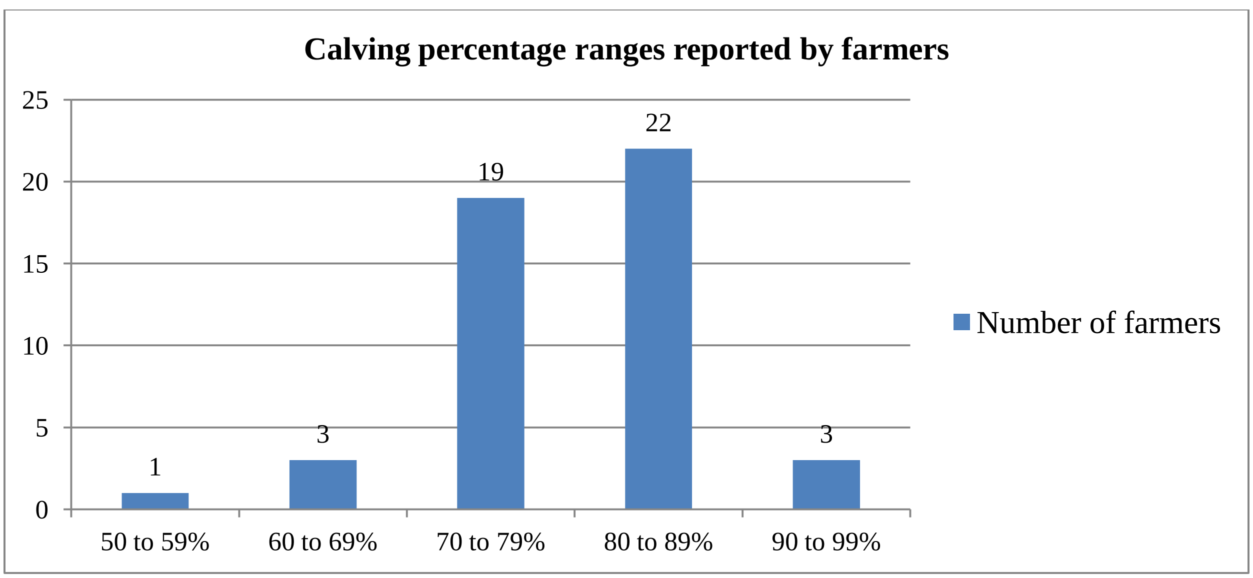


**Figure 4.1** Calving percentage ranges of the cows reported by the farmers



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The provision of supplements seemed to be general practice (100%, *n* = 48) in the district as all the farmers gave some form of supplementation to their cattle. Only 11 (22.9%) of the farmers provided supplements according to the production status of the animals and the main reason for not doing so is that 14 (37.8%) of the respondents believed that it complicated management and seven (18.9%) thought it not necessary. Supplementation should be done according to the season (Cronje, 1990; Van Pletzen, 2009; Ferreira, 2015; Taute, 2015) and 44 (91.7%) farmers put this advice into practice.

Groenewald (1986); De Brouwer *et al.* (1993), De Waal *et al.* (1996), Van Niekerk (1996), De Brouwer *et al.* (2000), Van Pletzen (2009), Taute (2013) and Ferreira (2015) recommend that phosphate (P) supplements be used during the summer (wet season) as phosphate is the main limiting nutrient on green summer grazing. However, three (6.3%) of the respondents supplied no supplements at all in summer to any of their cattle (Figure 4.2). Of the 45 (93.7%) farmers who did supply supplements in summer five (11.1%) supplied insufficient P due to poorly formulated supplements (*n* = 4) or only offered rock salt (*n* = 1).

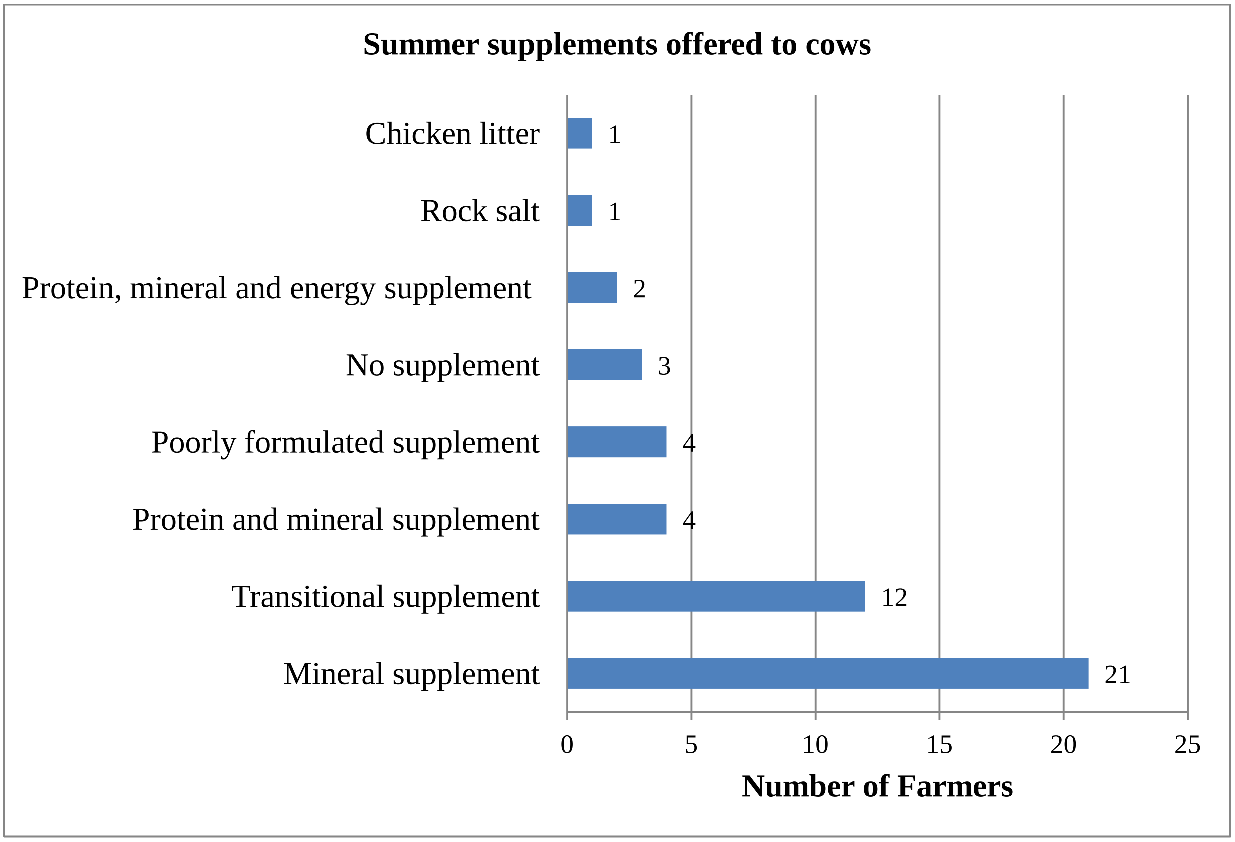


**Figure 4.2** Supplements offered by the farmers to their cows in summer



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Cows were offered the following supplements in summer by the respondents (Figure 4.2): namely, 21 (43.8%) farmers offered a mineral supplement, 12 (25%) farmers offered a transitional supplement, four (8.3%) farmers offered a protein and mineral supplement, four (8.3%) farmers offered a poorly formulated supplement, three (6.3%) farmers offered no supplement, two farmers (4.2%) offered a protein, mineral and energy supplement, one (2.1%) farmer offered rock salt and one (2.1%) farmer offered chicken litter. Summer supplements were offered on an *ad libitum* basis by 38 (84.4%) farmers.

Cows were offered the following supplements in winter by the respondents (Figure 4.3): namely, 39 (81.3%) offered a protein and mineral supplement, four (8.3%) offered chicken litter, three (6.3%) offered a protein supplement and two (4.2%) farmers offered a poorly formulated supplement that could not be categorized (Figure 4.3). More than half of the farmers ($n$ = 26, 54.2%) offered supplements on an *add libitum* basis to their cows in winter. However, 10 (20.8%) respondents offered less than 400g supplement per animal per day.

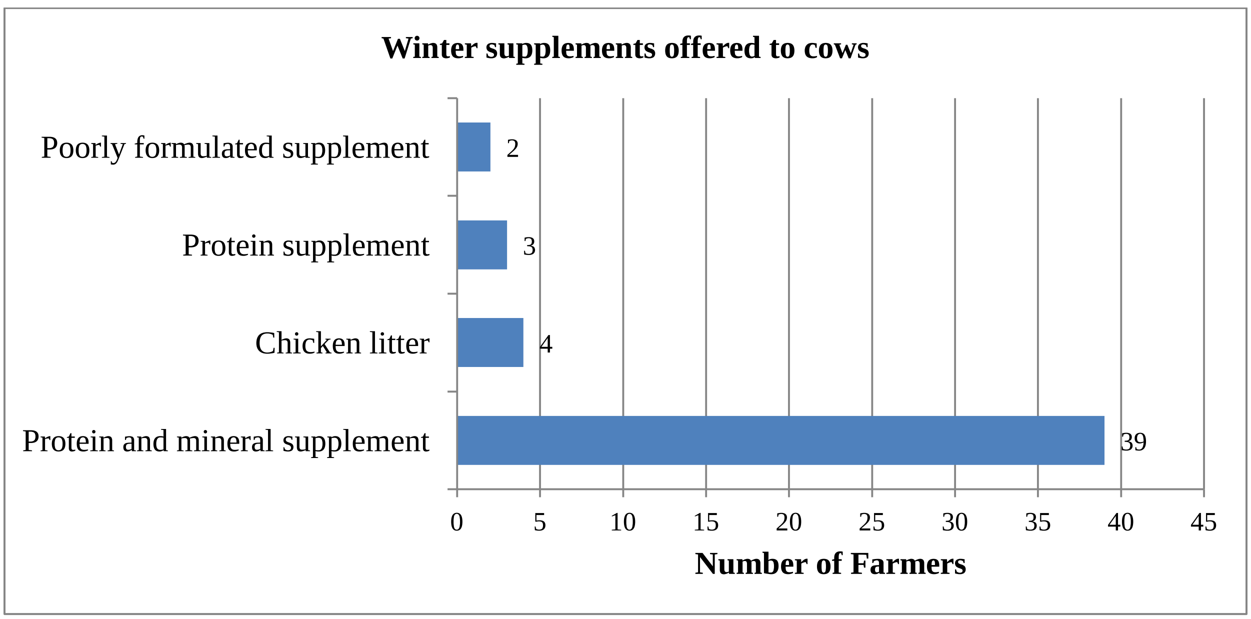


**Figure 4.3** Supplements offered by the farmers to their cows in winter

Table 4.1 summarizes the winter supplements offered to the cows and the calving percentages ranges reported by farmers and Table 4.2 the summer supplements offered and the calving percentages reported.



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**Table 4.1** Winter supplements offered and calving percentage ranges reported by farmers.

| **Supplements offered in winter** | **Calving percentage ranges reported** | | | | |
|---|---|---|---|---|---|
| | 50 to 59 | 60 to 69 | 70 to 79 | 80 to 89 | 90 to 99 |
| Protein and mineral supplement (n = 39) | 1 | 3 | 16 | 16 | 3 |
| Chicken litter (n = 4) | | | 2 | 2 | |
| Protein supplement (n = 3) | | | 1 | 2 | |
| Poorly formulated supplement (n = 5) | | | | 2 | |

**Table 4.2** Summer supplements offered and calving percentage ranges reported by farmers.

| **Supplements offered in summer** | **Calving percentage ranges reported** | | | | |
|---|---|---|---|---|---|
| | 50 to 59 | 60 to 69 | 70 to 79 | 80 to 89 | 90 to 99 |
| Mineral supplement (n = 21) | 1 | 1 | 12 | 6 | 1 |
| Transitional supplement (n = 12) | | | 3 | 8 | 1 |
| Protein and mineral supplement (n = 4) | | | 1 | 2 | 1 |
| Poorly formulated supplement (n = 4) | | | 2 | 2 | |
| No supplement (n = 3) | | 2 | 1 | | |
| Protein, mineral and energy supplement (n = 2) | | | | 2 | |
| Rock salt (n = 1) | | | | 1 | |
| Chicken litter (n = 1) | | | | 1 | |

It is generally accepted that beef heifers conceive at a high rate during their first breeding season provided they have grown sufficiently. However, when breeding takes place while they are suckling their first calf pregnancy rate is often low, especially if heifers are bred to calf as 2-year-olds (Lishman *et al*., 1984). The nutritional requirements for growth of the young cow in addition to those for lactation are not usually met by the natural grazing available (Lishman *et al*., 1984) and the provision of supplements thus plays a vital role in their reproductive performance. The survey indicated that only six (12.5%) farmers bred their heifers at a young age (12 to 18 months). The decision of what summer supplement to offer these heifers as first-calf-heifers thus plays a vital role as nutritional stress could affect their fall-out rate, longevity



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and mature cow size (Endecott *et al.*, 2013). According to the survey, farmers breeding heifers to calve as 2-year-olds offered the following supplements to their first-calf heifers in summer, namely four (66.7%) farmers offered a mineral supplement, one (16.7%) farmer offered a poorly formulated supplement and one (16.7%) farmer offered a protein, mineral and energy supplement. The farmer who offered a poorly formulated supplement reported a calving percentage ranging between 50 to 59%, the four farmers offering a mineral supplement a calving percentage of 70 to 79% and the farmer who offered a protein, mineral and energy supplement a calving percentage of 80 to 89%.

## 4.5 CONCLUSIONS

It is important to note that responses to P supplementation vary substantially from one area to the next; indicating that some areas are clearly P deficient and other areas are evidently not (De Waal, 1990; De Brouwer *et al.*, 2000). Read *et al.*, (1986b) ruled out a sub-clinical P deficiency at Glen using rib-bone samples. Possible reasons for the lack of response to supplementary P feeding at Glen could have been the use of well-conserved veld and light stocking rates (7.3 ha/LSU) by Read *et al.* (1986a) (Van Niekerk, 1996). However, conditions of over-grazing are often applied in practice and it is questioned whether the results by Read *et al.* (1986a) could be replicated under realistic farming conditions. In light of this the results of this survey indicated that eight farmers (16.67%) did not offer sufficient amounts of P to their cows during the summer, which could have a negative impact on the production and reproduction of their cow-calf production system.

When considering the winter supplementation programs of the farmers it appears that the majority of the respondents offer supplements according to the guidelines stipulated by animal nutritionists. Only two farmers (4.2%) did not offer a well balanced supplement to their cows in winter. On the other hand, when scrutinizing the amounts of winter supplements offered to the cows, 10 (20.8%) farmers offered less than 400g supplement per cow per day and under conditions of overgrazing (which is often the case), drought or during the late winter, these amounts could be considered as insufficient.



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The decision to breed heifers as yearlings involves careful consideration of the economics of production and the reproductive status, breed type, or genetic-make-up of the heifers involved (Short *et al*., 1990). Geographical-region differences in the age at which heifers are first exposed for breeding depend on management systems, forage quality and availability, and adaptation of respective breed types to specific environmental conditions (Short *et al*., 1990). For early mating (12 to 18 months old) to be a feasible proposition additional inputs are considered necessary (Scholtz *et al*., 1991). Only one of the six farmers who implemented early mating made the additional inputs required, offering a protein, mineral and energy supplement to his calving 2-year-old heifers and was subsequently rewarded with a good conception rate of between 80 and 89%. The other five farmers did not give what is considered to be adequate supplementation of 2-year-old first-calf-heifers by animal nutritionists and as a result reported lower calving percentages.

When considering the farmers' major educational qualification obtained and their choice of supplements offered it is interesting to note that of the eight farmers (16.7%) who gave no supplements in summer or offered insufficient amounts of P, seven did not have any formal agricultural qualification. In contrast, all the farmers (n = 3) who reported a calving percentage of between 90 and 99% had a tertiary agricultural qualification. It is therefore believed that a lack of understanding of the function of supplements by some of the farmers in the district could be the cause of what could be considered as insufficient supplementation by animal nutritionists. The results of the survey regarding supplements used by the farmers will be used as a guideline in the formulation of supplementation treatments for the study.

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# CHAPTER 5

# THE PRODUCTIVE ENVIRONMENT

## 5.1 INTRODUCTION

Three basic production situations for an individual animal have been identified by Van de Ven *et al*. (2003), namely, potential, limited and reduced production. Potential production only transpires when all the water and feed requirements (limiting factors) of an animal have been met in the absence of reducing factors such as disease and pollutants (Van de Ven *et al.*, 2003).

Cattle are generally kept in herds and not as individuals so decision making at herd level has bearing on the herd dynamics, herd composition and production (Van de Ven *et al.*, 2003). In South Africa most beef herds are kept on pastures therefore grazing management forms an integral part of the production system (see Chapter 3). Veld type is a relative constant factor at farm level while climatic conditions are dependent on prevailing weather systems and are therefore both out of the control of the producer. Factors that the producers can control include stocking rate, supplementary feeding to the animals and the rotation of cattle between various camps (Cros *et al*., 2004). The producer must find a coherent combination of these factors that will ensure optimal production and many satisfactory combinations may exist. The determination of the best combinations will depend on the characteristics of the production system such as available resources as well as labour constraints, and economic targets (Cros *et al.*, 2004).

Reproductive rate is fundamental to the success of a weaner production system and above-average managerial skills are required for proper pasture and rangeland management (see Chapter 2) and for supplementary feeding (see Chapter 3). Management in terms of reproduction and disease control and a meticulous record system to support selection are keys to a profitable weaner production system (Maree & Casey, 1993).



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## 5.2 STUDY SITE

### 5.2.1 Location

The study was conducted from August 2011 to July 2014 on the farm Quaggafontein, which is 3559 ha in size and is situated 30 km south of the town Zastron in the south-eastern Free State province of South Africa. The farm is located between 1352 and 1626 meters above sea level at South latitude 30°27′ and East latitude 27°13′. The vegetation is typical of the *Elionurus* sour-grassland of the south-eastern Free State with a grazing capacity of 5 to 7 ha/LSU.

### 5.2.2 Climate

The study site is located in a summer rainfall area with an annual long term average of 550 mm. Large variations in rainfall occur with a standard deviation of more than 180 mm (SAWS). Summer temperatures are temperate and winters very cold (Table 5.1) with frost occurring at the end of April until the beginning of October. Frost occurs on an average 157 days of the year and the growing season is 208 days long (SAWS, 2015).

**Table 5.1** Average daily maximum and minimum temperatures (in °C) by month for the period 1 August 2011 to 31 July 2014 for the south-eastern Free State (SAWS, 2015) as well as the long term (August 1999 to 31 July 2014) average daily maximum and minimum temperatures

| | August 2011 – July 2012 | | August 2012 – July 2013 | | August 2013 – July 2014 | | August 1999 – July 2014 | |
|---|---|---|---|---|---|---|---|---|
| Month | Max (°C) | Min (°C) | Max (°C) | Min (°C) | Max (°C) | Min (°C) | Max (°C) | Min (°C) |
| August | 20.3 | 1.4 | 20.4 | 3.0 | 19.1 | 0.3 | 20.1 | 1.8 |
| September | 24.8 | 4.8 | 22.7 | 3.9 | 23.7 | 3.7 | 23.7 | 5.3 |
| October | 26.4 | 8.1 | 26.0 | 8.7 | 26.2 | 7.8 | 26.3 | 9.4 |
| November | 28.3 | 9.9 | 29.2 | 11.8 | 27.5 | 10.6 | 27.9 | 11.7 |
| December | 28.6 | 13.1 | 27.1 | 14.2 | 27.5 | 13.7 | 29.1 | 14.0 |
| January | 31.3 | 15.1 | 30.8 | 15.7 | 30.9 | 15.9 | 29.7 | 15.3 |
| February | 28.6 | 14.9 | 30.8 | 13.6 | 28.0 | 16.4 | 28.8 | 15.1 |
| March | 27.3 | 12.2 | 28.2 | 13.1 | 25.9 | 12.7 | 27.0 | 12.7 |
| April | 22.2 | 5.9 | 23.1 | 6.4 | 23.2 | 6.4 | 23.0 | 7.8 |
| May | 22.3 | 3.3 | 21.3 | 2.9 | 21.5 | 3.7 | 20.2 | 3.6 |
| June | 16.2 | 0.6 | 18.3 | -1.4 | 17.5 | -1.7 | 17.2 | -0.1 |
| July | 17.2 | -0.9 | 19.1 | 0.9 | 17.0 | -2.6 | 17.4 | -1.3 |



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The average monthly rainfall (mm) measured on the study site during the course of the study as well as the long term (2003 to 2014) monthly averages are presented in Table 5.2 and Figure 5.1

**Table 5.2** The average monthly rainfall (mm) measured on Quaggafontein from Aug 2011 to Jul 2014 as well as the long term (2003 to 2014) monthly average

| | August 2011to July 2012 | August 2012 to July 2013 | August 2013 to July 2014 | January 2003 to December 2014 |
|---|---|---|---|---|
| Month | Rainfall (mm) | Rainfall (mm) | Rainfall (mm) | Rainfall (mm) |
| August | 0 | 0 | 0 | 13 |
| September | 0 | 51 | 6 | 14 |
| October | 28 | 12 | 21 | 50 |
| November | 0 | 110 | 30 | 57 |
| December | 141 | 102 | 143 | 87 |
| January | 43 | 57 | 76 | 89 |
| February | 144 | 88 | 136 | 103 |
| March | 80 | 28 | 18 | 70 |
| April | 28 | 0 | 18 | 36 |
| May | 0 | 0 | 17 | 11 |
| June | 67 | 0 | 0 | 20 |
| July | 28 | 0 | 0 | 3 |
| TOTAL | 559 | 448 | 465 | 550 |

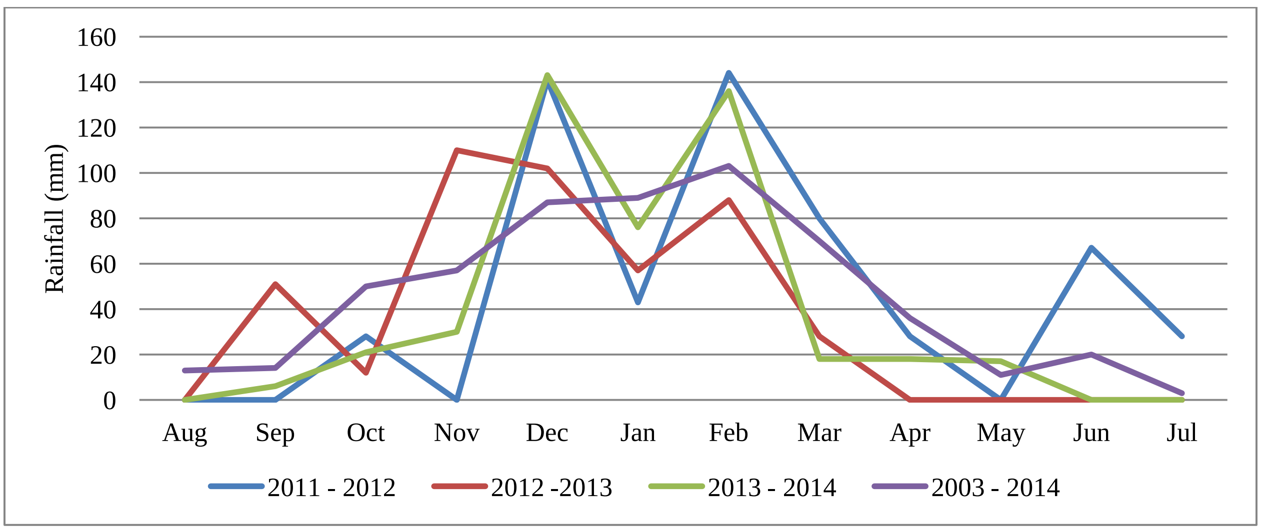


**Figure 5.1** The average monthly rainfall (mm) measured on Quaggafontein from Aug 2011 to Jul 2014 as well as the long term (2003 to 2014) monthly average



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## 5.3 ANIMALS

### 5.3.1 Experimental design

The trial was conducted using 250 Drakensberger cows. The animals were initially stratified according to age and production/reproduction status. Four production/reproduction groups were identified namely:

- Young Heifers (wean to 22 months old);
- Heifers (22 to 34 month old);
- First-calf-heifers; and
- Cows

The animals in each production/reproduction group were then randomly divided into three supplementation treatment groups. The experimental designs of the four production stage groups (young heifers, heifers, first-calf-heifers and cows) are presented in Figure 5.2 to Figure 5.5.

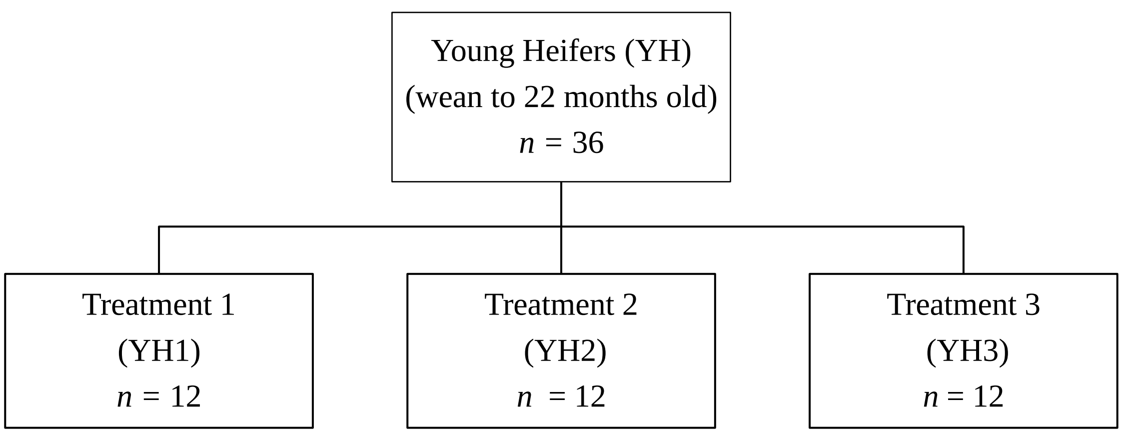


**Figure 5.2** Experimental design of the Young Heifer (wean to 22 months old) production group



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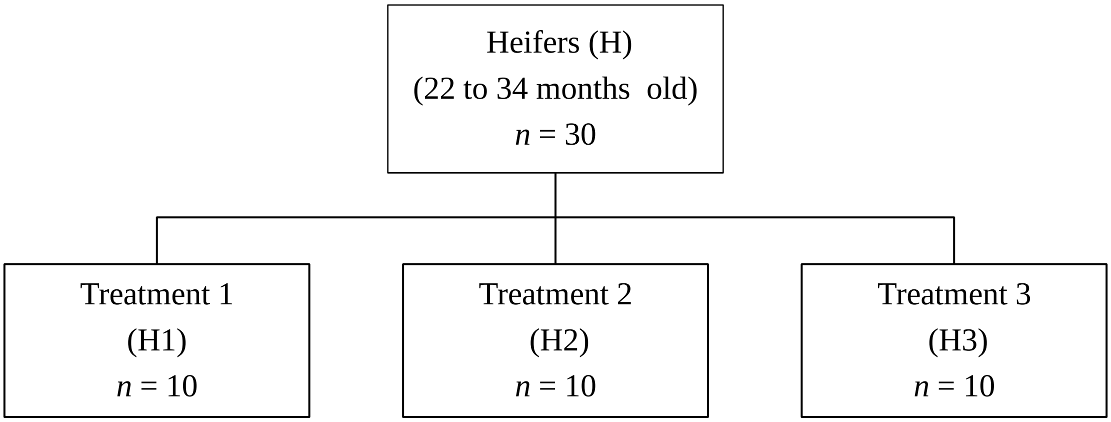


**Figure 5.3** Experimental design of the Heifer (22 to 34 months old) production group

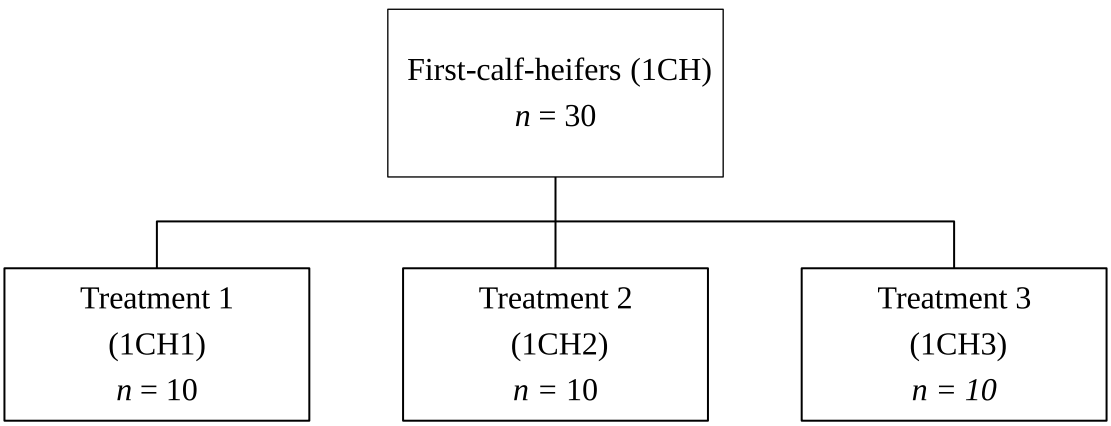


**Figure 5.4** Experimental design of the First-calf-heifer production/reproduction group

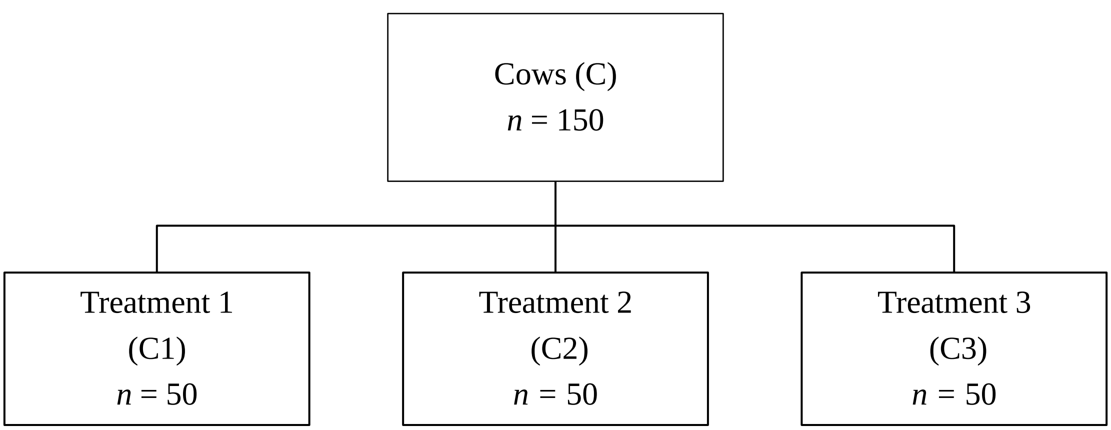


**Figure 5.5** Experimental design of the Cow production/reproduction group



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### 5.3.2 Grazing system

Each treatment group was randomly assigned to a camp within a grazing block according to the principles of the three-camp-*Elionurus*-cattle grazing system of Van der Westhuizen (2014) (See Chapter 3). Treatment groups were rotated every two weeks between allocated camps to minimize camp effect.

### 5.3.3 Supplementation programme

It must be stressed that the levels of supplementation used in this study were chosen to be similar to the levels commonly recommended by animal nutritionists and often employed by farmers. Although the level of energy supplementation for some of the supplementation treatments was low in relation to the animals' daily requirements, this is nevertheless typical of the level used under practical farming conditions.

A three-phase supplementation programme was used in which the production year was divided into three periods, namely a wet season (summer) supplementation period (approximately mid-December to March), an early dry season (winter) supplementation period (April to July) and a late winter supplementation period (August to approximately mid-December). Commercially available supplementation formulations were used and mixed on site as well as one pre-mixed supplement. The intake of the supplements was accurately recorded on a herd level. The supplements were available on an *ad libitum* basis but never exceeded the maximum recommended daily intake and were replenished twice a week to ensure that the animals had access to adequate supplies. Weekly weather forecasts of possible rainfall were considered in determining which day supplements would be replenished. This was an attempt to prevent supplements containing urea from getting wet which can affect intake and cause poisoning and ultimately death. Adjustments were made for wet supplements that had to be replaced. The economic viability of the different treatments was tested in terms of supplement cost and comparative animal production attained.

September raw material prices of 2011 to 2013 were used to calculate the cost (R per animal per day) of supplements offered to the animal in late winter, February raw material prices of 2012 to 2014 were used to calculate the average cost (R per animal per day) of supplements offered to



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the animal in summer and the May raw material prices of 2012 to 2014 were used to calculate the cost (R per animal per day) of the supplements offered to the animal in winter.

### 5.3.4 Production system for weaner calves

A weaner production system that entails the production and sale of weaner calves at 6 to 7 months was employed. Reproductive rate is fundamental to the success of this production system therefore the following management system was implemented:

#### *5.3.4.1 Calving season*

- The breeding season was initiated four weeks earlier for the heifers than for the cow herd.
- The heifers were mated to calve at three years of age and were put to the bull in mid-November.
- A 90-day breeding season was applied for the heifers.
- The breeding season for the cows started in mid-December and lasted until the end of March resulting in a spring and summer calving season.
- Breeding soundness and fertility evaluation of all bulls were done prior the breeding season.
- Single-sire and multiple-sire matings were used; DNA testing was done to determine paternity.
- Bulls were rotated every two weeks between treatment groups to minimize bull effects,
- Pregnancy was established in April for the heifers and in June for the cows.

The productive environment was managed as follows:

#### *5.3.4.2 Calving and weaning practices*

- Calves were weighed and tagged within three days after birth.
- Calves were de-horned between the ages of a week and three months old.
- Calves were grouped into three age groups according to their birth date namely, calves born between 20 August to 3 October, between 4 October to 17 November and between 18 November to 31 December and were weaned accordingly. The first age group was



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weaned on the 4th of April, the second age group on the 16th of May and the third age group on the 2nd of July.

### 5.3.5 Herd health

#### *5.3.5.1 External and internal parasites*

- The study site is located in an area where *Ixodes rubicundus* occurs which causes Karoo paralysis. Tick control was achieved by applying a pour-on acaricidal chemical. All the animals were dipped at three week intervals starting mid-April to mid-July.
- Suckling calves were de-wormed in January using an anthelmintic.

An immunization programme was drawn up with the assistance of the local veterinarian to prevent the outbreak of diseases commonly occurring in the area. The immunization programme is summarized in Table 5.3 and indicates the class of animal, disease and time of administration of the vaccine.

**Table 5.3** Immunisation programme

| Class of animal | Disease | Time of administration |
|---|---|---|
| Calves | Multi-Clostridia | February (booster 21 days later) |
| Young heifers | *Brucella abortus* (S19) | June |
| | BVD, IBR, PI3 | July (booster 21 days later) |
| | Vitamin A | July |
| | Anaplasmosis | August |
| | Anthrax, Black Quarter | September |
| | Lumpy Skin | September |
| Heifers | Vitamin A | July |
| | BVD, IBR, PI3 | July |
| | *Brucella abortus* (RB51) | August |
| | Anthrax, Black Quarter | September |
| | Lumpy Skin | September |
| Cows | Vitamin A | July |
| | BVD, IBR, PI3 | July |
| | Anthrax, Black Quarter | September |
| | Lumpy Skin | September |



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# CHAPTER 6

# EFFECT OF DIFFERENT LEVELS OF SUPPLEMENTATION AFTER WEANING ON YOUNG (WEAN – 22 MONTHS OLD) BEEF HEIFER DEVELOPMENT

## 6.1 INTRODUCTION

Irrespective of whether heifers are mated at 12 – 14 months or at two years of age, an adequate level of feed is necessary for good performance in their first and subsequent production cycles as cows (Bond & Wiltbank, 1970; Wiltbank *et al.*, 1984; Scholtz *et al.*, 1991). It is important to take note that the effects of supplementation must be reflected in terms of animal production (De Brouwer *et al.*, 1993). Positive body weight changes and increased reproduction are the parameters to be used. The returns in the aforementioned must, at least, compensate for the costs incurred in feeding supplements (De Waal, 1990).

A range of procedures are available to cow/calf producers as an aid in the reproductive management of replacement beef heifers and determine the outcome of a development program. Adoption of specific procedures for an operation depends on factors influencing current levels of performance, availability of facilities and labour, and economic return (Patterson *et al*., 2002).

Geographical-region differences in the age at which heifers are first exposed for breeding depend on management systems, forage quality and availability, and adaptation of respective breed types to specific environmental conditions. The economic advantage of early breeding and calving is in some cases thwarted by biological limitations of the animal and management constraints of the environment (Short *et al.*, 1990). Because most mechanisms of fertility that influence calving and subsequent reproductive performance are not highly heritable, it is logical to assume that the majority of factors associated with reproductive performance in cattle are influenced almost exclusively by management (Patterson *et al.*, 2002). It is the management of replacement heifers during the postweaning to prebreeding period that influences to a large extent when puberty, pregnancy, and parturition will occur (Patterson *et al.*, 2002).



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The identification of an efficient supplementation regimen to rear replacement heifers (wean to 22 months old) in terms of weight gains necessary to achieve acceptable conception rates at the lowest possible cost, is thus essential to the beef industry of the south-eastern Free State, and therefore the objective of this section of study was to investigate means of achieving this goal.

## 6.2 MATERIALS AND METHODS

### 6.2.1 Outlay of the Young Heifer Treatment Groups

During mid-July of 2011, prior to the start of the study, 36 young Drakensberger heifers (7-months old) were randomly allocated to one of three supplementation treatment groups, namely Young Heifer Supplementation Treatment Group 1 (YH1), Young Heifer Supplementation Treatment Group 2 (YH2) and Young Heifer Supplementation Treatment Group 3 (YH3) (See Figure 5.2) In the second and third year of the study replacement heifers were assigned to a treatment group according their dams' supplementation treatment group (see Chapter 9). Replacement heifers born to dams allocated to the Cow Supplementation Treatment Group 1 (C1) were reassigned to the YH1 Treatment Group and replacement heifers born to dams allocated to the Cow Supplementation Treatment Group 2 (C2) were reassigned to the YH2 Treatment Group etc.

### 6.2.2 The Young Heifer supplementation treatments

The young heifers were offered the late winter supplementation treatments from wean to the 31$^{st}$ of July even though this period fell within the winter supplementation period. The supplementary intake during this period (from wean the 31$^{st}$ of July) was not included in calculating supplemental intake and cost as the replacement heifers were weaned according to age and resulted in heifers being weaned over a period of three months (April to July). All three Young Heifer Supplementation Treatment Groups were offered the same urea based protein supplement during the winter supplementation period. A summary of the Young Heifer Supplementation Treatments and the nutrient compositions of the treatments are shown in Table 6.1.



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**Table 6.1** Summary of the Young Heifer Supplementation Treatments and nutrient composition of each treatment

| YOUNG HEIFER SUPPLEMENTATION TREATMENTS | | |
|---|---|---|
| YH1 | YH2 | YH3 |
| LATE WINTER | | |
| Winter production supplement<br>CP: 30.6%<br>From NPN: 47.4%<br>ME: 7.4 MJ/kg | Cottonseed oilcake and urea based late winter protein and mineral supplement<br>CP: 32.91%<br>From NPN: 70.72%<br>ME: 6.89 MJ/kg | Urea based protein and mineral supplement<br>CP: 47.5<br>From NPN: 95.86<br>ME: 2.4 MJ/kg |
| SUMMER | | |
| Summer production supplement<br>CP: 16.4%<br>From NPN: 37.0%<br>ME: 9.0 MJ/kg<br>P: 1.3% | Mineral supplement containing 15% protein<br>CP: 15.0%<br>From NPN: 13.6%<br>ME: -<br>P: 5% | Mineral supplement<br>CP: -<br>From NPN: -<br>ME: -<br>P: 6% |
| WINTER | | |
| Urea based protein and mineral supplement<br>CP: 47.5%<br>From NPN: 95.86%<br>ME: 2.4 MJ/kg | Urea based protein and mineral supplement<br>CP: 47.5%<br>From NPN: 95.86%<br>ME: 2.4 MJ/kg | Urea based protein and mineral supplement<br>CP: 47.5%<br>From NPN: 95.86%<br>ME: 2.4 MJ/kg |

The supplementation formulations and nutrient compositions of the treatments offered to the Young Heifer Supplementation Treatment Groups during the late winter supplementation period are presented in Table 6.2.



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**Table 6.2** Supplementation formulations and nutrient compositions of treatments offered to the Young Heifer Supplementation Treatment Groups (YH1, YH2 and YH3) during the late winter supplementation period

| **Young Heifer Treatment 1 (YH1)** | | **Young Heifer Treatment 2 (YH2)** | | **Young Heifer Treatment 3 (YH3)** | |
|---|---|---|---|---|---|
| **Late winter (August to mid-December)** | | | | | |
| Raw material | % | Raw material | % | Raw material | % |
| Maize meal | 28.50 | Maize meal | 37.34 | Maize meal | 18.46 |
| Cottonseed oilcake | 37.99 | Cottonseed oilcake | 16.59 | Cottonseed oil cake | - |
| Feed grade Urea | 4.75 | Feed grade Urea | 8.30 | Feed grade Urea | 15.38 |
| Kimtrafos 12 | 7.12 | Kimtrafos 12 | 8.30 | Kimtrafos 12 | 15.38 |
| Kalori 3000 | 2.37 | Kalori 3000 | 4.15 | Kalori 3000 | 3.85 |
| Feed grade Sulfur | 0.28 | Feed grade Sulfur | 0.42 | Feed grade Sulfur | 0.77 |
| Salt | 18.99 | Salt | 24.90 | Salt | 46.15 |
| **Nutrient composition** | | | | | |
| Crude protein (%) | 30.6 | Crude protein (%) | 32.91 | Crude protein (%) | 47.5 |
| From NPN (%) | 47.4 | From NPN (%) | 70.72 | From NPN (%) | 95.86 |
| ME (MJ/kg) | 7.4 | ME (MJ/kg) | 6.89 | ME (MJ/kg) | 2.4 |
| Ca (%) | 1.9 | Ca (%) | 2.2 | Ca (%) | 3.36 |
| P (%) | 1.3 | P (%) | 1.25 | P (%) | 2.57 |
| Intake (g/animal/day) | 480 – 960 | Intake (g/animal/day) | 290 – 340 | Intake (g/animal/day) | 170 – 240 |

During the late winter supplementation period the YH1 treatment consisted of a winter production supplement. Cottonseed oilcake was the main ingredient (37.99%) of this treatment resulting in 47.4% of the CP content being derived from NPN (Table 6.2). The YH2 treatment consisted of cottonseed oilcake and urea based protein and mineral supplement. Maize meal was the main ingredient (37.34%) of this treatment. The CP content derived from NPN was 70.72%. The YH3 treatment consisted of a urea based protein and mineral supplement. The main ingredient of this treatment was salt (46.15%) and the CP content derived from NPN was 95.86% (Table 6.2).

The supplementation formulations and nutrient compositions of the treatments offered to the Young Heifer Supplementation Treatment Groups during the summer supplementation period are presented in Table 6.3.



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**Table 6.3** Supplementation formulations and nutrient compositions of treatments offered to the Young Heifer Supplementation Treatment Groups (YH1, YH2 and YH3) during the summer supplementation period

| Young Heifer Treatment 1 (YH1) | | Young Heifer Treatment 2 (YH2) | | Young Heifer Treatment 3 (YH3) | |
|---|---|---|---|---|---|
| **Summer (mid-December to March)** | | | | | |
| Raw material | % | Raw material | % | Raw material | % |
| Voermol Superfos | - | Voermol Superfos | 100 | Voermol Superfos | - |
| Maize meal | 55.78 | Maize meal | - | Maize meal | - |
| Cotton oil cake | 15.94 | Cottonseed oilcake | - | Cottonseed oilcake | - |
| Feed grade Urea | 1.99 | Feed grade Urea | - | Feed grade Urea | - |
| Kimtrafos 12 | 7.97 | Kimtrafos 12 | - | Kimtrafos 12 | 50 |
| Kalori 3000 | 1.99 | Kalori 3000 | - | Kalori 3000 | - |
| Feed grade Sulfur | 0.40 | Feed grade Sulfur | - | Feed grade Sulfur | 5 |
| Salt | 15.94 | Salt | - | Salt | 45 |
| **Nutrient composition** | | | | | |
| Crude protein (%) | 16.4 | Crude protein (%) | 15.0 | Crude protein (%) | - |
| From NPN (%) | 37.0 | From NPN (%) | 13.6 | From NPN (%) | - |
| ME (MJ/kg) | 9.0 | ME (MJ/kg) | - | ME (MJ/kg) | - |
| Ca (%) | 2.1 | Ca (%) | 8.0 | Ca (%) | 11.8 |
| P (%) | 1.3 | P (%) | 5.0 | P (%) | 6.0 |
| Intake (g/cow/day) | 640 – 960 | Intake (g/cow/day) | 80 – 155 | Intake (g/cow/day) | 65 – 155 |

The YH1 summer treatment consisted of a summer production supplement. The supplement had a high ME content (9.0 MJ/kg) due to maize meal being the main ingredient (55.78%) (Table 6.3). The CP content of the supplement was 16.4%. The YH2 treatment consisted of a ready mixed mineral supplement (Voermol Superfos) containing 15% CP. The YH3 treatment consisted of a mineral supplement providing no CP or ME (Table 6.3).

The three Young Heifer Supplementation Treatment Groups were approximately 18 months old at the start of the winter supplementation period. As all three treatment groups had already reached a prebreeding weight that represents 60 to 65% of the heifer's projected mature weight, it was decided that a urea based protein supplement (Table 6.4) would suffice for all three treatment groups during the winter supplementation period. As all three Young Heifer



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Supplementation Treatment Groups were receiving the same supplement it was decided to pool the three treatment groups into one group.

**Table 6.4** Supplementation formulation and nutrient composition of the treatment offered to the Young Heifer Supplementation Treatment Groups (YH1, YH2, YH3) during the winter supplementation period

| Winter (April to July) | |
|---|---|
| Young Heifer Supplementation Treatment Groups (YH1, YH2 and H3) | |
| Raw material | % |
| Maize meal | 18.46 |
| Feed grade Urea | 15.38 |
| Kimtrafos 12 | 15.38 |
| Kalori 3000 | 3.85 |
| Feed grade Sulfur | 0.77 |
| Salt | 46.15 |
| Nutrient composition | |
| Crude protein (%) | 47.5 |
| From NPN (%) | 95.86 |
| ME (MJ/kg) | 2.4 |
| P (%) | 2.57 |
| Intake (g/animal/day) | 190 – 270 |

## 6.3 STATISTICAL METHOD

The same statistical methods were used in Chapters 6 to 9. Data was captured electronically in Microsoft Excel. Analyses were done using SAS Version 9.2. Descriptive statistics namely frequencies and percentages were calculated for categorical data. Means and standard deviations or medians and percentiles were calculated for numerical data. Analytical statistics namely the analysis of variance (ANOVA) was used to compare the mean values and the mean differences between the three treatment groups. The unpaired t-test was used to compare the mean values and the mean differences between two treatment groups at a time. The paired t-test was used to investigate significant mean differences within each treatment group. A significance level (a) of 0.05 was used.



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## 6.4 RESULTS

### 6.4.1 Supplement intake and cost of supplementation

The period that animals were given access to the supplements differed annually, as the initiation and conclusion of a supplementation phase was prescribed by the condition of the available grazing. Table 6.5 displays the yearly (2011, 2012 and 2013) average late winter supplement and calculated nutrient (CP, ME and P) intakes (g/animal/day) of the Young Heifer Supplementation Treatment Groups (YH1, YH2 and YH3) and Table 6.6 displays the three year average late winter supplement and calculated nutrient intake.

**Table 6.5** The yearly (2011, 2012 and 2013) average late winter supplement and nutrient intakes (g/animal/day) of the Young Heifer Supplementation Treatment Groups (YH1, YH2 and YH3)

| Season | Period (d) | Component | Treatment YH1 | Treatment YH2 | Treatment YH3 |
|---|---|---|---|---|---|
| Late winter 2012 | 133 | Supplement intake (g/animal/day) | 555 | 288 | 141 |
| | | CP (g/animal/day) | 170 | 95 | 67 |
| | | Protein from NPN (g/animal/day) | 4.10 | 1.98 | 0.34 |
| | | ME (MJ/animal/day) | 10.55 | 6.34 | 4.74 |
| | | P (g/animal/day) | 7.22 | 3.6 | 3.62 |
| Late winter 2013 | 135 | Supplement intake (g/animal/day) | 627 | 307 | 131 |
| | | CP (g/animal/day) | 192 | 102 | 62 |
| | | Protein from NPN (g/animal/day) | 4.64 | 2.12 | 0.31 |
| | | ME (MJ/animal/day) | 11.91 | 6.75 | 4.40 |
| | | P (g/animal/day) | 8.15 | 3.83 | 3.37 |
| Late winter 2014 | 142 | Supplement intake (g/animal/day) | 782 | 302 | 226 |
| | | CP (g/animal/day) | 240 | 99 | 107 |
| | | Protein from NPN (g/animal/day) | 5.79 | 2.08 | 0.54 |
| | | ME (MJ/animal/day) | 14.86 | 6.64 | 7.59 |
| | | P (g/animal/day) | 10.17 | 3.78 | 5.81 |



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**Table 6.6** Three year (2011 to 2013) average late winter supplement and nutrient intakes (g/animal/day) of the Young Heifer Supplementation Treatment Groups (YH1, YH2 and YH3) as well as the cost of the treatments (R/animal/late winter supplementation period)

| Season and Year | Period (d) | Component | Treatment | | |
|---|---|---|---|---|---|
| | | | YH1 | YH2 | YH3 |
| Late winter | 137 | Supplement intake (g/animal/day) | 657 | 299 | 167 |
| 2011 - 2014 | | CP (g/animal/day) | 201 | 98 | 79 |
| | | Protein from NPN (g/animal/day) | 4.86 | 2.06 | 0.40 |
| | | ME (MJ/animal/day) | 12.48 | 6.58 | 5.64 |
| | | P (g/animal/day) | 8.54 | 3.74 | 4.29 |
| | | Cost (R/animal/suppl. period) | R 286.33 | R 116.45 | R 58.91 |

The late winter supplementation period lasted an average of 137 days. Supplement intakes (Table 6.5) of the YH1 and YH2 Supplementation Treatment Groups were within the recommended intake ranges of 480 – 960 g/animal per day for the YH1 Treatment Group and 290 – 340 g/animal/day for the YH2 Treatment Group. The YH3 Supplementation Treatment Group on the other hand was only able to consume supplement within the recommended range of 170 – 240 g/animal per day during the drought of 2013 (226 g/animal/day). The three year average cost incurred in supplying the late winter production supplement to the YH1 Treatment Group was R286.33 per animal, the urea and cottonseed oilcake based protein and mineral supplement to the YH2 Treatment Group R116.45 and the urea based protein and mineral supplement to the YH3 Treatment Group R58.91 (Table 6.6).

The yearly (2011-12, 2012-13 and 2013-14) average summer supplement and calculated nutrient (CP, ME and P) intakes (g/animal/day) of the Young Heifer Supplementation Treatment Groups (YH1, YH2 and YH3) are presented in Table 6.7. Table 6.8 displays the three year (2011-12 to 2013-14) average summer supplement and calculated nutrient intake.



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**Table 6.7** The yearly (2011-12, 2012-13 and 2013-14) average summer supplement and nutrient intakes (g/animal/day) of the Young Heifer Supplementation Treatment Groups (YH1, YH2 and YH3)

| Season | Period (d) | Component | Treatment YH1 | Treatment YH2 | Treatment YH3 |
|---|---|---|---|---|---|
| Summer 2011 to 2012 | 109 | Supplement intake (g/animal/day) | 398 | 105 | 56 |
| | | CP (g/animal/day) | 65 | 16 | - |
| | | Protein from NPN (g/animal/day) | 3.58 | 14.51 | - |
| | | ME (MJ/animal/day) | 8.36 | 8.40 | 6.61 |
| | | P (g/animal/day) | 5.17 | 5.25 | 3.36 |
| Summer 2012 to 2013 | 106 | Supplement intake (g/animal/day) | 335 | 102 | 70 |
| | | CP (g/animal/day) | 56 | 15 | - |
| | | Protein from NPN (g/animal/day) | 3.01 | 13.61 | - |
| | | ME (MJ/animal/day) | 7.04 | 8.16 | 8.26 |
| | | P (g/animal/day) | 4.36 | 5.1 | 4.20 |
| Summer 2013 to 2014 | 101 | Supplement intake (g/animal/day) | 408 | 95 | 65 |
| | | CP (g/animal/day) | 67 | 14 | - |
| | | Protein from NPN (g/animal/day) | 3.67 | 12.70 | - |
| | | ME (MJ/animal/day) | 8.57 | 7.6 | 7.67 |
| | | P (g/animal/day) | 5.30 | 4.75 | 3.9 |

**Table 6.8** Three year (2011 - 2014) average summer supplement and nutrient intakes (g/animal/day) of the Young Heifer Supplementation Treatment Groups (YH1, YH2 and YH3) as well as the cost of the treatments (R/animal/summer supplementation period)

| Season and Year | Period (d) | Component | Treatment | | |
|---|---|---|---|---|---|
| | | | YH1 | YH2 | YH3 |
| Summer 2011 - 2014 | 106 | Supplement intake (g/animal/day) | 380 | 100 | 64 |
| | | CP (g/animal/day) | 62 | 15 | - |
| | | Protein from NPN (g/animal/day) | 3.42 | - | - |
| | | ME (MJ/animal/day) | 7.98 | 8.0 | 7.55 |
| | | P (g/animal/day) | 4.94 | 5.0 | 3.84 |
| | | Cost (R/animal/suppl. period) | R 114.48 | R 46.64 | R 21.20 |



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The YH1 Treatment Group was not able to consume sufficient amounts (640 – 960 g/animal/day) of their summer production supplement in any of the three summers (398, 335 and 408 g/animal/day). The intake of the mineral supplement with a 15% inclusion of protein offered to the YH2 Treatment Group was, in contrast to the YH1 Treatment Group, within the recommended intake range of 80 – 155 g/animal/day. The intake of the mineral supplement offered to the YH3 Treatment Group was close to the expected intake of 65 – 155 g/animal/day. The three year average cost incurred in supplying the summer supplement to the YH1 Treatment Group was R114.48 per animal, the supplement to the YH2 Treatment Group R46.64 and the supplement to the YH3 Treatment Group R21.20 (Table 6.8).

The yearly (2012, 2013 and 2014) average winter supplement and calculated nutrient (CP, ME and P) intakes (g/animal/day) of the Young Heifer Supplementation Treatment Groups (YH1, YH2 and YH3) are presented in Table 6.9. Table 6.10 displays the three year (2012 to 2014) average. The Young Heifer Supplementation Treatment Groups (YH1, YH2 and YH3) were just able to consume the winter supplement (192g/animal/day) within the recommended intake range of 190 – 270 g/animal per day. The average cost of supplying the urea based protein and mineral supplement was R 65.19 per animal (Table 6.10).



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**Table 6.9** The yearly (2012, 2013 and 2014) average winter supplement and nutrient intakes (g/animal/day) of the Young Heifer Supplementation Treatment Groups (YH1, YH2 and YH3)

| Season and Year | Period (d) | Component | Treatment Group |
|---|---|---|---|
| | | | YH1, YH2, YH3 |
| Winter 2012 | 123 | Supplement intake (g/animal/day) | 144 |
| | | CP (g/animal/day) | 68.4 |
| | | Protein from NPN (g/animal/day) | 0.35 |
| | | ME (MJ/animal/day) | 4.84 |
| | | P (g/animal/day) | 3.70 |
| Winter 2013 | 124 | Supplement intake (g/animal/day) | 197 |
| | | CP (g/animal/day) | 94 |
| | | Protein from NPN (g/animal/day) | 0.47 |
| | | ME (MJ/animal/day) | 6.62 |
| | | P (g/animal/day) | 5.06 |
| Winter 2014 | 122 | Supplement intake (g/animal/day) | 235 |
| | | CP (g/animal/day) | 112 |
| | | Protein from NPN (g/animal/day) | 0.56 |
| | | ME (MJ/animal/day) | 7.90 |
| | | P (g/animal/day) | 6.04 |

**Table 6.10** Three year (2011 - 2014) average winter supplement and nutrient intakes (g/animal/day) of the Young Heifer Supplementation Treatment Groups (YH1, YH2 and YH3) as well as the cost of the treatments (R/animal/winter supplementation period)

| Season and Year | Period (d) | Component | Treatment |
|---|---|---|---|
| | | | YH1, YH2, YH3 |
| Winter 2011 – 2013 | 123 | Supplement intake (g/animal/day) | 192 |
| | | CP (g/animal/day) | 91 |
| | | Protein from NPN (g/animal/day) | 0.46 |
| | | ME (MJ/animal/day) | 6.45 |
| | | P (g/animal/day) | 4.93 |
| | | Cost (R/animal/suppl. period) | R 65.19 |



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Figure 6.1 clearly illustrates the difference in supplement intake (g/animal/day) between the Young Heifer Supplementation Treatment Groups during the course of the three year study.

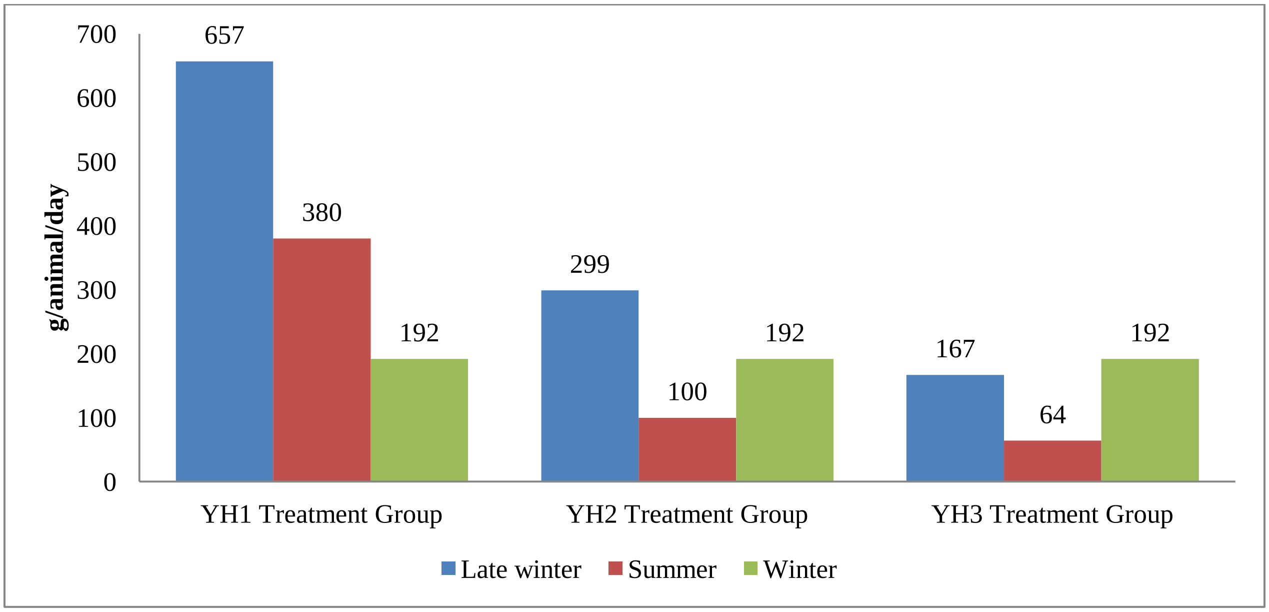


**Figure 6.1** Three year average supplement intakes (g/animal/day) of the Young Heifer Supplementation Treatment Groups during the late winter-, summer- and winter supplementation periods

The three year average costs incurred in supplying the Young Heifer Supplementation Treatments are summarized in Table 6.11.

**Table 6.11** The three year (2011-12 to 2013-14) average costs (R/animal) incurred in offering treatments to the Young Heifers Supplementation Treatments Groups

| Supplementation period | YH1 | YH2 | YH3 |
|---|---|---|---|
| Average cost of late winter supplementation | R 286.33 | R 116.45 | R 58.91 |
| Average cost of summer supplementation | R 114.48 | R 46.64 | R 21.20 |
| Average cost of winter supplementation | R 65.19 | R 65.19 | R 65.19 |
| Total average cost of supplementation (R/animal/year) | R 466.00 | R 228.28 | R 145.30 |



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### 6.4.2 Body weights and BCS of the Young Heifer Supplementation Treatment Groups

The body weights and weight gains of the young heifer supplementation treatment groups are summarized in Table 6.12.

**Table 6.12** Mean (± SD) body weights (kg) and mean weight gains (kg) of the Young Heifer Supplementation Treatment Groups for the period August 2011 to July 2014

| Treatments | YH1 | YH2 | YH3 |
|---|---|---|---|
| 1 August 2011 to 31 July 2012 | | | |
| | Mean weight (kg) n = 12 | Mean weight (kg) n = 12 | Mean weight (kg) n = 12 |
| Late winter ( Aug) | $234^{a} \pm 17$ | $220^{b} \pm 13$ | $223^{ab} \pm 12$ |
| Spring (Nov) | $279^{a} \pm 18$ | $261^{b} \pm 15$ | $271^{ab} \pm 16$ |
| Summer (Mar) | $344^{a} \pm 19$ | $327^{ab} \pm 21$ | $323^{b} \pm 21$ |
| Winter (Jul) | $360^{a} \pm 21$ | $350^{a} \pm 28$ | $343^{a} \pm 19$ |
| Weight gain Aug to Nov | $45^{ab} \pm 9$ | $41^{a} \pm 6$ | $48^{b} \pm 7$ |
| Total weight gain | $125^{a} \pm 10$ | $130^{a} \pm 13$ | $120^{a} \pm 12$ |
| 1 August 2012 to 31 July 2013 | | | |
| | n = 13 | n = 12 | n = 14 |
| Late winter ( Aug) | $232^{a} \pm 26$ | $215^{ab} \pm 14$ | $209^{b} \pm 18$ |
| Spring (Nov) | $268^{a} \pm 34$ | $264^{a} \pm 16$ | $257^{a} \pm 22$ |
| Summer (Mar) | $369^{a} \pm 33$ | $357^{a} \pm 23$ | *$334^{b} \pm 23$ |
| Winter (Jul) | $361^{a} \pm 43$ | $351^{a} \pm 27$ | $328^{b} \pm 27$ |
| Weight gain Aug to Nov | *$36^{a} \pm 13$ | $49^{b} \pm 7$ | $48^{b} \pm 7$ |
| Total weight gain | $129^{ab} \pm 20$ | $136^{a} \pm 20$ | $119^{b} \pm 14$ |
| 1 August 2013 to 31 July 2014 | | | |
| | n = 15 | n = 15 | n = 15 |
| Late winter ( Aug) | $214^{a} \pm 15$ | $214^{a} \pm 13$ | $212^{a} \pm 11$ |
| Spring (Nov) | **$253^{a} \pm 17$ | $229^{b} \pm 14$ | $228^{b} \pm 17$ |
| Summer (Mar) | *$354^{a} \pm 19$ | $329^{b} \pm 18$ | $327^{b} \pm 20$ |
| Winter (Jul) | $356^{a} \pm 22$ | $334^{b} \pm 23$ | $328^{b} \pm 19$ |
| Weight gain Aug to Nov | ***$39^{a} \pm 6$ | $9^{b} \pm 5$ | $16^{c} \pm 9$ |
| Total weight gain | *$142^{a} \pm 18$ | $120^{b} \pm 16$ | $115^{b} \pm 12$ |

Mean values in the same row with different superscripts differ significantly: $P < 0.05$; *$P < 0.01$; * *$P < 0.001$; *** $P < 0.0001$



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At the inception of Year 1 (2011/12), the YH1 treatment group weighed (234 kg ± 17) significantly ($P$ < 0.05) heavier than the YH2 treatment group (220 kg ± kg). No significant differences in body weights were measured between the YH3 treatment group (223 kg ± 12) and the YH1 treatment group as well as the YH3 treatment group and the YH2 treatment group. The weight gain of 48 kg ± 7 of the YH3 Treatment Group during the spring was however significantly more than that of the 41 kg ± 6 of the YH2 Treatment Group. By the end of Year 1 the differences in body weights as well as the total weight gains between the three treatment groups were not significant. The YH2 treatment group gained the most weight (130 kg ± 13) and YH3 treatment group the least weight (120 kg ± 12). The YH1 treatment group weighed the most (359 kg ± 21) and the YH3 treatment group the least (343 kg ± 12) ($P$ > 0.05). Figure 6.2 illustrates the average weights of the Heifer Supplementation Treatment Groups during the course of Year 1.

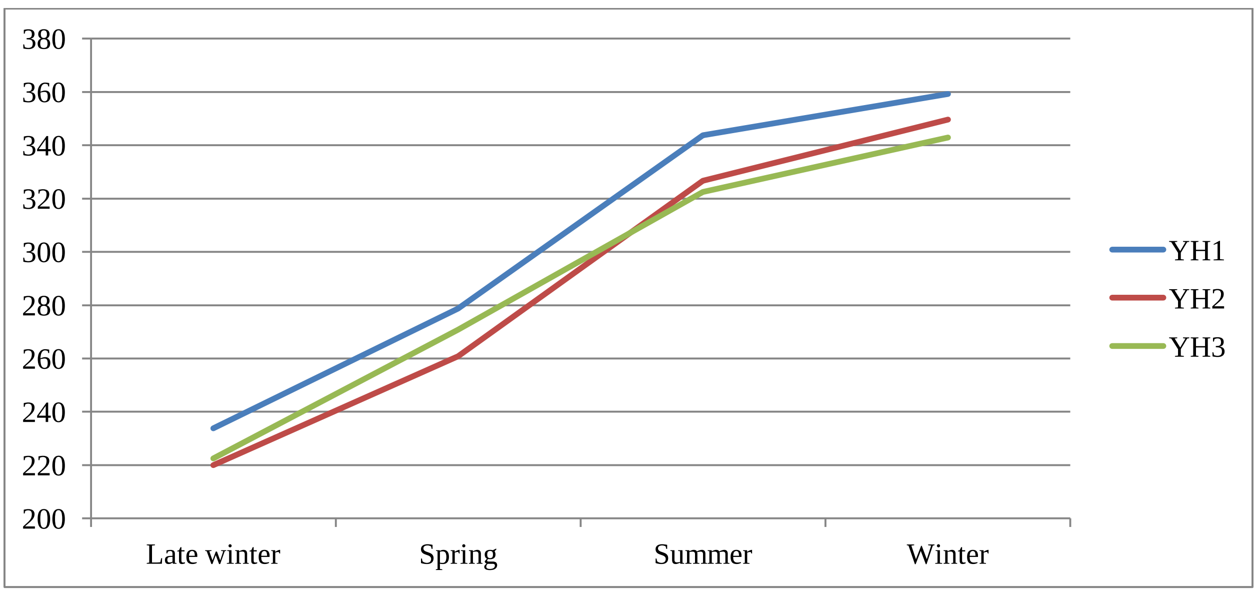


**Figure 6.2** Average weights of the Young Heifer Supplementation Treatment Groups (YH1, YH2 and YH3) during the course of Year 1

At the start of Year 2 (2012/13) the YH1 treatment group once again had the heaviest body weight (232 kg ± 26), which was significantly ($P$ < 0.05) heavier than the body weight of the YH3 treatment group (209 kg ± 18). No significant differences in body weights were measured between the YH3 treatment group and the YH2 treatment group (215 kg ± 14). Differences in body weights that were measured between the Young Heifer Supplementation Treatment Groups



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by the end of spring (November) were also not significant. This was due to the significantly ($P < 0.01$) higher weight gains of the YH2 (49 kg ± 7) and the YH3 (48 kg ± 7) Treatment Groups compared to the 36 kg ± 13 of the YH1 Treatment Group during spring. The YH3 treatment group (328 kg ± 27) was however not able to maintain its rate of gain and weighed significantly ($P < 0.01$) less in March and July ($P < 0.05$) than the YH1 treatment group (361 ± 43) and the YH2 treatment group (351 ± 27). ). The average weights of the Heifer Supplementation Treatment Groups during the course of Year 2 are illustrated in Figure 6.3.

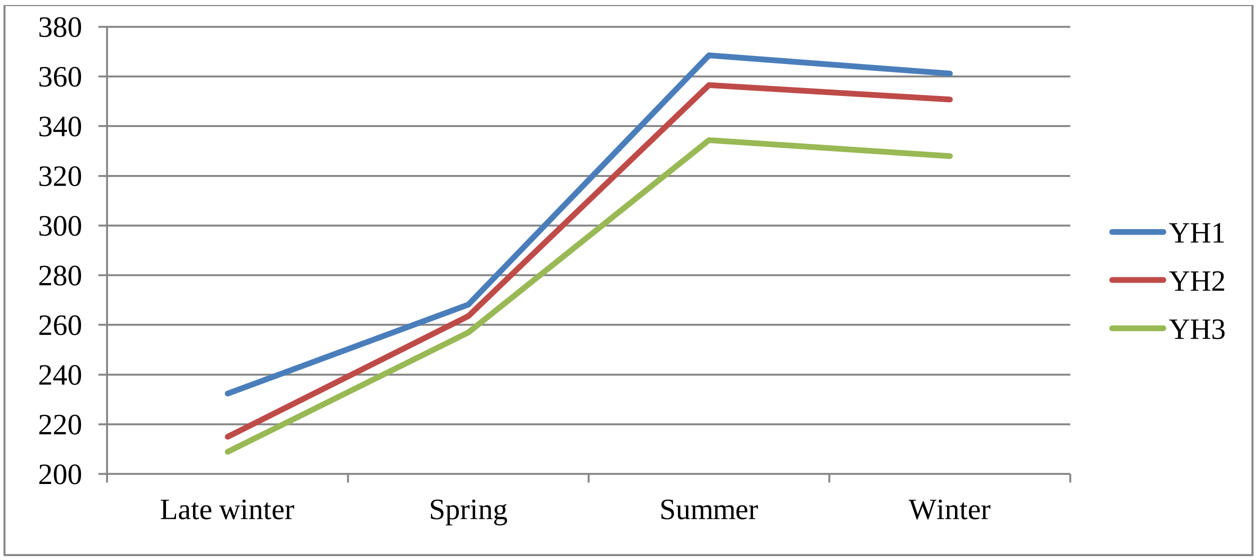


**Figure 6.3** Average weights of the Young Heifer Supplementation Treatment Groups (YH1, YH2 and YH3) during the course of Year 2

No significant differences ($P > 0.05$) in body weights were measured between the treatment groups at the onset of Year 3 (2013/14) even though an extremely dry spell was experienced during this period in which only a paltry 57 mm rain was measured. This period was also followed by a dry summer in which a mere 275 mm rain fell. As a result a shortage in dry matter was experienced from June 2013 to mid-December 2013. The shortage in the availability of grazeable roughage is evident through the much lower weight gains of the YH2 (9 kg ± 5) and YH3 Treatment Groups (16 kg ± g) during the spring compared to the previous two years. The higher weight gain of the YH1 Treatment Group (39 kg ± 6), which received a production supplement during this period, was highly significant ($P < 0.0001$). The YH1 treatment group maintained its superior ($P < 0.05$) weight gain until the end of the season.



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The average weights of the Heifer Supplementation Treatment Groups during the course of Year 3 are illustrated in Figure 6.4.

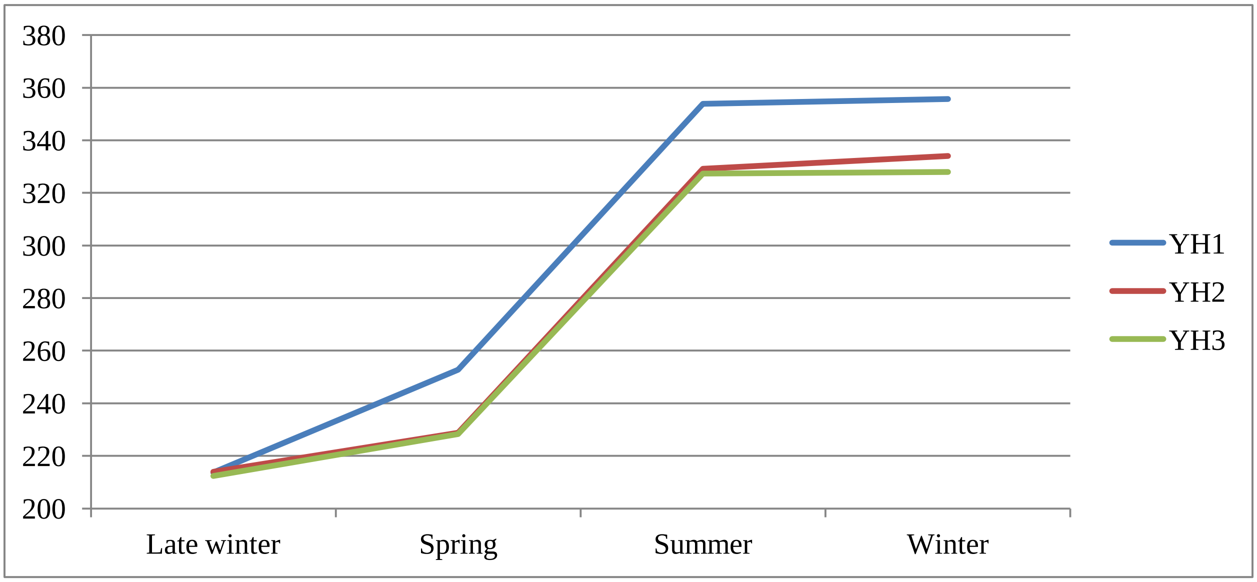


**Figure 6.4** Average weights of the Young Heifer Supplementation Treatment Groups (YH1, YH2 and YH3) during the course of Year 3

The mean BCS of the Young Heifer Supplementation Treatment Groups are presented in Table 6.13.



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**Table 6.13** Mean BCS (± SD) (1 = severely emaciated, 9 = very obese) of the Young Heifers Supplementation Treatment Group for the period August 2011 to 31 July 2014

| Treatments | YH1 | YH2 | YH3 |
|---|---|---|---|
| | 1 August 2011 to 31 July 2012 | | |
| | Mean BCS | Mean BCS | Mean BCS |
| | n = 12 | n = 12 | n = 12 |
| Late winter ( Aug) | **4.58[a] ± 0.51 | 3.42[b] ± 0.51 | 3.08[b] ± 0.29 |
| Spring (Nov) | **5.83[a] ± 0.39 | 5.00[b] ± 0.00 | 4.92[b] ± 0.67 |
| Summer (Mar) | 6.08[a] ± 0.29 | 5.92[a] ± 0.29 | 5.83[a] ± 0.39 |
| Winter (Jul) | 4.17[a] ± 0.39 | 3.92[a] ± 0.29 | 4.00[a] ± 0.00 |
| | 1 August 2012 to 31 July 2013 | | |
| | n = 13 | n = 12 | n = 14 |
| Late winter ( Aug) | 4.08[a] ± 0.28 | 4.00[a] ± 0.00 | 4.00[a] ± 0.00 |
| Spring (Nov) | 4.69[a] ± 0.63 | 4.58[a] ± 0.51 | 4.86[a] ± 0.36 |
| Summer (Mar) | 6.00[a] ± 0.58 | 6.00[a] ± 0.42 | 5.86[a] ± 0.53 |
| Winter (Jul) | 5.23[a] ± 0.60 | 5.00[a] ± 0.43 | 5.00[a] ± 0.55 |
| | 1 August 2013 to 31 July 2014 | | |
| | n = 15 | n = 15 | n = 15 |
| Late winter ( Aug) | 5.00[a] ± 0.00 | 5.00[a] ± 0.00 | 5.00[a] ± 0.00 |
| Spring (Nov) | *4.60[a] ± 0.51 | 4.13[b] ± 0.35 | 4.53[a] ± 0.52 |
| Summer (Mar) | 6.73[a] ± 0.46 | 6.73[a] ± 0.46 | 6.67[a] ± 0.49 |
| Winter (Jul) | 4.33[a] ± 0.49 | 4.20[a] ± 0.56 | 4.27[a] ± 0.46 |

Mean values in the same row with different superscripts differ significantly: $P < 0.05$;* $P < 0.01$; ** $P < 0.0001$

The YH1 Treatment group which received the production supplements consistently had higher BCS than the YH2 and YH3 Treatment Groups; however the difference was not always significant.



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## 6.5 DISCUSSION AND CONCLUSION

Year had marked effect on whether the different supplementation treatments had an effect on the production (growth) performance of the three young heifer supplementation treatment groups. It is assumed that variation in total rainfall and rainfall distribution between years which in turn had an effect on the availability of grazeable roughage during certain periods of the study was the reason why year had an effect on the growth performance.

No significant difference ($P > 0.05$) in weight gain, concluding weight or BCS was measured between the three supplementation treatment groups during Year 1.

In Year 2 the YH2 treatment group gained significantly ($P < 0.05$) more weight than the YH3 treatment group and the YH1 and YH2 treatment groups weighed significantly ($P < 0.05$) more than the YH3 treatment group at the end of the season. In spite of the recovery growth exhibited by the YH3 treatment group during the spring of Year 2, heifers in this treatment group were not able to keep up with the rate of weight gain exhibited by the YH1 and YH2 treatment groups. The period of inferior weight gain by the YH3 treatment group compared to the weight gains of the YH1 and YH2 treatment groups also coincided with the period in which a shortage in grazeable material was experienced.

In Year 3 the YH1 treatment group gained significantly ($P < 0.01$) more weight than the YH2 and YH3 treatment group and weighed significantly ($P < 0.05$) more at the conclusion of the season than the YH2 and YH3 treatment groups. The results from Year 2 and Year 3 are is in agreement with the findings of several researches (O'Donovan *et al.*, 1972; Horton & Holmes, 1978; Baker *et al.*, 1985) who recorded higher feed intakes in cattle during periods of readjustment than would normally be expected. It is therefore obvious that if grass is in short supply (as in Year 2 and Year 3) during the readjustment phase, then complete recovery is not possible.

The average cost of supplementation to the YH1 treatment group amounted to R466.00 per animal per year; for the YH2 treatment group R228.28 per animal per year and R145.30 per animal per year for the YH1 treatment group.

The combined production and economic data underlines the importance of selecting the correct rearing strategy for replacement heifers. Results from this research suggests that the optimum



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supplementation strategy for raising heifers in a year of normal rainfall in the *Elionurus* sour grassland which is in good condition would be that offered to the YH3 treatment group. When rainfall and availability of grazeable roughage becomes a limiting factor better production data is attained by supplementing heifers with the supplements offered to the YH1 and YH2 treatment groups. Owing to the high intakes and thus costs of the supplements offered to the YH1 treatment group, animals receiving these supplements would have to perform considerably better as heifers (22 – 34 months old) and cows than heifers and cows raised on the supplementation regimens offered to the YH2 and YH3 treatment groups.

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# CHAPTER 7

# EFFECTS OF DIFFERENT LEVELS OF SUPPLEMENTATION ON BEEF HEIFER (22 TO 34 MONTHS) GROWTH AND CONCEPTION RATE

## 7.1 INTRODUCTION

Replacement heifers are not generally mated before the age of 24 months because of the extensive nature of the majority of beef enterprises in the Republic of South Africa (Meaker *et al.*, 1980; Van Niekerk & Kernick, 1990). According to Meaker *et al.* (1980), weight at puberty is mainly a function of pre- and post-weaning nutrition. However, due to the time factor and quantity of feed required when heifers are mated to calve down as three-year-olds, the economic implications of the enterprise become vitally important (Van Niekerk & Kernick, 1990).

The identification of an efficient supplementation regimen to rear replacement heifers (22 to 34 months old) in terms of weight gains necessary to achieve acceptable conception rates at the lowest possible cost, is therefore essential to the beef industry of the south-eastern Free State, and therefore the objective of this section of study was to investigate means of achieving this goal.

## 7.2 MATERIALS AND METHODS

### 7.2.1 Outlay of the Heifer Treatment Groups

During mid-July of 2011, prior to the start of the study, 30 Drakensberger heifers (22 months old) were randomly allocated to one of three supplementation treatment groups, namely Heifer Supplementation Treatment Group 1 (H1), Heifer Supplementation Treatment Group 2 (H2) and Heifer Supplementation Treatment Group 3 (H3) (see Figure 5.3). The pre-experimental treatment of the heifers prior to the start of the study was similar.

In the second and third year of the study replacement heifers were assigned to a treatment group according the Young Heifer Supplementation Treatment Group in which they were previously



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allocated to. In other words animals that were assigned to the Young Heifer Supplementation Treatment Group 1 (YH1) were reassigned the following year to the Heifer Supplementation Treatment Group 1 (H1) etc.

### 7.2.2 The Heifer supplementation treatments

The heifers were approximately 2 years of age at the start of this section of the study and as all three treatment groups had already reached the target breeding weight it was decided to offer all three Heifer Supplementation Treatment Groups the same urea based protein and mineral supplement during the late winter supplementation period as well as the same salt and phosphate based mineral supplement during the summer supplementation period. As all three treatment groups were receiving the same supplements during these treatment periods it was decided to pool all three treatment groups into one group. The animals were in early to mid-pregnancy at the start of winter supplementation period and were once again separated into their respective treatment groups as the supplements offered differed in composition. The weights of the animals were taken into account in determining the recommended daily intakes of supplements as the Heifer Supplementation Treatment Groups were still gaining in weight. A summary of the Heifer Supplementation Treatments and the nutrient compositions of the treatments are shown in Table 7.1.



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**Table 7.1** Summary of the Heifer Supplementation Treatments and the nutrient composition of each treatment

| HEIFER SUPPLEMENTATION TREATMENTS | | |
|---|---|---|
| H1 | H2 | H3 |
| LATE WINTER | | |
| Urea based protein and mineral supplement<br>CP: 47.5%<br>From NPN: 95.86%<br>ME: 2.4 MJ/kg | Urea based protein and mineral supplement<br>CP: 47.5%<br>From NPN: 95.86%<br>ME: 2.4 MJ/kg | Urea based protein and mineral supplement<br>CP: 47.5%<br>From NPN: 95.86%<br>ME: 2.4 MJ/kg |
| SUMMER | | |
| Mineral supplement<br>P: 6% | Mineral supplement<br>P: 6% | Mineral supplement<br>P: 6% |
| WINTER | | |
| Cottonseed oilcake and urea based protein and mineral supplement<br>CP: 36.7%<br>From NPN: 77.5%<br>ME: 5.25 MJ/kg | Urea and cottonseed oilcake based protein and mineral supplement<br>CP: 46.6%<br>From NPN: 88.7%<br>ME: 4.4 MJ/kg | Urea based protein and mineral supplement<br>CP: 47.5%<br>From NPN: 95.86%<br>ME: 2.4 MJ/kg |

The Heifer Supplementation Treatment Groups were offered the same urea based protein and mineral supplement in late winter. The supplementation formulation and nutrient composition of the treatment offered is presented in Table 7.2. The supplement had a crude protein (CP) content of 47.5% of which 95.86% was derived from non-protein-nitrogen (NPN). The expected intake of the treatment was 270 – 380 g per animal per day (Table 7.2).



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**Table 7.2** Supplementation formulation and nutrient composition of the treatment offered to the Heifer Supplementation Treatment Groups (H1, H2 and H3) during the late winter supplementation period

| Late winter (August to mid-December) | |
|---|---|
| Heifer Supplementation Treatment Groups (H1, H2, H3) | |
| Raw material | % |
| Maize meal | 18.46 |
| Feed grade Urea | 15.38 |
| Kimtrafos 12 | 15.38 |
| Kalori 3000 | 3.85 |
| Feed grade Sulfur | 0.77 |
| Salt | 46.15 |
| Nutrient composition | |
| Crude protein (%) | 47.5 |
| From NPN (%) | 95.86 |
| ME (MJ/kg) | 2.4 |
| P (%) | 2.57 |
| Intake (g/animal/day) | 270 – 380 |

The supplementation formulation and nutrient composition of the summer treatment offered is presented in Table 7.3. The summer Heifer Supplementation Treatment consisted of a mineral supplement which supplied 6g P per 100g intake. The expected intake of the treatment was 65 – 155 g per animal per day.



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**Table 7.3** Supplementation formulation and nutrient composition of the treatment offered to the Heifer Supplementation Treatment Groups (H1, H2, H3) during the summer period

| Summer (mid-December to March) | |
|---|---|
| Heifer Supplementation Treatment Group (H1, H2, H3) | |
| Raw material | % |
| Kimtrafos 12 | 50 |
| Feed grade Sulfur | 5 |
| Salt | 45 |
| Nutrient composition | |
| P (%) | 6.0 |
| Intake (g/animal/day) | 85 – 200 |

The supplementation formulations and nutrient compositions of the supplements offered to the Heifer Supplementation Treatment Groups during the winter supplementation period are presented in Table 7.4

**Table 7.4** Supplementation formulations and nutrient compositions of the treatments offered to the Heifer Supplementation Treatment Groups (H1, H2 and H3) during the winter supplementation period

| **Winter (April to July)** | | | | | |
|---|---|---|---|---|---|
| **Heifer Treatment 1 (H1)** | | **Heifer Treatment 2 (H2)** | | **Heifer Treatment 3 (H3)** | |
| Raw material | % | Raw material | % | Raw material | % |
| Maize meal | 24.88 | Maize meal | 23.65 | Maize meal | 18.46 |
| Cottonseed oilcake | 14.93 | Cottonseed oilcake | 9.46 | Cottonseed oilcake | - |
| Feed grade Urea | 9.95 | Feed grade Urea | 14.93 | Feed grade Urea | 15.38 |
| Kimtrafos 12 | 9.95 | Kimtrafos 12 | 14.93 | Kimtrafos 12 | 15.38 |
| Kalori 3000 | 4.98 | Kalori 3000 | 4.73 | Kalori 3000 | 3.85 |
| Feed grade Sulfur | 0.49 | Feed grade Sulfur | 0.66 | Feed grade Sulfur | 0.77 |
| Salt | 34.83 | Salt | 33.11 | Salt | 46.15 |
| Nutrient composition | | Nutrient composition | | Nutrient composition | |
| Crude protein (%) | 36.7 | Crude protein (%) | 46.6 | Crude protein (%) | 47.5 |
| From NPN (%) | 77.5 | From NPN (%) | 88.7 | From NPN (%) | 95.86 |
| ME (MJ/kg) | 5.25 | ME (MJ/kg) | 4.4 | ME (MJ/kg) | 2.4 |
| P (%) | 1.4 | P (%) | 1.9 | P (%) | 2.57 |
| Intake (g/animal/day) | 360 – 520 | Intake (g/animal/day) | 280 – 400 | Intake (g/animal/day) | 280 – 400 |



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The cottonseed oilcake and urea based protein and mineral based supplement offered to the H1 Treatment Group consisted of 14.93% cottonseed oilcake and 9.95% urea. The urea and cottonseed oilcake based protein and mineral supplement offered to the H2 Treatment Group consisted of 14.93% urea and 9.46% cottonseed oilcake. The H3 Treatment Group was offered a urea based protein and mineral supplement which contained 15.38% urea and no cottonseed oilcake.

## 7.3 RESULTS

### 7.3.1 Supplement intake and cost of supplementation

The yearly (2011, 2012 and 2013) average late winter supplement and calculated nutrient (CP, ME and P) intakes (g/animal/day) of the Heifer Supplementation Treatment Groups (H1, H2 and H3) are presented in Table 7.5.

**Table 7.5** Yearly (2011, 2012 and 2013) average late winter supplement and nutrient intakes (g/animal/day) of the Heifer Supplementation Treatment Groups (H1, H2 and H3)

| Season and Year | Period (d) | Component | Treatment |
|---|---|---|---|
| | | | H1, H2, H3 |
| Late winter 2011 | 133 | Supplement intake (g/animal/day) | 134 |
| | | CP (g/animal/day) | 64 |
| | | Protein from NPN (g/animal/day) | 61 |
| | | ME (MJ/animal/day) | 0.32 |
| | | P (g/animal/day) | 3.44 |
| Late winter 2012 | 135 | Supplement intake (g/animal/day) | 168 |
| | | CP (g/animal/day) | 80 |
| | | Protein from NPN (g/animal/day) | 77 |
| | | ME (MJ/animal/day) | 0.40 |
| | | P (g/animal/day) | 4.32 |
| Late winter 2013 | 142 | Supplement intake (g/animal/day) | 324 |
| | | CP (g/animal/day) | 154 |
| | | Protein from NPN (g/animal/day) | 148 |
| | | ME (MJ/animal/day) | 0.78 |
| | | P (g/animal/day) | 8.33 |



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The three year (2011 to 2013) average late winter supplement and calculated nutrient intakes are presented in Table 7.6. The three year average cost incurred in providing the late winter supplementation treatments are also shown in Table 7.6.

**Table 7.6** Three year (2011 - 2013) average late winter supplement and nutrient intakes (g/animal/day) and cost (R/animal/late winter supplementation period) of the Heifer Supplementation Treatment Groups (H1, H2 and H3)

| Season and Year | Component | Period (d) | Treatment |
|---|---|---|---|
| | | | H1, H2, H3 |
| Late winter | Supplement intake (g/animal/day) | 137 | 211 |
| 2011 – 2013 | CP (g/animal/day) | | 100 |
| | Protein from NPN (g/animal/day) | | 96 |
| | ME (MJ/animal/day) | | 0.51 |
| | P (g/animal/day) | | 5.42 |
| | Cost (R/animal/supplementation period) | | R 73.15 |

The three late winter supplementation periods lasted an average of 137 days. The 2011 and 2012 late winter supplement (134g and 168g/animal/day) and nutrient intakes (Table 7.5) of the Heifer Supplementation Treatment Groups (H1, H2 and H3) were far below the recommended 270 – 380g per animal per day, however during the 2013 late winter supplementation period in which a shortage of grazeable material was experienced the supplement intake increased to 324g/animal/day. The three year average cost incurred in supplying the urea based protein and mineral supplement to the treatment groups was R73.15 per animal per late winter supplementation period (Table 7.6).

The yearly (2011-12, 2012-13 and 2013-14) average summer supplement and nutrient intakes are presented in Table 7.7 and the three year average (2011-12 to 2013-14) summer supplement and nutrient intakes are presented in Table 7.8.



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**Table 7.7** Yearly (2011-12, 2012-13 and 2013-14) average summer supplement and nutrient intakes (g/animal/day) of the Heifer Supplementation Treatment Groups (H1, H2 and H3) (2011 – 2014)

| Season and Year | Period (d) | Component | Treatment |
|---|---|---|---|
| | | | H1, H2, H3 |
| Summer 2011-12 | 109 | Supplement intake (g/animal/day) | 51 |
| | | P (g/animal/day) | 1.23 |
| Summer 2012-13 | 106 | Supplement intake (g/animal/day) | 65 |
| | | P (g/animal/day) | 1.67 |
| Summer 2013-14 | 101 | Supplement intake (g/animal/day) | 65 |
| | | P (g/animal/day) | 1.67 |

**Table 7.8** Three year (2011 - 2014) average summer supplement and nutrient intakes (g/animal/day) and cost (R/animal/summer supplementation period) of the Heifer Supplementation Treatment Groups (H1, H2 and H3)

| Season | Component | Period (d) | Treatment |
|---|---|---|---|
| | | | H1, H2, H3 |
| Summer | Supplement intake (g/animal/day) | 106 | 60 |
| 2011 - 2014 | P (g/animal/day) | | 1.54 |
| | Cost (R/animal/supplementation period) | | R 20.71 |

The three summer supplementation periods lasted an average of 106 days. The average summer supplement intakes (51, 65 and 65g/animal/day) in all three years were below the recommended 85 - 200g per animal per day and thus the P intake never exceeded 1.67g P per day which was well short of the recommended 5.1g P per animal. The three year average cost incurred in supplying the mineral supplement to the Heifer Supplementation Treatment Groups (H1, H2 and H3) was R20.71 per animal (Table 7.8).

The yearly (2012, 2013 and 2014) average winter supplement and nutrient intakes are presented in Table 7.9 and the three year (2012 to 2014) average winter supplement and nutrient intakes are presented in Table 7.10.



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**Table 7.9** Yearly (2012, 2013 and 2014) average winter supplement and nutrient intakes (g/animal/day) of the Heifer Supplementation Treatment Groups (H1, H2 and H3)

| Season | Component | Period (d) | Treatment H1 | Treatment H2 | Treatment H3 |
|---|---|---|---|---|---|
| Winter 2012 | Supplement intake (g/animal/day) | 123 | 467 | 345 | 323 |
| | CP (g/animal/day) | | 171 | 161 | 153 |
| | Protein from NPN (g/animal/day) | | 133 | 143 | 147 |
| | ME (MJ/animal/day) | | 2.45 | 1.52 | 0.78 |
| | P (g/animal/day) | | 6.54 | 6.56 | 8.30 |
| Winter 2013 | Supplement intake (g/animal/day) | 124 | 432 | 430 | 320 |
| | CP (g/animal/day) | | 159 | 200 | 152 |
| | Protein from NPN (g/animal/day) | | 123 | 177 | 145 |
| | ME (MJ/animal/day) | | 2.44 | 1.89 | 0.77 |
| | P (g/animal/day) | | 6.05 | 8.17 | 8.22 |
| Winter 2014 | Supplement intake (g/animal/day) | 122 | 426 | 332 | 290 |
| | CP (g/animal/day) | | 156 | 154 | 138 |
| | Protein from NPN (g/animal/day) | | 121 | 137 | 132 |
| | ME (MJ/animal/day) | | 2.24 | 1.46 | 0.70 |
| | P (g/animal/day) | | 5.96 | 6.31 | 7.45 |

**Table 7.10** Three year (2012 - 2014) average winter supplement and nutrient intakes (g/animal/day) and cost (R/animal/winter supplementation period) of the Heifer Supplementation Treatment Groups (H1, H2 and H3)

| Season and Year | Component | Period (d) | Treatment | | |
|---|---|---|---|---|---|
| | | | H1 | H2 | H3 |
| Winter 2012 - 2014 | Supplement intake (g/animal/day) | 123 | 442 | 369 | 311 |
| | CP (g/animal/day) | | 162 | 172 | 148 |
| | Protein from NPN (g/animal/day) | | 126 | 153 | 142 |
| | ME (MJ/animal/day) | | 2.32 | 1.62 | 0.75 |
| | P (g/animal/day) | | 6.12 | 7.01 | 7.99 |
| | Cost (R/animal/suppl. period) | | R 158.67 | R 137.76 | R 104.55 |



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The three winter supplementation periods lasted an average of 123 days. All three yearly (2012 – 2014) winter supplement intakes of all three Heifer Supplementation Treatment Groups (H1, H2 and H3) were within the recommended intake ranges for each supplemental treatment (Table 7.8 and Table 7.9). The three year average cost incurred in supplying the winter supplementation treatments were as follows: H1 (R158.67 per animal/winter supplementation period), H2 (R137.76 per animal per winter supplementation period) and H3 (R104.55 per animal per supplementation period).

Table 7.11 summarizes the three year average cost incurred in supplying the different Heifer Supplementation Treatments.

**Table 7.11** Three year average cost (R/animal/year) incurred in supplying the Heifer Supplementation Treatments

| | H1 | H2 | H3 |
|---|---|---|---|
| Average cost of late winter supplementation | R 73.15 | R 73.15 | R 73.15 |
| Average cost of summer supplementation | R 20.71 | R 20.71 | R 20.71 |
| Average cost of winter supplementation | R 158.67 | R 137.76 | R 104.55 |
| Total average cost of supplementation (R/animal/year) | R 252.53 | R 231.62 | R 198.41 |

### 7.3.2 Body weight and BCS of the Heifer Supplementation Treatment Groups

The body weight and weight gains of the Heifer Supplementation Treatment Groups are summarized in Table 7.12. No significant difference ($P > 0.05$) in body weight or weight gain between measurements or total weight gain was measured between the Heifers Supplementation Treatment Groups in Year 1 (2011/12) or Year 2 (2012/13).



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**Table 7.12** Mean (± SD) body weight (kg) and mean weight gain (kg) of Heifer Supplementation Treatment Groups for the period August 2011 to July 2014

| Treatments | H1 | H2 | H3 |
|---|---|---|---|
| 1 August 2011 to 31 July 2012 | | | |
| | Mean weight (kg) | Mean weight (kg) | Mean weight (kg) |
| | n = 10 | n = 9 | n = 7 |
| Late winter ( Aug) | 332[a] ± 17 | 327[a] ± 35 | 333[a] ± 26 |
| Spring (Nov) | 364[a] ± 21 | 362[a] ± 36 | 366[a] ± 26 |
| Summer (Mar) | 431[a] ± 21 | 429[a] ± 36 | 434[a] ± 30 |
| Winter (Jul) | 482[a] ± 25 | 472[a] ± 44 | 486[a] ± 35 |
| Total weight gain | 150[a] ± 23 | 145[a] ± 21 | 154[a] ± 15 |
| 1 August 2012 to 31 July 2013 | | | |
| | n = 9 | n = 11 | n = 10 |
| Late winter ( Aug) | 357[a] ± 22 | 344[a] ± 22 | 340[a] ± 17 |
| Spring (Nov) | 397[a] ± 33 | 380[a] ± 19 | 379[a] ± 23 |
| Summer (Mar) | 478[a] ± 33 | 461[a] ± 23 | 460[a] ± 23 |
| Winter (Jul) Weight gain | 493[a] ± 42 | 478[a] ± 23 | 468[a] ± 26 |
| Total weight gain | 137[a] ± 27 | 134[a] ± 134 | 128[a] ± 15 |
| 1 August 2013 to 31 July 2014 | | | |
| | n = 10 | n = 10 | n = 13 |
| Late winter ( Aug) | 366[a] ± 45 | 356[a] ± 27 | 327[b] ± 28 |
| Spring (Nov) | 374[a] ± 34 | 356[ab] ± 25 | 338[b] ± 28 |
| Summer (Mar) | 485[a] ± 40 | 468[ab] ± 35 | 440[b] ± 32 |
| Winter (Jul) | 513[a] ± 41 | 497[ab] ± 24 | 478[b] ± 33 |
| Total weight gain | 147[a] ± 19 | 141[a] ± 15 | 151[a] ± 21 |

Mean values in the same row with different superscripts differ significantly: $P < 0.05$; * $P < 0.01$

At the start of Year 3 (2013/14) the H1 Treatment Group (366 kg ± 45) and H2 Treatment Group (356 kg ± 27) weighed significantly ($P < 0.05$) heavier than the H3 Treatment Group (327 kg ± 28). This was to be expected as the Year 2 YH1 Treatment Group (which was reassigned to the H1 Treatment Group in Year 3) and Year 2 YH2 Treatment Group (which was reassigned to the



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H2 Treatment Group in Year 3) had gained more weight as young heifers in Year 2 compared to the YH3 Treatment Group (which was reassigned to the H3 Treatment Group in Year 3) (see Table 6.12). Even though the H3 Treatment Group gained more weight (151 kg ± 21) than the H1 Treatment Group (147 kg ± 19) and H2 Treatment Group (141 kg ± 15) the H3 Treatment Group was not able recover from the lower weight gains as the YH3 treatment group in Year 2.

Figure 7.1 illustrates the average weight of the three Heifer Supplementation Treatment Groups during Year 1.

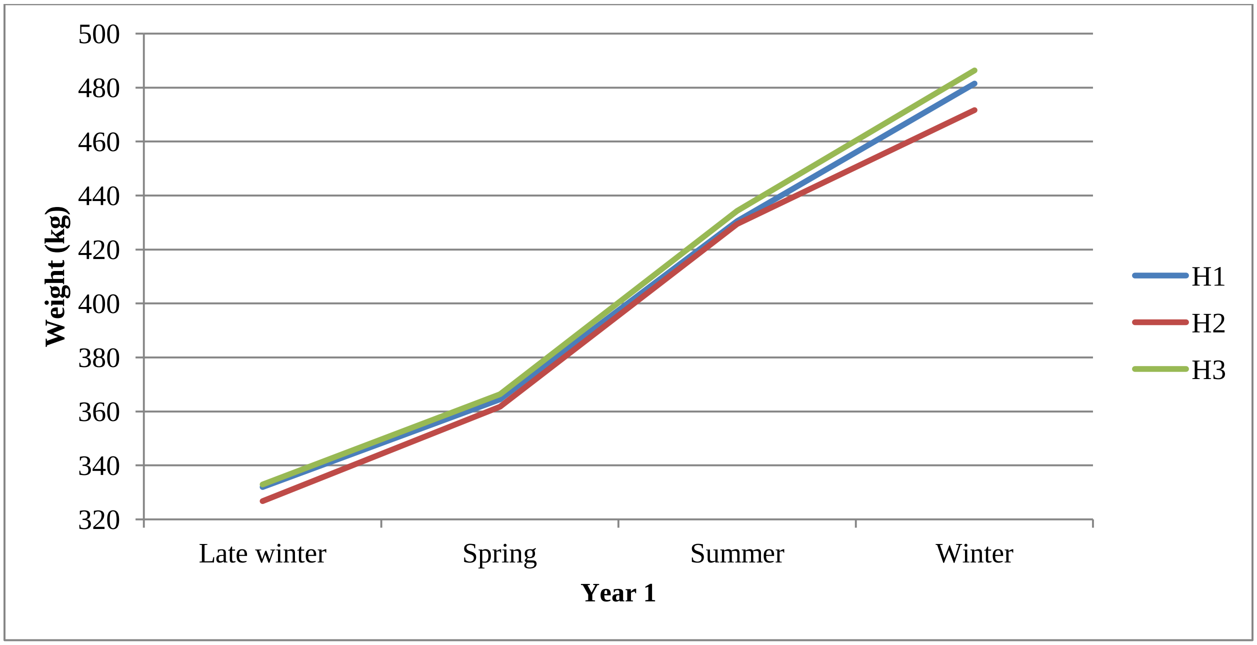


**Figure 7.1** Average weight of the Heifer Supplementation Treatment Groups (H1, H2 and H3) during Year 1

Figure 7.2 illustrates the average weight of the three Heifer Supplementation Treatment Groups during Year 2 and Figure 7.3 the average weight of the three Heifer Supplementation Treatment Groups during Year 3.



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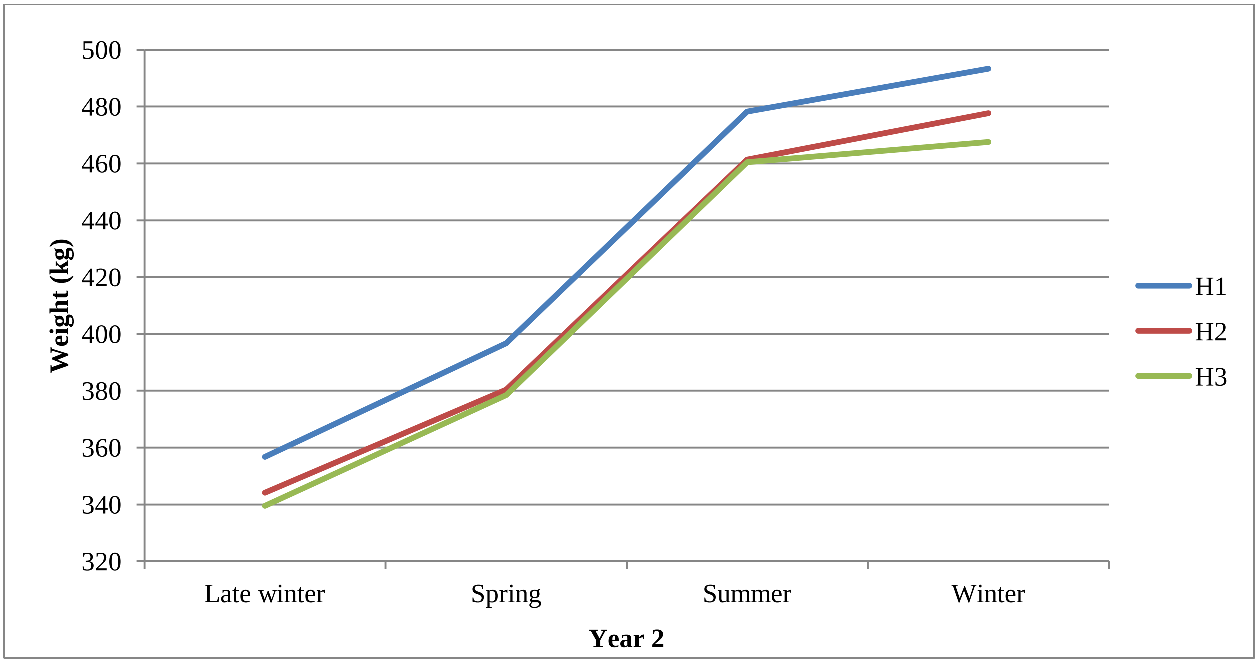


**Figure 7.2** Average weight of the Heifer Supplementation Treatment Groups (H1, H2 and H3) during Year 2

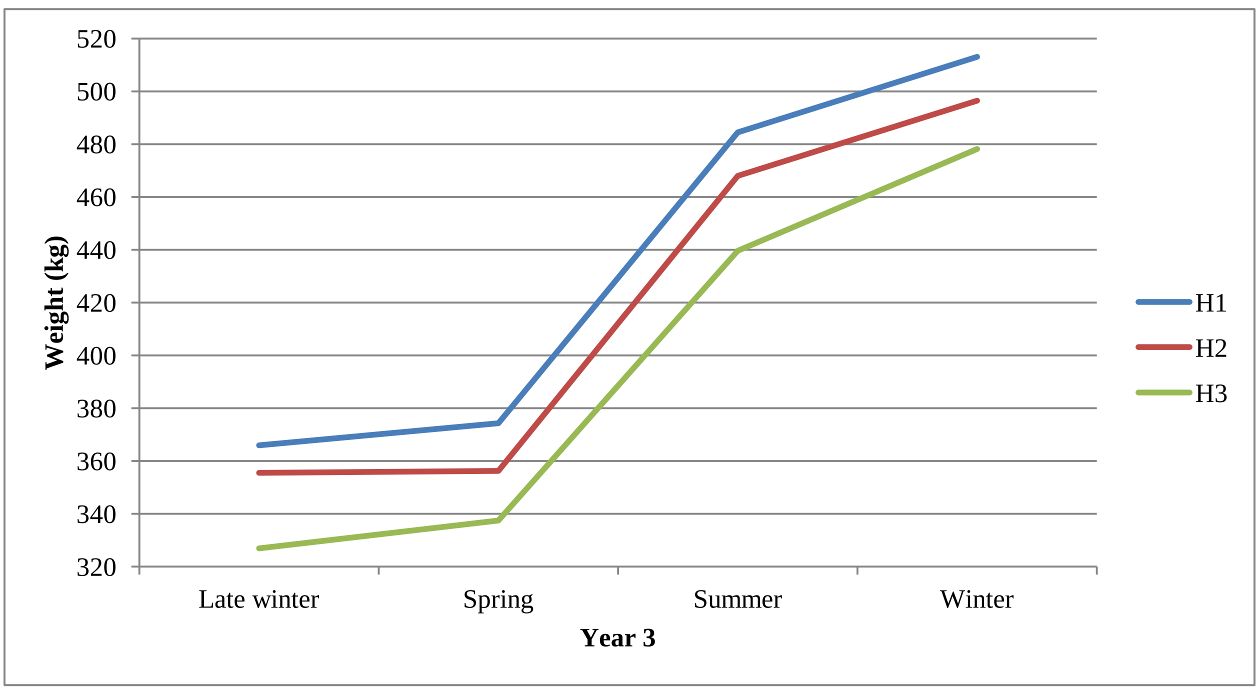


**Figure 7.3** Average weight of the Heifer Supplementation Treatment Groups (H1, H2 and H3) during Year 3



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The mean BCS of the different Heifer Supplementation Treatment Groups are presented in Table 7.13.

**Table 7.13** Mean (± SD) BCS (1 = severely emaciated, 9 = very obese) of the Heifer Supplementation Treatment Groups for the period August 2011 to 31 July 2014

| Treatments | H1 | H2 | H3 |
|---|---|---|---|
| 1 August 2011 to 31 July 2012 | | | |
| | Mean BCS | Mean BCS | Mean BCS |
| | n = 10 | n = 9 | n = 7 |
| Late winter ( Aug) | $3.00^{a} \pm 0.00$ | $3.11^{a} \pm 0.33$ | $3.00^{a} \pm 0.00$ |
| Spring (Nov) | $5.20^{a} \pm 0.42$ | $5.11^{a} \pm 0.60$ | $4.86^{a} \pm 0.38$ |
| Summer (Mar) | $6.30^{a} \pm 0.48$ | $6.22^{a} \pm 0.44$ | $6.00^{a} \pm 0.00$ |
| Winter (Jul) | $4.80^{a} \pm 0.63$ | $4.67^{a} \pm 0.50$ | $4.57^{a} \pm 0.53$ |
| 1 August 2012 to 31 July 2013 | | | |
| | n = 9 | n = 11 | n = 10 |
| Late winter ( Aug) | $4.11^{a} \pm 0.33$ | $3.91^{a} \pm 0.30$ | $4.00^{a} \pm 0.00$ |
| Spring (Nov) | $5.00^{a} \pm 0.00$ | $4.91^{a} \pm 0.30$ | $5.10^{a} \pm 0.32$ |
| Summer (Mar) | $7.00^{a} \pm 0.00$ | $7.00^{a} \pm 0.00$ | $7.20^{a} \pm 0.42$ |
| Winter (Jul) | $6.11^{a} \pm 0.33$ | $5.55^{b} \pm 0.52$ | $5.90^{a} \pm 0.57$ |
| 1 August 2013 to 31 July 2014 | | | |
| | n = 10 | n = 10 | n = 13 |
| Late winter ( Aug) | $5.30^{a} \pm 0.67$ | $5.00^{a} \pm 0.47$ | $4.92^{a} \pm 0.49$ |
| Spring (Nov) | $3.50^{a} \pm 0.53$ | $3.20^{a} \pm 0.42$ | $3.38^{a} \pm 0.51$ |
| Summer (Mar) | $5.40^{a} \pm 0.70$ | $5.40^{a} \pm 0.52$ | $5.46^{a} \pm 0.52$ |
| Winter (Jul) | $5.40^{a} \pm 0.52$ | $5.60^{a} \pm 0.52$ | $5.46^{a} \pm 0.66$ |

Mean values in the same row with different superscripts differ significantly: $P < 0.05$

A significant ($P < 0.05$) difference in BCS between treatment groups was only measured once. In Year 2 (2012-13) of the study the H2 Treatment Group had a lower BCS (5.55 ± 0.52) at the end of the year than the H1 and H3 Treatment Groups. In Year 1 (2011-12) and Year 2 (2012-13) the BCS of the heifers were the lowest at the beginning (August) of the year. As the grazing conditions improved during spring and summer BCS increased peaking in late summer (March).



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The BCS declined in the subsequent autumn and winter as grazing conditions deteriorated. As mentioned, a dry Year 3 (2013-14) was experienced with a shortage in the availability of roughage experienced in the spring and summer of 2013. In Year 3 the BCS of the Heifer Supplementation Treatment Groups were at their lowest in spring, which corresponded with the roughage shortage. The BCS increased in the subsequent summer (March) but peaked at a lower score than in the previous two years. The Heifer Supplementation Treatment Groups also maintained their summer BCS in winter and did not lose condition as in Year 1 and Year 2.

### 7.3.3 Conception rate of the Heifer Supplementation Treatment Groups

The average conception rate over all three Heifer Supplementation Treatment Groups was 84.85% in 2011, 50% in 2012 and 84.62% in 2013. In view of the authors' and local veterinarians' observations and the controversial statements made about one of the commercially available *Brucella* vaccines, it is suspected that the use of this vaccine was the cause of the unprecedented decline in the pregnancy rate of the heifers as a conception rate of 95% is considered normal for the herd. Conception rate was thus not used as a production parameter for the Heifer Supplementation Treatment Groups.

## 7.4 DISCUSSION AND CONCLUSION

Protein is an essential ingredient of a late winter maintenance supplement Reyneke, 1971; Winks & Laing, 1972; Hennessy, 1983; Van Niekerk & Jacobs, 1985; Groenewald, 1986; McCosker *et al*., 1991; De Brouwer *et al.*, 1993; Van Niekerk, 1996) as protein is the most important limiting nutrient during winter. Even though the intake (211g/animal/day) of the late winter supplement was far below the recommended daily intake of 270 – 380g/animal per day it would appear that animal production was not adversely affected as all Heifer Treatment Groups were able to gain weight during this period.

Due to reports published by Van Niekerk & Jacobs (1985), Groenewald (1986), Read *et al.* (1986a), Read *et al.* (1986b), De Waal (1990), De Brouwer *et al.* (1993), De Waal *et al.* (1996), Van Niekerk (1996) and De Brouwer *et al.* (2000) phosphorus supplementation has become general practice in South Africa. However, the average daily intake of supplemental P during the summer supplementation period was 1.54g/animal per day which was far below the



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recommended minimum of 5.1g P per animal per day. A possible reason for the low intake of supplemental P could be the possible use of well-conserved veld and the question arises whether to what extent the results could be replicated under conditions of over-grazing, which is often applied in practice.

The inclusion of a natural protein source in the form of cottonseed oilcake and the higher energy content of the supplements offered to the H1 Treatment Group (14.93 % cottonseed oilcake and 5.25 MJ/kg) and the H2 Treatment Group (9.46% cottonseed oilcake and 4.4 MJ/kg) *versus* no cottonseed oilcake and 2.4 MJ/kg of the supplement offered to the H3 Treatment Group during the winter supplementation period did not bring about a production response as no significant ($P > 0.05$) difference in total weight gain was measured between treatment groups during the course of the study.

The body weights at the start of the breeding season (November) of all three Heifer Supplementation Treatment Groups over the entire 3-year study period fell well within the optimum weight range as suggested by Lamond (1970), Meaker (1980), Dreyer (1982), Lepen, (1991), BIF (1990) and Lynch *et al.* (1997). It calls for feeding heifers to a prebreeding weight that represents 60 to 65% of the heifer's projected mature weight and only when heifers reach the genetically predetermined weight can high pregnancy rates be obtained (Lamond, 1970 and Lynch *et al.*, 1997). Dreyer (1982) and Lepen *et al.* (1991) both established that Drakensberger heifers reached puberty at an average weight of 300 kg.

A body condition score of 5 to 6 is thus considered (for various reasons) as ideal for heifers at breeding. Fleck *et al.* (1980) and Ferrel (1982) indicate that the condition of heifers during the postweaning period influenced first exposure pregnancy rates and that those that were either thin or fat prior to the breeding season had more difficulty in conceiving. Nolan *et al.* (1998) and Armstrong *et al.* (2001) are in an agreement that nulliparious heifers having moderately high body condition scores on a high plane of nutrition was detrimental to oocyte quality and had low post fertilization developmental rates. Adamiak *et al.* (2005) concluded that the effects of the level of feeding on oocyte quality were dependent on the body condition of the animal. High levels of feeding improved post fertilization development for animals in low body condition score but reduced post fertilization development for animals in good body condition score. The



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effects of high levels of feeding were also cumulative, with blastocyst yields for heifers in moderately good body condition deteriorating over time relative to heifers in low body condition. Adamiak *et al.* (2005) also produced evidence that indicated that moderately fat animals on a high level of feeding were hyperinsulinemic and that those very high plasma insulin concentrations were associated with impaired oocyte quality.

In Year 1 and Year 2 all three Heifer Supplementation Treatment Groups were able to reach the target breeding BCS at the start of the breeding season (November). At the beginning of Year 3 breeding season the BCS of the three Heifer Supplementation Treatment Groups ranged between 3.2 and 3.5 which were far below the target breeding BCS of 5 to 6. As grazing conditions improved the BCS increased and heifers were able to attain the ideal breeding BCS of between 5 and 6 by the end of the breeding season.

When considering the costs incurred when developing the three Heifer Supplementation Treatment Groups the importance of selecting the correct rearing strategy is underlined. All three Treatment Groups were able to reach production targets (target weight and BCS) at breeding. However an economic analysis of the costs incurred in developing heifers from wean to late pregnancy (wean to 34 months old) indicates an economic advantage in offering the supplements offered to the Young Heifer Supplementation Treatment 3 Group (YH3) (wean to 22 months old) and the Heifer Supplementation Treatment 3 Group (H3) (22 months to 34 months old).

The total average cost of developing the YH1 and H1 Supplementation Treatment Groups from wean to late pregnancy (wean – 34 months old) was R 717.38, the YH2 and H2 Supplementation Treatment Groups was R 457.44 and the YH3 and H3 Supplementation Treatment Groups was R 344.71.

These results are in agreement with the findings of Clanton *et al.* (1993), Lynch *et al.* (1997), Grings *et al.* (1999), Funston *et al.* (2012) and Endecott *et al.* (2013) who found recovery growth periods could be utilized and provided an opportunity to decrease feed costs. Studies from multiple locations indicate that restricting body weight by developing heifers on dormant winter forage increased economic advantages, potentially creating heifers that are better suited to maintain themselves as cows compared with programs that develop heifers to a greater target



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body weight (Endecott *et al.*, 2013). However the availability of adequate roughage during recovery growth periods cannot be over emphasized. This study has once again demonstrated that feeding replacement heifers to a traditional body weight increased development costs without improving reproduction.

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# CHAPTER 8

# REPRODUCTION AND PROFITABILITY OF EXTENSIVE FIRST-CALF BEEF HEIFERS ON THREE LEVELS OF SUPPLEMENTATION

## 8.1 INTRODUCTION

It is generally accepted that beef heifers have the ability to conceive at a high rate during their first breeding season provided they have grown sufficiently (Lamond, 1970; Meaker *et al.*, 1980a; Meaker *et al.*, 1980b; Lynch *et al.*, 1997). However, when breeding takes place while they are suckling their first calf the reconception can be low (O'Rourke, 1991; Schatz & Hearnden, 2008). The nutritional requirements for growth of the young cow in addition to those for lactation are not usually met by the natural grazing available (Lishman, 1984).

The purpose of this study was to determine whether offering a production supplement instead of a maintenance supplement to three year old first-calf-heifers on *Elionurus* sour grassland would reduce the loss in body weight during lactation and thereby increase reconception and whether supplementation with a production supplement is economically justifiable.

## 8.2 MATERIALS AND METHODS

### 8.2.1 Outlay of the First-calf-heifer Treatment Groups

During mid-July of 2011, prior to the start of the study, 30 pregnant two-and-a-half year old Drakensberger heifers were randomly allocated to one of three supplementation treatment groups namely: First-calf-heifer supplementation treatment group 1 (1CH1), First-calf-heifer supplementation treatment group 2 (1CH2) and First-calf-heifer supplementation treatment group 3 (1CH3) (see Figure 5.4). The pre-experimental treatment of the heifers prior to the start of the study was similar. The heifers were mated to calf down at the age of three years.

In the second and third year of the study animals that were in the Heifer Supplementation Treatment Group 1 (H1) were reassigned to the First-calf-heifer Supplementation Treatment



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Group 1 (1CH1) and the animals in the H2 Supplementation Treatment Group were reassigned to the 1CH2 Supplementation Treatment Group etc.

### 8.2.2 The First-calf-heifer supplementation treatments

A summary of the First-calf-heifer Supplementation Treatments and the nutrient compositions of the treatments are shown in Table 8.1.

**Table 8.1** Summary of the First-calf-heifer Supplementation Treatments and nutrient composition of each treatment

| FIRST-CALF-HEIFER SUPPLEMENTATION TREATMENTS | | |
|---|---|---|
| 1CH1 | 1CH2 | 1CH3 |
| LATE WINTER | | |
| Winter production supplement<br>CP: 30.6%<br>From NPN: 47.4%<br>ME: 7.4 MJ/kg | Cottonseed oilcake and urea based late winter protein and mineral supplement<br>CP: 32.91%<br>From NPN: 70.72%<br>ME: 6.89 MJ/kg | Urea based protein and mineral supplement<br>CP: 47.5<br>From NPN: 95.86<br>ME: 2.4 MJ/kg |
| SUMMER | | |
| Summer production supplement<br>CP: 16.4%<br>From NPN: 37.0%<br>ME: 9.0 MJ/kg<br>P: 1.3% | Mineral supplement containing 15% protein<br>CP: 15.0%<br>From NPN: 13.6%<br>ME: -<br>P: 5% | Mineral supplement<br>CP: -<br>From NPN: -<br>ME: -<br>P: 6% |
| WINTER | | |
| Cottonseed oilcake and urea based protein and mineral supplement<br>CP: 36.7%<br>From NPN: 77.5%<br>ME: 5.25 MJ/kg | Urea and cottonseed oilcake based protein and mineral supplement<br>CP: 46.6%<br>From NPN: 88.7%<br>ME: 4.4 MJ/kg | Urea based protein and mineral supplement<br>CP: 47.5%<br>From NPN: 95.86%<br>ME: 2.4 MJ/kg |



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The supplementation formulations and nutrient compositions of the treatments offered to the First-calf-heifer Supplementation Treatment Groups during the late winter supplementation period are presented in Table 8.2.

**Table 8.2** Supplementation formulations and nutrient compositions the treatments offered to the First-calf-heifer Supplementation Treatment Groups (1CH1, 1CH2 and 1CH3) during the late winter supplementation period

| **Late winter supplementation period (August to mid-December)** | | | | | |
|---|---|---|---|---|---|
| **First-calf-heifer Treatment 1** | | **First-calf-heifer Treatment 2** | | **First-calf-heifer Treatment 3** | |
| Raw material | % | Raw material | % | Raw material | % |
| Maize meal | 28.50 | Maize meal | 37.34 | Maize meal | 18.46 |
| Cottonseed oilcake | 37.99 | Cottonseed oilcake | 16.59 | Cottonseed oilcake | - |
| Feed grade Urea | 4.75 | Feed grade Urea | 8.30 | Feed grade Urea | 15.38 |
| Kimtrafos 12 | 7.12 | Kimtrafos 12 | 8.30 | Kimtrafos 12 | 15.38 |
| Kalori 3000 | 2.37 | Kalori 3000 | 4.15 | Kalori 3000 | 3.85 |
| Feed grade Sulfur | 0.28 | Feed grade Sulfur | 0.42 | Feed grade Sulfur | 0.77 |
| Salt | 18.99 | Salt | 24.90 | Salt | 46.15 |
| Nutrient composition | | Nutrient composition | | Nutrient composition | |
| Crude protein (%) | 30.6 | Crude protein (%) | 32.91 | Crude protein (%) | 47.5 |
| From NPN (%) | 47.4 | From NPN (%) | 70.72 | From NPN (%) | 95.86 |
| ME (MJ/kg) | 7.4 | ME (MJ/kg) | 6.89 | ME (MJ/kg) | 2.4 |
| P (%) | 1.3 | P (%) | 1.25 | P (%) | 2.57 |
| Intake (g/cow/day) | 1000 – 2000 | Intake (g/cow/day) | 600 – 700 | Intake (g/cow/day) | 350 – 500 |

The 1CH1 Treatment Group was offered a winter production supplement (Table 8.2) in late winter which had cottonseed oilcake as the main ingredient (37.99%). The 1CH2 Treatment Group was offered a cottonseed-oilcake and urea based protein and mineral supplement which had maize meal as the main ingredient (37.34%). The 1CH3 Treatment Group was offered a urea based protein and mineral supplement which had salt (46.15%) as the main ingredient (Table 8.2).

The supplementation formulations and nutrient compositions of the treatments offered to the First-calf-heifer Supplementation Treatment Groups during the summer supplementation period are presented in Table 8.3.



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**Table 8.3** **S**upplementation formulations and nutrient compositions of the treatments offered to the First-calf-heifer Supplementation Treatment Groups (1CH1, 1CH2 and 1CH3) during the summer supplementation period

| Summer supplementation period (mid-December to March) | | | | | |
|---|---|---|---|---|---|
| **First-calf-heifer Treatment 1** | | **First-calf-heifer Treatment 2** | | **First-calf-heifer Treatment 3** | |
| Raw material | % | Raw material | % | Raw material | % |
| Voermol Superfos | - | Voermol Superfos | 100 | Voermol Superfos | - |
| Maize meal | 55.78 | Maize meal | - | Maize meal | - |
| Cottonseed oilcake | 15.94 | Cottonseed oilcake | - | Cottonseed oilcake | - |
| Feed grade Urea | 1.99 | Feed grade Urea | - | Feed grade Urea | - |
| Kimtrafos 12 | 7.97 | Kimtrafos 12 | - | Kimtrafos 12 | 50 |
| Kalori 3000 | 1.99 | Kalori 3000 | - | Kalori 3000 | - |
| Feed grade Sulfur | 0.40 | Feed grade Sulfur | - | Feed grade Sulfur | 5 |
| Salt | 15.94 | Salt | - | Salt | 45 |
| Nutrient composition | | Nutrient composition | | Nutrient composition | |
| Crude protein (%) | 16.4 | Crude protein (%) | 15.0 | Crude protein (%) | - |
| From NPN (%) | 37.0 | From NPN (%) | 13.60 | From NPN (%) | - |
| ME (MJ/kg) | 9.0 | ME (MJ/kg) | - | ME (MJ/kg) | - |
| P (%) | 1.3 | P (%) | 5.0 | P (%) | 6.0 |
| Intake (g/cow/day) | 1000 – 1500 | Intake (g/cow/day) | 120 – 240 | Intake (g/cow/day) | 100 – 240 |

During the summer supplementation period the 1CH1 Treatment Group was offered a summer production supplement and due to the high maize meal content (55.78%) the supplement had a high ME value of 9.0 MJ/kg. The 1CH2 Treatment Group was offered a ready mixed mineral supplement (Voermol Superfos) which had a CP content of 15%. The 1CH3 Treatment Group was offered a mineral supplement containing 6% P (Table 8.3).

The winter supplementation treatments (Table 8.4) consisted of three different protein and mineral supplements. The nutrient composition of the supplements differed due to different inclusion rates of raw materials. The 1CH1 Treatment Group was offered a cottonseed-oilcake and urea based protein and mineral supplement, the 1CH2 Treatment Group a urea and cottonseed-oilcake based protein and mineral supplement and the 1CH3 Treatment Group a urea based protein and mineral supplement.



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**Table 8.4** Supplementation formulations and nutrient compositions of the treatments offered to the First-calf-heifer Supplementation Treatment Groups during the winter supplementation period

| Winter supplementation period (April to July) | | | | | |
|---|---|---|---|---|---|
| **First-calf-heifer Treatment 1** | | **First-calf-heifer Treatment 2** | | **First-calf-heifer Treatment 3** | |
| Raw material | % | Raw material | % | Raw material | % |
| Maize meal | 24.88 | Maize meal | 23.65 | Maize meal | 18.46 |
| Cottonseed oilcake | 14.93 | Cottonseed oilcake | 9.46 | Cottonseed oilcake | - |
| Feed grade Urea | 9.95 | Feed grade Urea | 14.93 | Feed grade Urea | 15.38 |
| Kimtrafos 12 | 9.95 | Kimtrafos 12 | 14.93 | Kimtrafos 12 | 15.38 |
| Kalori 3000 | 4.98 | Kalori 3000 | 4.73 | Kalori 3000 | 3.85 |
| Feed grade Sulfur | 0.49 | Feed grade Sulfur | 0.66 | Feed grade Sulfur | 0.77 |
| Salt | 34.83 | Salt | 33.11 | Salt | 46.15 |
| Nutrient composition | | Nutrient composition | | Nutrient composition | |
| Crude protein (%) | 36.7 | Crude protein (%) | 46.6 | Crude protein (%) | 47.5 |
| From NPN (%) | 77.5 | From NPN (%) | 88.7 | From NPN (%) | 95.86 |
| ME (MJ/kg) | 5.25 | ME (MJ/kg) | 4.4 | ME (MJ/kg) | 2.4 |
| P (%) | 1.4 | P (%) | 1.9 | P (%) | 2.57 |
| Intake (g/cow/day) | 360 – 520 | Intake (g/cow/day) | 280 – 400 | Intake (g/cow/day) | 280 – 400 |

## 8.3 RESULTS

### 8.3.1 Supplement intake and cost of supplementation

The period that animals were given access to the supplements differed annually, as the initiation and conclusion of a supplementation phase was prescribed by the condition of the available grazing. The yearly (2011, 2012 and 2013) average late winter supplement and calculated nutrient (CP, ME and P) intakes (g/animal/day) of the First-calf-heifer Supplementation Treatment Groups (1CH1, 1CH2 and 1CH3) during the course of the study are summarized in Table 8.5. The three year (2011 to 2013) average late winter supplement and nutrient intakes as well as the average cost of the treatments (R/animal/late winter supplementation period) are summarized in Table 8.6.



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**Table 8.5** The yearly (2011, 2012 and 2013) average late winter supplement and nutrient intakes (g/animal/day) of the First-calf-heifer Supplementation Treatment Groups (1CH1, 1CH2 and 1CH3)

| Season | Period (d) | Component | Treatment 1CH1 | Treatment 1CH2 | Treatment1 CH3 |
|---|---|---|---|---|---|
| Late winter 2011 | 133 | Supplement intake (g/animal/day) | 909 | 524 | 287 |
| | | CP (g/animal/day) | 278 | 172 | 136 |
| | | Protein from NPN (g/animal/day) | 132 | 122 | 131 |
| | | ME (MJ/animal/day) | 6.73 | 3.61 | 0.69 |
| | | P (g/animal/day) | 11.8 | 6.55 | 7.38 |
| Late winter 2012 | 135 | Supplement intake (g/animal/day) | 1200 | 553 | 310 |
| | | CP (g/animal/day) | 367 | 182 | 147 |
| | | Protein from NPN (g/animal/day) | 174 | 129 | 141 |
| | | ME (MJ/animal/day) | 8.88 | 3.8 | .074 |
| | | P (g/animal/day) | 15.60 | 6.90 | 7.97 |
| Late winter 2013 | 142 | Supplement intake (g/animal/day) | 1440 | 664 | 372 |
| | | CP (g/animal/day) | 441 | 219 | 177 |
| | | Protein from NPN (g/animal/day) | 209 | 155 | 169 |
| | | ME (MJ/animal/day) | 10.66 | 4.57 | 0.89 |
| | | P (g/animal/day) | 18.72 | 8.3 | 9.56 |

**Table 8.6** Three year (2011 - 2013) average late winter supplement and nutrient intakes (g/animal/day) of the First-calf-heifer Supplementation Treatment Groups as well as the average cost of supplying the treatments (R/animal/late winter supplementation period)

| Season and Year | Period (d) | Component | Treatment | | |
|---|---|---|---|---|---|
| | | | 1CH1 | 1CH2 | 1CH3 |
| Late winter 2011 - 2013 | 137 | Supplement intake (g/animal/day) | 1189 | 582 | 324 |
| | | CP (g/animal/day) | 364 | 192 | 154 |
| | | Protein from NPN (g/animal/day) | 172 | 135 | 148 |
| | | ME (MJ/animal/day) | 8.80 | 4.01 | 0.78 |
| | | P (g/animal/day) | 15.46 | 7.23 | 8.33 |
| | | Cost (R/animal/suppl. period) | R 520.12 | R 226.69 | R 113.93 |



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The late winter supplementation period lasted an average of 137 days. The three year average supplement intakes of all three First-calf-heifer Treatment Groups were well within the recommended intake ranges of each supplement (Table 8.5). The higher average supplement intake of all three First-calf-heifer Treatment Groups during the late winter of 2013 could be due to the shortage of roughage that was experienced because of very dry conditions in 2013. As expected, the 1CH1 Treatment Group that received the production supplement had the highest average supplement and nutrient intake (supplement intake 1189 g/animal/day, supplemental CP intake 364 g/animal/day and supplemental ME intake of 8.80 MJ/animal/day) and the 1CH3 Treatment Group which received the urea based protein supplement the lowest supplement and nutrient intake (supplement intake 324 g/animal/day, supplemental CP intake 154 g/animal/day and supplemental ME intake of 0.78 MJ/animal/day). The supplement and nutrient intake of the 1CH2 Treatment Group which received the cottonseed oilcake and urea based protein supplement was intermediary (supplement intake 582 g/animal/day, supplemental CP intake 192 g/animal/day and supplemental ME intake of 4.01 MJ/animal/day). The average cost incurred in supplying the late winter supplementation treatments to the 1CH1 Treatment Group was R520.12, the 1CH2 Treatment Group R226.69 and the 1CH3 Treatment group R113.93).

The yearly (2011-12, 2012-13 and 2013-14) average summer supplement and nutrient intakes of the First-calf-heifer Supplementation Treatment Groups are summarized in Table 8.7 and the three year average summer supplement and nutrient intakes as well as the cost of supplying the summer supplement treatments in Table 8.8.



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**Table 8.7** The yearly (2011-12, 2012-13 and 2013-14) average summer supplement and nutrient intakes (g/animal/day) of the First-calf-heifer Supplementation Treatment Groups

| Season | Period (d) | Component | Treatment 1CH1 | Treatment 1CH2 | Treatment1 CH3 |
|---|---|---|---|---|---|
| Summer 2011 - 12 | 109 | Supplement intake (g/animal/day) | 1120 | 148 | 83 |
| | | CP (g/animal/day) | 184 | 22 | - |
| | | Protein from NPN (g/animal/day) | 68 | - | - |
| | | ME (MJ/animal/day) | 10.08 | - | - |
| | | P (g/animal/day) | 14.56 | 7.4 | 4.98 |
| Summer 2012 - 13 | 106 | Supplement intake (g/animal/day) | 1208 | 218 | 124 |
| | | CP (g/animal/day) | 198 | 33 | - |
| | | Protein from NPN (g/animal/day) | 73 | - | - |
| | | ME (MJ/animal/day) | 10.87 | - | - |
| | | P (g/animal/day) | 15.70 | 10.90 | 7.44 |
| Summer 2013 - 14 | 101 | Supplement intake (g/animal/day) | 904 | 231 | 108 |
| | | CP (g/animal/day) | 148 | 35 | - |
| | | Protein from NPN (g/animal/day) | 55 | - | - |
| | | ME (MJ/animal/day) | 8.13 | - | - |
| | | P (g/animal/day) | 11.75 | 11.55 | 6.48 |

**Table 8.8** Three year (2011-12 to 2013-14) average summer supplement and nutrient intakes (g/animal/day) of the First-calf-heifer Supplementation Treatment Groups as well as the average cost of the treatments (R/animal/summer supplementation period)

| Season and Year | Period (d) | Component | Treatment | | |
|---|---|---|---|---|---|
| | | | 1CH1 | 1CH2 | 1CH3 |
| Summer 2011-12 to 2013-14 | 106 | Supplement intake (g/animal/day) | 1080 | 198 | 105 |
| | | CP (g/animal/day) | 177 | 30 | - |
| | | Protein from NPN (g/animal/day) | 66 | 27 | - |
| | | ME (MJ/animal/day) | 9.72 | - | - |
| | | P (g/animal/day) | 14.04 | 9.90 | 6.30 |
| | | Cost (R/animal/suppl. period) | R 327.43 | R 94.81 | R 34.73 |



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The three summer supplementation periods lasted an average of 106 days. The yearly average summer supplement intake of all three First-calf-heifer Supplementation Treatment Groups were within the recommended daily intake ranges for each supplementation treatment except for the summer supplement intake of the 1CH3 Treatment Group (83g/animal/day) in 2011-12 (Year 1). The supplement intake of the 1CH3 Treatment Group was below the recommended 100g/animal/day and thus the supplemental P intake of the 1CH3 Treatment Group (4.98 g P/animal/day) was below the recommended minimum of 6g P/animal/day (Table 8.8). The 1CH1 Treatment supplied an additional 177g CP/animal/day, 9.72MJ ME/animal/day and 14.04g P/animal/day (Table 8.8). The supplementation treatment offered to the 1CH2 Treatment Group provided an additional 30g CP/animal/day and 9.9g P/animal/day and the supplement offered to the 1CH3 Treatment Group supplied each animal with 6.48g P/animal/day. The three year average cost incurred in supplying the summer supplementation treatments to the 1CH1 Treatment Group was R327.43, the 1CH2 Treatment Group R94.81 and the 1CH3 Treatment group R34.74.

The yearly (2012, 2013 and 2014) average winter supplement and nutrient intakes of the First-calf-heifer Supplementation Treatment Groups are presented in Table 8.9 and the three year average (2012 to 2014) winter supplement and nutrient intakes as well as the three year average costs incurred in supplying the supplements are presented in Table 8.10.

The three year average winter supplement and nutrient intake of the First-calf-heifers were as follows (Table 8.10): 1CH1 (intake 514 g/animal/day, supplemental CP intake 189 g/animal/day, supplemental ME intake 2.70 MJ/animal/day), 1CH2 (intake 428 g/animal/day, supplemental CP intake 199 g/animal/day, supplemental ME intake 1.88 MJ/animal/day), 1CH3 (intake 346 g/animal/day, supplemental CP intake 164 g/animal/day, supplemental ME intake 0.83 MJ/animal/day). The average cost incurred in supplying the winter supplementation treatments to the 1CH1 Treatment Group was R185.25, the 1CH2 Treatment 2 Group R161.05 and the 1CH3 Treatment group R116.25 (Table 8.10).



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**Table 8.9** Yearly (2012, 2013 and 2014) average winter supplement and nutrient intakes (g/animal/day) of the First-calf-heifer Supplementation Treatment Groups

| Season and Year | Period (d) | Component | Treatment | | |
|---|---|---|---|---|---|
| | | | 1CH2 | 1CH3 | 1CH3 |
| Winter 2012 | 123 | Supplement intake (g/animal/day) | 495 | 438 | 325 |
| | | CP (g/animal/day) | 182 | 204 | 153 |
| | | Protein from NPN (g/animal/day) | 141 | 181 | 148 |
| | | ME (MJ/animal/day) | 2.59 | 1.93 | 0.78 |
| | | P (g/animal/day) | 6.93 | 8.32 | 8.35 |
| Winter 2013 | 124 | Supplement intake (g/animal/day) | 507 | 430 | 325 |
| | | CP (g/animal/day) | 186 | 200 | 153 |
| | | Protein from NPN (g/animal/day) | 144 | 177 | 148 |
| | | ME (MJ/animal/day) | 2.66 | 1.89 | 0.78 |
| | | P (g/animal/day) | 7.10 | 8.17 | 8.35 |
| Winter 2014 | 122 | Supplement intake (g/animal/day) | 540 | 415 | 388 |
| | | CP (g/animal/day) | 198 | 193 | 184 |
| | | Protein from NPN (g/animal/day) | 153 | 171 | 177 |
| | | ME (MJ/animal/day) | 2.84 | 1.82 | 0.93 |
| | | P (g/animal/day) | 7.56 | 7.89 | 9.97 |

**Table 8.10** Three year (2012 - 2014) average winter supplement and nutrient intakes (g/animal/day) and average cost (R/animal/winter supplementation period) of the First-calf-heifer Supplementation Treatment Groups

| Season and Year | Period (d) | Component | Treatment | | |
|---|---|---|---|---|---|
| | | | 1CH1 | 1CH2 | 1CH3 |
| Winter 2012 – 2014 | 123 | Supplement intake (g/animal/day) | 514 | 428 | 346 |
| | | CP (g/animal/day) | 189 | 199 | 164 |
| | | Protein from NPN (g/animal/day) | 146 | 177 | 158 |
| | | ME (MJ/animal/day) | 2.70 | 1.88 | 0.83 |
| | | P (g/animal/day) | 7.20 | 8.13 | 8.89 |
| | | Cost (R/animal/suppl. period) | R 185.25 | R 161.05 | R116.25 |



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Figure 8.1 illustrates the three year average (2011-12 to 2013-14) supplement intakes (g/animal/day) of the First-calf-heifer Supplementation Treatment Groups during the late winter, summer and winter supplementation periods

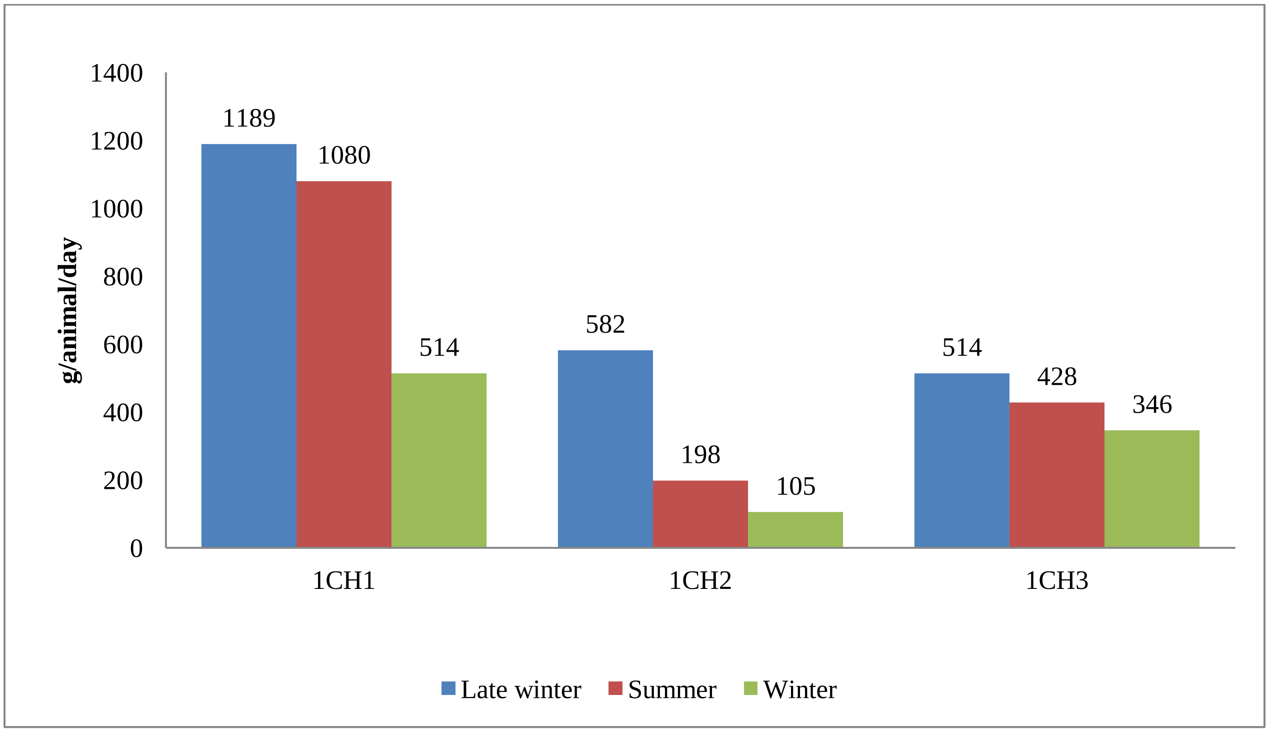


**Figure 8.1** Three year (2011-12 to 2013-14) average supplement intakes (g/animal/day) of the First-calf-heifer Supplementation Treatment Groups during the course of the study

The three year average cost incurred in supplying the supplementation treatments to the First-calf-heifer Supplementation Treatment Groups are summarized in Table 8.11 and illustrated in Figure 8.2.

**Table 8.11** Three year (2011-12 to 2013-14) average cost of the supplements offered to the First-calf-heifer Supplementation Treatment Groups

| Supplementation period | Treatment | | |
|---|---|---|---|
| | 1CH1 | 1CH2 | 1CH3 |
| Late winter (R/animal/winter supplementation period) | R 520 | R 227 | R 114 |
| Summer (R/animal/summer supplementation period) | R 327 | R 95 | R 35 |
| Winter (R/animal/winter supplementation period) | R 185 | R 161 | R 116 |
| Total average cost (R/animal/year) | R 1 032 | R 483 | R 265 |



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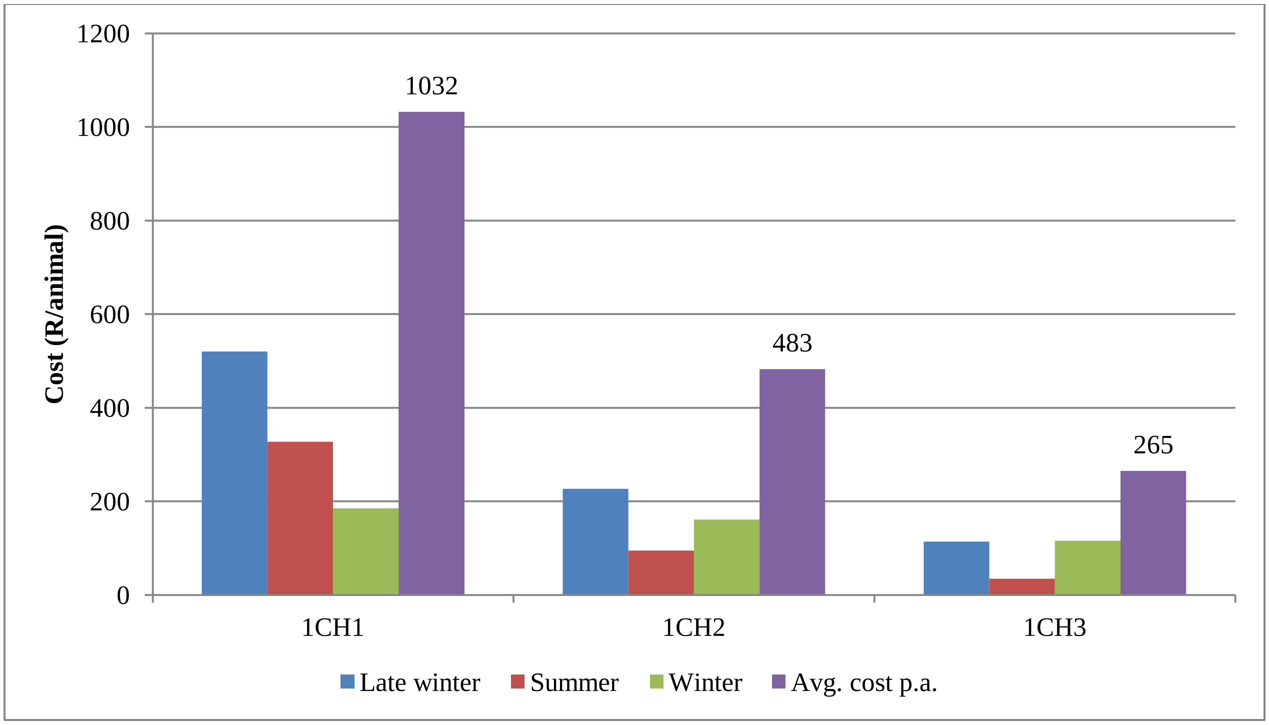


**Figure 8.2** Three year average costs of the supplements offered to the First-calf-heifer Supplementation Treatment Groups per supplementation period (2011-12 to 2013-14)



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## 8.3.2 Body weight and BCS of the First-calf-heifer Supplementation Treatment Groups

The mean body weights of the First-calf-heifer Supplementation Treatment Groups are summarized in Table 8.12.

**Table 8.12** The mean (± SD) body weights of the First-calf-heifer Supplementation Treatment Groups for the period 1 August 2011 to 31 July 2014

| Treatments | 1CH1 | 1CH2 | 1CH3 |
|---|---|---|---|
| | 1 August 2011 to 31 July 2012 | | |
| | Mean weight (kg) | Mean weight (kg) | Mean weight (kg) |
| | n = 7 | n = 6 | n = 8 |
| Late winter ( Aug) | $486^{a} \pm 51$ | $498^{a} \pm 50$ | $514^{a} \pm 40$ |
| Summer (Mar) | $531^{a} \pm 38$ | $502^{a} \pm 39$ | $541^{a} \pm 45$ |
| Wean | $527^{a} \pm 43$ | $505^{a} \pm 42$ | $509^{a} \pm 41$ |
| Winter (Jul) | $496^{a} \pm 37$ | $488^{a} \pm 37$ | $488^{a} \pm 43$ |
| | 1 August 2012 to 31 July 2013 | | |
| | n = 10 | n = 10 | n = 6 |
| Late winter ( Aug) | $482^{a} \pm 25$ | $469^{a} \pm 43$ | $479^{a} \pm 32$ |
| Summer (Mar) | $496^{a} \pm 31$ | $453^{b} \pm 40$ | $479^{ab} \pm 42$ |
| Wean | $496^{a} \pm 31$ | $454^{b} \pm 31$ | $481^{a} \pm 42$ |
| Winter (Jul) | $505^{a} \pm 20$ | $474^{a} \pm 45$ | $479^{a} \pm 32$ |
| | 1 August 2013 to 31 July 2014 | | |
| | n = 5 | n = 9 | n = 4 |
| Late winter ( Aug) | $498^{a} \pm 49$ | $479^{a} \pm 26$ | $489^{a} \pm 11$ |
| Summer (Mar) | $571^{a} \pm 23$ | $*507^{b} \pm 25$ | $521^{b} \pm 27$ |
| Wean | $545^{a} \pm 30$ | $508^{a} \pm 34$ | $505^{a} \pm 40$ |
| Winter (Jul) | $522^{a} \pm 29$ | $477^{b} \pm 36$ | $490^{ab} \pm 26$ |

Mean values in the same row with different superscripts differ significantly: $P < 0.05$; $*P < 0.01$

No significant differences in body weights were measured between the First-calf-heifer Supplementation Treatment Groups in Year 1 (2011-12) of the study (Table 8.12).



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In Year 2 (2012-13) of the study significant (*P* <0.05) differences in body weights were measured between the First-calf-heifer Supplementation Treatment Groups at the end of the breeding season (March) and again at wean. The 1CH2 Treatment Group had lost an average of 16 kg during this period but was able to gain (21 kg) sufficient weight from March to July so that no significant differences in weights were measured between the treatment groups by the end (July) of Year 2.

During Year 3 (2013-14) of the study the 1CH1 Supplementation Treatment Group gained an average of 73 kg form just before calving (August) to the end of the breeding season (March). This superior weight gain caused a significant (*P* < 0.01) difference in weight between the 1CH1 Treatment Group (571 ± 23 kg) and the 1CH2 Treatment Group (507 ± 25 kg) as well as a significant (*P* < 0.05) difference in weight between the 1CH1 Treatment Group and the 1CH3 Treatment Group (521 ±27 kg) at the end of the breeding season. A significant (*P* < 0.05) difference in weight between treatment groups was measured again at the end of Year 3 with the 1CH1 Treatment Group weighing (522 ± 29 kg) more than the 1CH2 Treatment Group (477 ± 36 kg). There was, however, a propensity over the three year study period for the 1CH1 Treatment Group to have the heaviest body weight and the 1CH2 Treatment Group the lightest body weight (Table 8.12).

The mean body condition scores of the First-calf-heifer Supplementation Treatment Groups are summarized in Table 8.13. Significant differences in BCS between treatment groups were measured in all three years. The 1CH1 Treatment Group had a tendency to have a higher BCS at the end of the breeding season (March) and at the end of each year (July) than the 1CH2 and 1CH3 Treatment Groups (Table 8.13). Even though the animals in the 1CH2 Treatment Group tended to be the lightest they did not consistently have the lowest BCS.



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**Table 8.13** Mean BCS (± SD) (1 = severely emaciated, 9 = very obese) of the First-calf-heifer Supplementation Treatment Groups for the period August 2011 to July 2014

| **Treatments** | **1CH1** | **1CH2** | **1CH3** |
|---|---|---|---|
| | 1 August 2011 to 31 July 2012 | | |
| | Mean BCS | Mean BCS | Mean BCS |
| Late winter (August) | $5.43^{a} \pm 0.79$ | $5.50^{a} \pm 0.55$ | $5.25^{a} \pm 0.71$ |
| Summer (March) | $6.43^{a} \pm 0.79$ | $5.67^{a} \pm 0.52$ | $6.38^{a} \pm 0.92$ |
| Winter (July) | $4.86^{a} \pm 0.38$ | $5.50^{b} \pm 0.55$ | $5.13^{ab} \pm 0.64$ |
| | 1 August 2012 to 31 July 2013 | | |
| Late winter (August) | $4.80^{a} \pm 0.63$ | $4.70^{a} \pm 0.48$ | $4.50^{a} \pm 0.55$ |
| Summer (March) | $5.80^{a} \pm 0.79$ | $4.80^{b} \pm 0.79$ | $*4.67^{b} \pm 0.52$ |
| Winter (July) | $5.20^{a} \pm 0.42$ | $*4.40^{b} \pm 0.52$ | $4.50^{b} \pm 0.55$ |
| | 1 August 2013 to 31 July 2014 | | |
| Late winter (August) | $6.20^{a} \pm 0.45$ | $5.44^{b} \pm 0.53$ | $6.25^{a} \pm 0.50$ |
| Summer (March) | $5.60^{a} \pm 0.55$ | $*5.00^{b} \pm 0.00$ | $5.00^{b} \pm 0.00$ |
| Winter (July) | $5.00^{a} \pm 1.00$ | $4.44^{a} \pm 0.53$ | $4.75^{a} \pm 0.50$ |

Mean values in the same row with different superscripts differ significantly: $P < 0.05$; $*P < 0.01$



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### 8.3.3 Production and reproduction data of the first calf heifer lick supplementation treatment groups

**Table 8.14** Mean (± SD) calf- birth weight (kg); -100-day weight (kg) and -weaning weight (kg); mean weight of first-calf-heifers (kg) at weaning, ICP (days), conception rate (%) and cost of the lick treatments per First-calf-heifer Supplementation Group (1 August 2011 to 31 July 2014)

| Treatments | 1CH1 | 1CH2 | 1CH3 |
|---|---|---|---|
| 1 August 2011 to 31 July 2012 | | | |
| | Mean weight (kg) | Mean weight (kg) | Mean weight (kg) |
| Calf birth weight | $37.6^{a} \pm 3.3$ | $36.3^{a} \pm 2.7$ | $39.0^{a} \pm 4.7$ |
| Calf 100 day weight | $147^{a} \pm 16$ | $133^{a} \pm 19$ | $141^{a} \pm 13$ |
| Calf wean weight | $258^{a} \pm 21$ | $233^{a} \pm 26$ | $243^{a} \pm 23$ |
| Cow weight at wean | $527^{a} \pm 43$ | $505^{a} \pm 42$ | $509^{a} \pm 41$ |
| ICP | 382 days | 387 days | 406 days |
| Conception rate | 100 % | 100 % | 100 % |
| 1 August 2012 to 31 July 2013 | | | |
| Calf birth weight | $39.3^{a} \pm 3.9$ | $36.1^{a} \pm 4.6$ | $41^{a} \pm 3.2$ |
| Calf 100 day weight | $133^{ab} \pm 15$ | $144^{a} \pm 7.9$ | $131^{b} \pm 14$ |
| Calf wean weight | $218^{a} \pm 21$ | $218^{a} \pm 12$ | $206^{a} \pm 20$ |
| Cow weight at wean | $496^{a} \pm 31$ | $454^{b} \pm 42$ | $481^{a} \pm 42$ |
| ICP | 478 days | 453 days | 587 days |
| Conception rate | 80 % | 90 % | 67 % |
| 1 August 2012 to 31 July 2014 | | | |
| Calf birth weight | $36.0^{a} \pm 4.2$ | $38.0^{a} \pm 4.3$ | $35.0^{a} \pm 1.4$ |
| Calf 100 day weight | $134^{a} \pm 14$ | $141^{a} \pm 16$ | $131^{a} \pm 10$ |
| Calf wean weight | $203^{a} \pm 14$ | $215^{a} \pm 25$ | $206^{a} \pm 18$ |
| Cow weight at wean | $545^{a} \pm 30$ | $508^{a} \pm 34$ | $505^{a} \pm 40$ |
| ICP | 435 days | 382 days | 354 days |
| Conception rate | 80 % | 100 % | 100 % |

Mean values in the same row with different superscripts differ significantly: $P < 0.05$

During Year 1 of the study no significant ($P > 0.05$) differences were measured in birth weight, 100-day calf weight, weaning weight of the calves or conception rate between the First-calf-



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heifer Supplementation Treatment Groups (Table 8.14). The inter-calving-period of 406 days of the 1CH3 Treatment Group was, however, notably longer than that of the 1CH1 Treatment Group (382 days) and the 1CH2 Treatment Group (387 days).

During Year 2 of the study the 100-day calf weight of the 1CH2 Treatment Group (144 ± 7.9 kg) was significantly ($P < 0.05$) heavier than that of the 1CH3 Treatment Group (131 ± 14 kg) but not significantly heavier than that of the 1CH2 Treatment Group (133 ± 15 kg). The inter-calving-period of the 1CH3 Treatment Group (587 days) was considerably longer than that of the 1CH1 Treatment Group (478 days) and the 1CH2 Treatment Group (453 days) due to the lower conception rate. The conception rate of the 1CH3 Treatment Group was 67% compared to the conception rate of 80% of the 1CH1 Treatment Group and 90% of the 1CH2 Treatment Group. The lower conception rate of the 1CH3 treatment group could not be explained. No significant differences were measured in the birth weight or weaning weight of the calves between treatment groups.

As with Year 1, no significant differences were measured in birth weight, 100-day calf weight or weaning weight of calves in Year 3. However, in Year 3 the 1CH1 Treatment Group only had an 80% conception rate compared to the 100% of the 1CH2 and 1CH3 Treatment Groups.

When considering important production and reproduction parameters such as weaning weight, inter-calving-period and conception rate the 1CH2 Treatment Group had the best results in two of the three years, though not always significantly so.

## 8.4 DISCUSSION AND CONCLUSION

There is a general consensus amongst many research workers that the lactating first-calf-heifer is likely to benefit (in terms of reproductive performance) from supplementary feeding with a production supplement before and after calving. The question arises as to why the results reported here are not in accordance with this accepted belief? While being aware that the response may vary from year to year, mainly due to rainfall distribution, as well as from one vegetation type to another, and that only a small number of animals were available, it must be noted that this study coincided with a severe drought and was also done (according to Snyman,



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2015) on one of the most challenging vegetation types (*Elionurus*-sour-grassland of the south-eastern Free State) to manage.

The results of this study could not establish a relationship between conception rate and mean body weight before calving (August), weight at the end of the breeding season (March), weight gain or loss over the breeding season or BCS. These results are not unique. It has been suggested by Broster (1974), Meaker (1980), MacGregor & Swanepoel (1992) and Lademann & Schoeman (1994) that when animals operate within an optimum weight range, overall fertility is not affected by body weight *per se*. It is therefore believed that all three supplementation treatments offered enabled the animals in each treatment group to operate within their optimal weight range. However, when considering the costs incurred in supplying each of the supplementation treatments and the resulting production and reproduction rates achieved, it is clear that differences in weaner income above supplementation costs are observed.

When focusing on the need to achieve good reconception rates of first-calf-heifers from year to year and good pre-weaning growth, the practice of providing a production supplement to first-calf-heifers before calving and during lactation is often recommended by animal nutritionists. This advice was emulated by the 1CH1 Treatment Group. The 1CH1 Treatment Group did however have the heaviest calves at weaning. Due to the lower conception rate achieved and the much higher cost of supplementation the practice of offering a production supplement to three year old first-calf-heifers that are kept on well managed rangeland cannot be recommended.

The average conception rate (97%) and weaning weight (222 kg) of the 1CH2 Treatment Group was higher than that of the 1CH3 Treatment Group (89% and 218 kg), however the much lower cost of supplementation (R265 *versus* R483 per animal per year) of the 1CH3 Treatment Group compared to the 1CH2 treatment group makes the supplements offered to the 1CH3 Treatment Group a viable option.



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# CHAPTER 9

# EFFECT OF THREE LEVELS OF SUPPLEMENTATION ON EXTENSIVE BEEF COW PRODUCTION, REPRODUCTION AND PROFITABILITY

## 9.1 INTRODUCTION

The U.S. Department of Agriculture determined in a survey of management practices related to profitable cow-calf herds that producers who worked toward optimal production rather than maximum production showed positive returns and achieved them through better herd efficiency and cost containment (Ramsey *et al.*, 2005).

In extensive studies by Falconer *et al.* (1999), Miller *et al*. (2001), Dunn (2000), and Ramsey *et al.* (2005) using cow-herd standardized performance analysis (SPA) data to determine economic factors affecting cow-herd costs, production, and profitability it was found that variables affecting performance measures most were herd size; kilograms feed fed; real estate, machinery, and breeding-stock investments; calving percentage; death loss and breeding-season length. Management variables were especially important for financial costs and profitability of the cow herd operation (Ramsey *et al*., 2005). In all of the above mentioned studies total cost of production was significantly affected by feeding costs and total production (kilograms weaned) (Falconer *et al.*, 1999; Dunn, 2000; Miller *et al*., 2001 and Ramsey *et al.*, 2005.

Due to the importance of feeding costs and calving percentage in the profit model of the cow-calf enterprise the present study was an attempt to identify a cost effective supplementation regimen to offer cows in a cow/calf enterprise grazing *Elionurus* sour grassland without affecting production, reproduction and profitability negatively.



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## 9.2 MATERIALS AND METHODS

### 9.2.1 Outlay of the Cow Treatment Groups

During mid-July of 2011, prior to the start of the study, 150 pregnant Drakensberger cows were stratified according to age and then randomly allocated to one of three supplementation treatment groups namely: Cow Supplementation Treatment Group 1 (C1), Cow Supplementation Treatment Group 2 (C2) and Cow Supplementation Treatment Group 3 (C3) (see Figure 5.5). The pre-experimental treatment of the cows prior to the start of the study was similar.

In the second and third year of the study first-calf-heifers that had weaned their first calves were reassigned to the Cow Supplementation Treatment Groups. First-calf-heifers that were allocated to the First Calf Heifer Supplementation Treatment 1 Group (1CH1) were reassigned to the Cow Supplementation Treatment 1 Group (C1) etc.

### 9.2.2 The Cow supplementation treatments

A summary of the Cow Supplementation Treatments and the nutrient compositions of the treatments are shown in Table 9.1. The winter and late winter supplementation treatments had the same nutrient compositions, however, during the winter supplementation periods the Cow Treatment Groups were offered a smaller amount of supplement compared to the late winter supplementation periods (80% of that offered during the late winter supplementation period).



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**Table 9.1** Summary of the Cow Supplementation Treatments and nutrient composition of each treatment

| COW SUPPLEMENTATION TREATMENTS | | |
|---|---|---|
| C1 | C2 | C3 |
| LATE WINTER | | |
| Cottonseed oilcake and urea based protein and mineral supplement<br>CP: 36.7%<br>From NPN: 77.5%<br>ME: 5.25 MJ/kg | Urea and cottonseed oilcake based protein and mineral supplement<br>CP: 46.6%<br>From NPN: 88.7%<br>ME: 4.4 MJ/kg | Urea based protein and mineral supplement<br>CP: 47.5%<br>From NPN: 95.86%<br>ME: 2.4 MJ/kg |
| SUMMER | | |
| Mineral supplement containing 15% protein<br>CP: 15.0%<br>From NPN: 13.6%<br>ME: -<br>P: 5% | Mineral supplement<br>CP: -<br>From NPN: -<br>ME: -<br>P: 6% | Mineral supplement<br>CP: -<br>From NPN: -<br>ME: -<br>P: 6% |
| WINTER | | |
| Cottonseed oilcake and urea based protein and mineral supplement<br>CP: 36.7%<br>From NPN: 77.5%<br>ME: 5.25 MJ/kg | Urea and cottonseed oilcake based protein and mineral supplement<br>CP: 46.6%<br>From NPN: 88.7%<br>ME: 4.4 MJ/kg | Urea based protein and mineral supplement<br>CP: 47.5%<br>From NPN: 95.86%<br>ME: 2.4 MJ/kg |

The supplementation formulations and nutrient compositions of the treatments offered to the Cow Supplementation Treatment Groups during the late winter supplementation period are presented in Table 9.2.



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**Table 9.2** Supplementation formulations and nutrient compositions of the treatments offered to the Cow Supplementation Treatment Groups during the late winter supplementation period

| **Late winter supplementation period (August to mid-December)** | | | | | |
|---|---|---|---|---|---|
| **Cow treatment 1** | | **Cow treatment 2** | | **Cow treatment 3** | |
| Raw material | % | Raw material | % | Raw material | % |
| Maize meal | 24.88 | Maize meal | 23.65 | Maize meal | 18.46 |
| Cottonseed oilcake | 14.93 | Cottonseed oilcake | 9.46 | Cottonseed oilcake | - |
| Feed grade Urea | 9.95 | Feed grade Urea | 14.93 | Feed grade Urea | 15.38 |
| Kimtrafos 12 | 9.95 | Kimtrafos 12 | 14.93 | Kimtrafos 12 | 15.38 |
| Kalori 3000 | 4.98 | Kalori 3000 | 4.73 | Kalori 3000 | 3.85 |
| Feed grade Sulfur | 0.49 | Feed grade Sulfur | 0.66 | Feed grade Sulfur | 0.77 |
| Salt | 34.83 | Salt | 33.11 | Salt | 46.15 |
| Nutrient composition | | Nutrient composition | | Nutrient composition | |
| Crude protein (%) | 36.7 | Crude protein (%) | 46.6 | Crude protein (%) | 47.5 |
| From NPN (%) | 77.5 | From NPN (%) | 88.7 | From NPN (%) | 95.86 |
| ME (MJ/kg) | 5.25 | ME (MJ/kg) | 4.4 | ME (MJ/kg) | 2.4 |
| P (%) | 1.4 | P (%) | 1.9 | P (%) | 2.57 |
| Intake (g/cow/day) | 450 – 650 | Intake (g/cow/day) | 350 – 500 | Intake (g/cow/day) | 350 – 500 |

During the late winter supplementation period the C1, C2 and C3 supplementation treatment groups were offered protein and mineral supplements which differed in nutrient composition due to different inclusion rates of raw materials. The C1 treatment contained 14.93% cottonseed oilcake and 9.95% urea, the C2 treatment contained 9.46% cottonseed oilcake and 14.83% urea and the C3 treatment no cottonseed oilcake and 15.38% urea (Table 9.2).

During the summer supplementation period the C1 Group was offered a ready mixed mineral supplement (Voermol Superfos) containing 15% protein and 5 % P, the C2 Group and the C3 Group were offered an identical mineral supplement containing 6 % P (Table 9.3).



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**Table 9.3** Supplementation formulation and nutrient composition of the treatments offered to the Cow Supplementation Treatment Groups during the summer supplementation period

| Summer supplementation period (mid-December to March) | | | | | |
|---|---|---|---|---|---|
| **Cow treatment 1** | | **Cow treatment 2** | | **Cow treatment 3** | |
| Raw material | % | Raw material | % | Raw material | % |
| Voermol Superfos | 100 | Voermol Superfos | - | Voermol Superfos | - |
| Maize meal | - | Maize meal | - | Maize meal | - |
| Cottonseed oilcake | - | Cottonseed oilcake | - | Cottonseed oilcake | - |
| Feed grade Urea | - | Feed grade Urea | - | Feed grade Urea | - |
| Kimtrafos 12 | - | Kimtrafos 12 | 50 | Kimtrafos 12 | 50 |
| Kalori 3000 | - | Kalori 3000 | - | Kalori 3000 | - |
| Feed grade Sulfur | - | Feed grade Sulfur | 5 | Feed grade Sulfur | 5 |
| Salt | - | Salt | 45 | Salt | 45 |
| Nutrient composition | | Nutrient composition | | Nutrient composition | |
| Crude protein (%) | 15.0 | Crude protein (%) | - | Crude protein (%) | - |
| From NPN (%) | - | From NPN (%) | - | From NPN (%) | - |
| ME (MJ/kg) | - | ME (MJ/kg) | - | ME (MJ/kg) | - |
| P (%) | 5.0 | P (%) | 6.0 | P (%) | 6.0 |
| Intake (g/cow/day) | 120 – 240 | Intake (g/cow/day) | 100 – 240 | Intake (g/cow/day) | 100 – 240 |

During the winter supplementation period the three cow supplementation treatment groups (C1, C2 and C3) were offered treatments with the same nutritional composition as the treatments offered during the late winter supplementation period but at a reduced recommended daily intake The cow treatment groups were only offered 80% of the amount of supplement offered during the late winter supplementation period namely: C1 (360 – 520 g during winter *vs.* 450 – 650g during late winter), C2 and C3 (280 – 400g during winter *vs.* 350 – 500g during late winter).

## 9.3 RESULTS

### 9.3.1 Supplement intake and cost of cow supplementation

The yearly (2011, 2012 and 2013) late winter supplement and nutrient intakes (g/animal/day) of the Cow Supplementation Treatment Groups are presented in Table 9.4. The three (2011 to 2013) year average late winter supplement and nutrient intakes and the cost incurred in supplying the supplements to the Cow Supplementation Treatment Groups are summarized in Table 9.5.



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**Table 9.4** The yearly (2011, 2012 and 2013) late winter supplement and nutrient intakes (g/animal/day) of the Cow Supplementation Treatment Groups

| Season | Period (d) | Component | Treatment C1 | Treatment C2 | Treatment C3 |
|---|---|---|---|---|---|
| Late winter 2012 | 133 | Supplement intake (g/animal/day) | 549 | 423 | 428 |
| | | CP (g/animal/day) | 201 | 197 | 203 |
| | | Protein from NPN (g/animal/day) | 156 | 175 | 195 |
| | | ME (MJ/animal/day) | 2.88 | 1.86 | 1.03 |
| | | P (g/animal/day) | 7.69 | 8.04 | 11.00 |
| Late winter 2013 | 135 | Supplement intake (g/animal/day) | 652 | 502 | 472 |
| | | CP (g/animal/day) | 239 | 234 | 224 |
| | | Protein from NPN (g/animal/day) | 185 | 208 | 215 |
| | | ME (MJ/animal/day) | 3.42 | 2.21 | 1.14 |
| | | P (g/animal/day) | 9.13 | 9.54 | 12.13 |
| Late winter 2014 | 142 | Supplement intake (g/animal/day) | 710 | 550 | 546 |
| | | CP (g/animal/day) | 261 | 256 | 259 |
| | | Protein from NPN (g/animal/day) | 202 | 227 | 249 |
| | | ME (MJ/animal/day) | 3.73 | 2.42 | 1.31 |
| | | P (g/animal/day) | 9.94 | 10.45 | 14.03 |

**Table 9.5** Three year (2011 - 2013) average late winter supplement and nutrient intakes (g/animal/day) of the Cow Supplementation Treatment Groups as well as the three year average cost of the treatments offered (R/animal/late winter supplementation period)

| Season and Year | Period (d) | Component | Treatment | | |
|---|---|---|---|---|---|
| | | | C1 | C2 | C3 |
| Late winter 2011 - 2014 | 137 | Supplement intake (g/animal/day) | 638 | 493 | 483 |
| | | CP (g/animal/day) | 234 | 230 | 229 |
| | | Protein from NPN (g/animal/day) | 181 | 204 | 220 |
| | | ME (MJ/animal/day) | 3.35 | 2.17 | 1.16 |
| | | P (g/animal/day) | 8.93 | 9.37 | 12.41 |
| | | Cost (R/animal/suppl. period) | R 247.97 | R 200.02 | R 171.25 |



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The three late winter supplementation periods lasted an average of 137 days. The three year average intake (g/cow/day) of supplements was within the recommended intake ranges of 450 – 650 g/animal/day for the C1 Treatment Group and 350 – 500 g/animal/day for the C2 and C3 Treatment Groups (Table 9.4). Due to the drought experienced in 2014 it was decided to offer all three treatment groups an additional 10% supplement in an attempt to prevent cows from losing excessive body weight. The three year average CP intakes of all three Cow Supplementation Treatment Groups were very similar (234, 230 and 229 g/animal/day) however due to differences in the composition of the supplementation treatments, differences occurred between treatment groups with regards to supplemental protein from NPN (181, 204 and 220 g/animal/day) and supplemental energy (3.35, 2.17 and 1.16 MJ/animal/day). The three year average cost incurred in supplying the late winter supplement to the C1 Treatment Group was R247.97 per animal, the C2 Treatment Group R200.02 and the C3 Treatment Group R171.25 (Table 9.5).

The yearly (2011-12, 2012-13 and 2013-14) average summer supplement and nutrient intakes (g/animal/day) of the Cow Supplementation Treatment Groups are presented in Table 9.6.

**Table 9.6** The yearly (2011-12, 2012-13 and 2013-14) average summer supplement and nutrient intakes (g/animal/day) of the Cow Supplementation Treatment Groups

| Season | Period (d) | Component | Treatment C1 | Treatment C2 | TreatmentC 3 |
|---|---|---|---|---|---|
| Summer 2011 - 12 | 109 | Supplement intake (g/animal/day) | 238 | 72 | 82 |
| | | CP (g/animal/day) | 36 | 0 | 0 |
| | | Protein from NPN (g/animal/day) | 33 | 0 | 0 |
| | | P (g/animal/day) | 11.90 | 4.32 | 4.92 |
| Summer 2012 - 13 | 106 | Supplement intake (g/animal/day) | 218 | 126 | 124 |
| | | CP (g/animal/day) | 33 | 0 | 0 |
| | | Protein from NPN (g/animal/day) | 30 | 0 | 0 |
| | | P (g/animal/day) | 10.90 | 7.56 | 7.44 |
| Summer 2013 - 14 | 101 | Supplement intake (g/animal/day) | 231 | 108 | 109 |
| | | CP (g/animal/day) | 35 | 0 | 0 |
| | | Protein from NPN (g/animal/day) | 32 | 0 | 0 |
| | | P (g/animal/day) | 11.55 | 6.48 | 6.54 |



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The three (2011-12 to 2013-14) year average summer supplement and nutrient intakes as well as the cost incurred in supplying the supplements to the Cow Supplementation Treatment Groups are summarized in Table 9.7.

**Table 9.7** Three year (2011-12 to 2013-14) average summer supplement and nutrient intakes (g/animal/day) of the Cow Supplementation Treatment as well as the three year average cost of supplying the treatments (R/animal/summer supplementation period)

| Season and Year | Period (d) | Component | Treatment | | |
|---|---|---|---|---|---|
| | | | C1 | C2 | C3 |
| Summer | 106 | Supplement intake (g/animal/day) | 229 | 101 | 104 |
| 2011 - 2014 | | CP (g/animal/day) | 34 | 0 | 0 |
| | | Protein from NPN (g/animal/day) | 31 | 0 | 0 |
| | | P (g/animal/day) | 11.45 | 6.06 | 6.24 |
| | | Cost (R/animal/suppl. period) | R 106.81 | R 33.08 | R 34.07 |

The three summer supplementation periods lasted and average of 106 days. The C1 Treatment Group consumed quantities (299 g/cow/day) close to the maximum recommended daily intake of 240 g/cow/day and the C2 and C3 Treatment Groups consumed quantities (101 and 104 g/cow/day) close to the minimum recommended daily intake of 100 g/animal/day resulting in a higher supplemental P intake for the C1 Treatment Group (11.45 g/cow/day) compared to the C2 and C3 Treatment Groups (6.06 and 6.24 g/cow/day) (Table 9.7). The three year average cost incurred in supplying the summer supplement to the C1 Treatment Group was R106.81 per cow, the supplement to the C2 Treatment Group R33.08 and the supplement to the C3 Treatment Group R34.07 (Table 9.7).

The yearly (2012, 2013 and 2014) winter supplement and nutrient intakes (g/animal/day) of the Cow Supplementation Treatment Groups are presented in Table 9.8. The three (2012 to 2014) year average late winter supplement and nutrient intakes and the cost incurred in supplying the supplements to the Cow Supplementation Treatment Groups are summarized in Table 9.9.



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**Table 9.8** The yearly (2012, 2013 and 2014) average winter supplement and nutrient intakes (g/animal/day) of the Cow Supplementation Treatment Groups

| Season | Period (d) | Component | Treatment C1 | Treatment C2 | TreatmentC 3 |
|---|---|---|---|---|---|
| Winter 2012 | 123 | Supplement intake (g/animal/day) | 495 | 438 | 325 |
| | | CP (g/animal/day) | 182 | 204 | 153 |
| | | Protein from NPN (g/animal/day) | 141 | 181 | 148 |
| | | ME (MJ/animal/day) | 2.59 | 1.93 | 0.78 |
| | | P (g/animal/day) | 6.93 | 8.32 | 8.35 |
| Winter 2013 | 124 | Supplement intake (g/animal/day) | 507 | 430 | 325 |
| | | CP (g/animal/day) | 186 | 200 | 153 |
| | | Protein from NPN (g/animal/day) | 144 | 177 | 148 |
| | | ME (MJ/animal/day) | 2.66 | 1.89 | 0.78 |
| | | P (g/animal/day) | 7.10 | 8.17 | 8.35 |
| Winter 2014 | 122 | Supplement intake (g/animal/day) | 540 | 415 | 388 |
| | | CP (g/animal/day) | 198 | 193 | 184 |
| | | Protein from NPN (g/animal/day) | 153 | 171 | 177 |
| | | ME (MJ/animal/day) | 2.84 | 1.82 | 0.93 |
| | | P (g/animal/day) | 7.56 | 7.89 | 9.97 |

**Table 9.9** Three year (2012 to 2014) average winter supplement and nutrient intakes (g/cow/day) of the Cow Supplementation Treatments as well as the three year average cost (R/cow/winter supplementation period) incurred in supplying the treatments

| Season and Year | Period (d) | Component | Treatment | | |
|---|---|---|---|---|---|
| | | | C1 | C2 | C3 |
| Winter 2012 – 2014 | 123 | Supplement intake (g/animal/day) | 514 | 428 | 347 |
| | | CP (g/animal/day) | 189 | 199 | 165 |
| | | Protein from NPN (g/animal/day) | 146 | 177 | 158 |
| | | ME (MJ/animal/day) | 2.70 | 1.88 | 0.83 |
| | | P (g/animal/day) | 7.20 | 8.13 | 8.92 |
| | | Cost (R/animal/suppl. period) | R 184.82 | R 161.44 | R 116.23 |



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The three winter supplementation periods lasted an average of 123 day. The average winter supplement intake of the C1 Treatment Group (514 g/cow/day) was close to the maximum recommended level of 520 g/cow/day. The C2 Treatment Group consumed (428 g/cow/day) slightly more than the maximum recommended level of 400g/cow/day and the C3 Treatment Group consumed (347 g/animal/day) slightly less than the maximum recommended level of 400g/cow/day. The three year average cost incurred in supplying the winter supplement to the C1 Treatment Group was R184.82 per cow, the supplement to the C2 Treatment Group R161.44 and the supplement to the C3 Treatment Group R116.23 (Table 9.9).

Figure 9.1 illustrates the differences in average supplement intake per supplementation period between the Cow Supplementation Treatment Groups and Figure 9.2 illustrates the differences in average cost (R/cow/year) incurred in supplying the supplementation treatments to the Cow Supplementation Treatment Groups

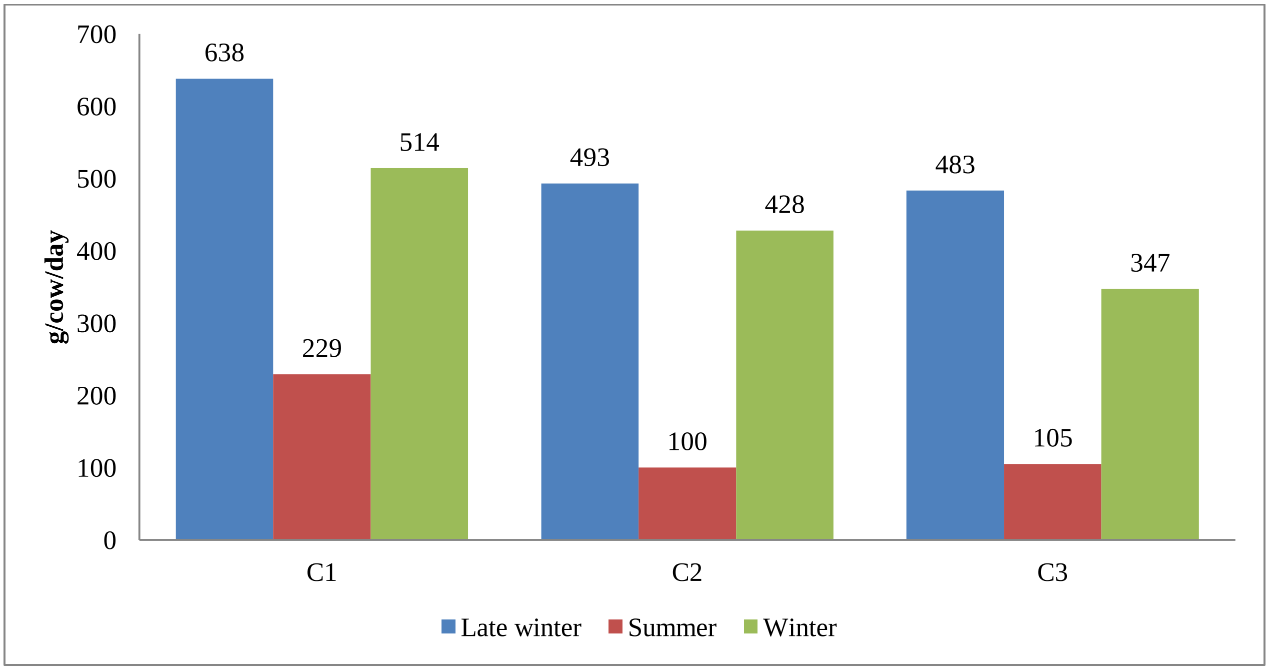


**Figure 9.1** The average supplement intake (g/animal/day) of the Cow Supplementation Treatment Groups (1 August 2011 to 31 July 2014)



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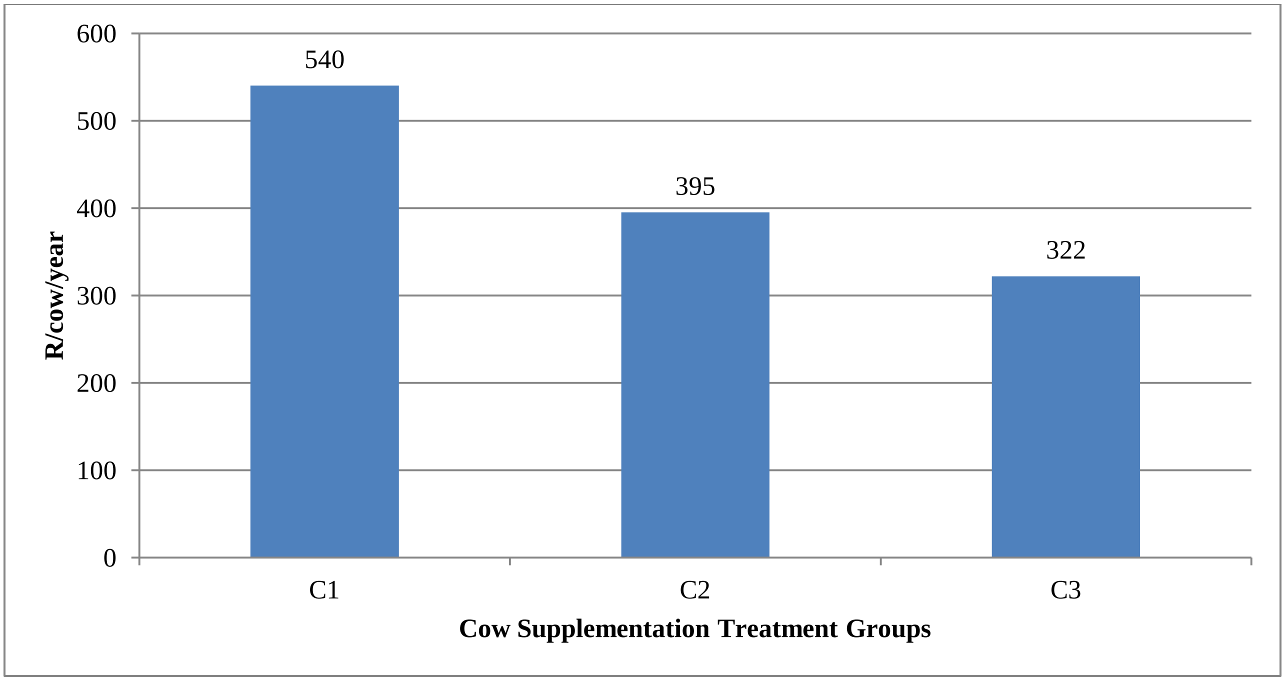


**Figure 9.2** The average cost (R/cow/year) of supplementation of the Cow Supplementation Treatment Groups (1 August 2011 to 31 July 2014)



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### 9.3.2 Body weights and BCS of the Cow Supplementation Treatment Groups

The mean body weights of the Cow Supplementation Treatment Groups are summarized in Table 9.10. The mean gains or losses in body weight (kg) from August to March of each year are also presented in Table 9.10.

**Table 9.10** Mean (± SD) body weights (kg) and weight gains/losses of the Cow Supplementation Treatment Groups

| Treatments | C1 | C2 | C2 |
|---|---|---|---|
| 1 August 2011 to 31 July 2012 | | | |
| | n = 40 | n = 46 | n = 40 |
| | Mean weight (kg) | Mean weight (kg) | Mean weight (kg) |
| Late winter ( Aug) | $548^{a} \pm 62$ | $544^{a} \pm 50$ | $543^{a} \pm 57$ |
| Summer (Mar) | $543^{a} \pm 57$ | $562^{a} \pm 52$ | $569^{b} \pm 49$ |
| Wean | $535^{a} \pm 58$ | $562^{b} \pm 56$ | $*529^{a} \pm 57$ |
| Winter (Jul) | $*513^{a} \pm 51$ | $*546^{b} \pm 53$ | $*512^{a} \pm 55$ |
| Weight gain/loss Aug to March | $-5^{a} \pm 35$ | $**18^{b} \pm 30$ | $***26^{b} \pm 26$ |
| 1 August 2012 to 31 July 2013 | | | |
| | n = 41 | n = 43 | n = 46 |
| Late winter ( Aug) | $523^{a} \pm 57$ | $537^{a} \pm 51$ | $527^{a} \pm 59$ |
| Summer (Mar) | $570^{a} \pm 68$ | $566^{a} \pm 60$ | $560^{a} \pm 47$ |
| Wean | $540^{a} \pm 58$ | $552^{ab} \pm 52$ | $563^{b} \pm 53$ |
| Winter (Jul) | $551^{a} \pm 59$ | $548^{a} \pm 56$ | $546^{a} \pm 47$ |
| Weight gain/loss Aug to March | $48^{a} \pm 42$ | $29^{b} \pm 28$ | $33^{ab} \pm 40$ |
| 1 August 2013 to 31 July 2014 | | | |
| | n = 34 | n = 37 | n = 39 |
| Late winter ( Aug) | $550^{a} \pm 58$ | $551^{a} \pm 67$ | $545^{a} \pm 50$ |
| Summer (Mar) | $553^{a} \pm 53$ | $566^{a} \pm 59$ | $569^{a} \pm 43$ |
| Wean | $551^{a} \pm 55$ | $566^{a} \pm 61$ | $556^{a} \pm 46$ |
| Winter (Jul) | $541^{a} \pm 54$ | $540^{a} \pm 54$ | $549^{a} \pm 46$ |
| Weight gain/loss Aug to March | $3^{a} \pm 39$ | $17^{ab} \pm 45$ | $24^{b} \pm 31$ |

Mean values in the same row with different superscripts differ significantly: $P < 0.05$; $*P < 0.01$, $** P < 0.001$, $*** P < 0.0001$



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In Year 1 (2011-12) of the study the C2 Treatment Group weighed (562 ± 56 kg) significantly (*P* < 0.01) heavier at the weaning of their calves than the C1 (535 ± 58 kg) and the C3 (529 ± 57 kg) Treatment Groups and this was also the case at the conclusion (July) of the Year 1 (Table 9.10).

In Year 2 (2012-13) of the study the C3 Treatment Group weighed (563 ± 53 kg) significantly (*P* < 0.05) heavier at the weaning of their calves than the C2 (540 ± 58 kg) Treatment Group. No significant differences in body weights were measured between the Cow Supplementation Treatment Groups during Year 3 (2013-14) of the study (Table 9.10).

The mean body condition scores of the Cow Supplementation Treatment Groups are summarized in Table 9.11

**Table 9.11** Mean (± SD) BCS (1 = severely emaciated, 9 = very obese) of the Cow Treatment Groups

| Treatments | C1 | | C2 | | C3 | |
|---|---|---|---|---|---|---|
| 1 August 2011 to 31 July 2012 | | | | | | |
| | Mean BCS | SD | Mean BCS | SD | Mean BCS | SD |
| Late winter (Augusts) | $4.80^{a}$ | 0.85 | $4.72^{ab}$ | 0.81 | $4.30^{b}$ | 0.69 |
| Summer (March) | $4.95^{a}$ | 0.55 | $5.02^{a}$ | 0.58 | $5.23^{a}$ | 0.95 |
| Winter (July) | $4.30^{a}$ | 0.56 | $4.54^{a}$ | 0.78 | $4.48^{a}$ | 0.55 |
| 1 August 2012 to 31 July 2013 | | | | | | |
| Late winter (Augusts) | $4.56^{a}$ | 0.78 | $4.81^{a}$ | 0.82 | $4.89^{a}$ | 0.85 |
| Summer (March) | $4.90^{ab}$ | 0.66 | $*5.05^{a}$ | 0.49 | $*4.76^{b}$ | 0.52 |
| Winter (July) | $4.70^{a}$ | 0.72 | $4.67^{a}$ | 0.52 | $4.70^{a}$ | 0.59 |
| 1 August 2012 to 31 July 2014 | | | | | | |
| Late winter (Augusts) | $4.85^{a}$ | 0.86 | $4.81^{a}$ | 0.88 | $4.95^{a}$ | 0.72 |
| Summer (March) | $4.59^{a}$ | 0.61 | $4.59^{a}$ | 0.55 | $4.67^{a}$ | 0.58 |
| Winter (July) | $4.88^{a}$ | 0.77 | $4.81^{a}$ | 0.57 | $4.71^{a}$ | 0.46 |

Mean values in the same row with different superscripts differ significantly: *P* < 0.05; **P* < 0.01

The C3 Treatment Group gained the most weight from August to March in Year 1 (*P* < 0.0001) and Year 3 (*P* < 0.05) and had the highest BCS (which was not significant) at the end of the breeding season (March) in Year 1 and Year 3 (Table 9.11). The C1 Treatment Group gained the



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least amount of weight from August to March in Year 1 ($P < 0.0001$) and Year 3 ($P < 0.05$) and also had the lowest BCS ($P > 0.05$) at the end of the breeding season (March) in Year 1 and Year 3. In Year 2 the C1 Treatment Group gained the most weight (48 ± 42 kg) from August to March ($P < 0.05$) and C2 the least weight (29 ± 28 kg). Even though the C2 Treatment Group gained the least weight it had the highest BCS (5.05 ± 0.49) at the end of the breeding season (March) ($P < 0.01$).

### 9.3.3 Production and reproduction data of the Cow Supplementation Treatment Groups

The production and reproduction levels attained by the Cow Supplementation Treatment Groups during the course of the study are summarized in Table 9.12. Conception rate and weaning weight were used as a measure of reproductive efficiency (Table 9.12). Although there was no statistical differences in weaning weights between supplementation treatments, there was a trend with the same tendency for C1 calves to be the heaviest (223 ± 26 kg, 218 ± 24 kg, 230 ± 26 kg) at weaning and the C3 calves to be the lightest (214 ± 23 kg, 210 ± 27 kg, 223 ± 16 kg). A conception rate of 90%, 91% and 92 % was recorded for the C1 treatment group, 91%, 88% and 92 % for the C2 treatment group and 92%, 94% and 96% for the C3 treatment group. While significant ($P < 0.001$) differences in 100-day calf weights were measured between treatment groups in 2012-13 and in the birth weights of calves in 2013-14 ($P < 0.01$) these variables were not used as production parameters. The three year average ICP for the C1 Treatment Group was 387 days, the C2 Treatment Group was 378 days and the C3 Treatment group was 387 days.



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**Table 9.12** Means (± SD) for birth weight (kg), 100-day weight (kg) and wean weight (kg) of calves as well as cow weights at wean, inter calving period (ICP) (days) and conception rate (%) of the Cow Supplementation Treatment Groups.

| Treatments | C1 | | C2 | | C3 | |
|---|---|---|---|---|---|---|
| 1 August 2011 to 31 July 2012 | | | | | | |
| | n = 40 | SD | n = 46 | SD | n = 40 | SD |
| | Mean weight (kg) | | Mean weight (kg) | | Mean weight (kg) | |
| Calf birth weight | 39.5[a] | 4.9 | 39.2[a] | 3.9 | 37.9[a] | 3.9 |
| Calf 100 day weight | 136[a] | 22 | 133[a] | 17 | 130[a] | 16 |
| Calf wean weight | 223[a] | 26 | 220[a] | 28 | 214[a] | 23 |
| Cow weight at wean | 535[a] | 52 | 562[b] | 56 | *529[a] | 57 |
| ICP | 380 days | | 382 days | | 382 days | |
| Conception rate | 90 % | | 91 % | | 92 % | |
| 1 August 2012 to 31 July 2013 | | | | | | |
| | n = 41 | | n = 43 | | n = 46 | |
| Calf birth weight | 39.3[a] | 4.7 | 38.0[a] | 4.7 | 37.4[a] | 4.9 |
| Calf 100 day weight | **147[a] | 17 | 133[b] | 18 | 131[b] | 18 |
| Calf wean weight | 218[a] | 24 | 211[a] | 26 | 210[a] | 27 |
| Cow weight at wean | 540[a] | 58 | 552[ab] | 52 | 563[b] | 53 |
| ICP | 397 days | | 385 days | | 398 days | |
| Conception rate | 91 % | | 88 % | | 94 % | |
| 1 August 2013 to 31 July 2014 | | | | | | |
| | n = 34 | | n = 37 | | n = 39 | |
| Calf birth weight | 41.1[a] | 5.1 | 39.0[b] | 4.0 | *37.8 | 4.5 |
| Calf 100 day weight | 140[a] | 19 | 142[a] | 21 | 134[a] | 21 |
| Calf wean weight | 230[a] | 26 | 227[a] | 23 | 223[a] | 16 |
| Cow weight at wean | 551[a] | 55 | 566[a] | 61 | 556[a] | 46 |
| ICP | 382 | | 364 | | 379 | |
| Conception rate | 90 % | | 92 % | | 96 % | |

Mean values in the same row with different superscripts differ significantly: $P < 0.05$; $*P < 0.01$, $** P < 0.001$



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## 9.4 DISCUSSION AND CONCLUSION

Supplement intakes of the different Cow Supplementation Treatment Groups were very close to the levels recommended by animal nutritionists and were also typical of the levels used under practical farming conditions and often employed by farmers in the area. Climatic and geographical variations in the nutritive value of natural pastures may be accommodated by varying the amount of supplements fed (Cronje, 1990). Very satisfactory cow production and reproduction results were achieved by increasing supplements fed by only 10% during the devastating drought of 2013 and thus a constant level of animal production was possible at a relatively minimal cost. This was however achieved by maintaining a realistic stocking that was applied according to the grazing capacity of the veld as well as the implementation of the three-camp-*Elionorus*-cattle rangeland management system developed by Van der Westhuizen (2014). The stability of the veld was maintained due to realistic stocking rates that were applied according to the grazing capacity of the veld and this ensured the availability of sufficient amounts of roughage during the dry spell of 2013.

Significant relationships between body weight and conception rate as well as body condition score and conception rate were not found. The reason that significant relationships between body weight, body condition score and conception rate were not established may be due to the 'target weight' concept proposed by Lamond (1970). According to Lamond (1970) each cow has the probability of conception within a range of body weight and body condition. It is thus believed that the level of supplementation of all three Cow Supplementation Treatment Groups enabled the cows in each treatment group to operate within their 'target weight' range. Similar results were also reported by Steenkamp *et al*. (1975), Meaker *et al.* (1980) and Lishman (1984).

Though not significant, there was a tendency for conception rate to increase as body weight increased from before calving to the end of the breeding season (August to March) as well as having a higher BCS at the end of the breeding season. Preston & Willis (1974), Lishman (1984), Groenewald (1986) and MacGregor & Swanepoel (1992) report similar findings. In Year 1 and 3 the C3 Treatment Group had the highest BCS at the end of the breeding season, the highest weight gain from August (before calving) to March (end of the breeding season) as well as the highest conception rate. The C1 Treatment Group in contrast had the lowest BCS at the



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end of the breeding season, the lowest weight gain from August to March and also the lowest conception rate in Year 1 and Year 3. In Year 2 there was however a slight deviation in the trend seen in Year 1 and Year 3. In Year 2 the C2 Treatment Group had the lowest weight gain from August to March, the lowest conception rate but the highest BCS at the end of the breeding season.

Owing to the high intake and cost of the ready mixed mineral supplement (5% P and 15% CP) offered to the C1 Supplementation Treatment Group in summer compared to the mineral supplement (6% P) offered to the C2 and C3 Supplementation Treatment Groups, as well as the higher recommended intake (due to lower CP content as a result of a higher inclusion rate of cottonseed oilcake) of the winter and late winter supplements offered to the C1 Treatment Group, the C1 Treatment Group would have to perform considerably better than the C2 and C3 Treatment Groups to cover expenses. This was not found in this trial. Conception was not affected by supplementation treatment. Despite the fact that C1 Treatment Cows weaned slightly heavier calves, the difference was not sufficient to make this practice economically justifiable. These results are in agreement with De Brouwer *at al.* (1993) who found supplementing cows on the western Highveld (Potchefstroom) with a dicalcium phosphate supplement in summer and a urea based protein supplement in winter gave satisfactory production and reproduction results but at a reduced cost (De Brouwer *et al*., 1993).

On well managed veld in the south-eastern Free State were sufficient roughage of good quality is available, supplementation of beef breeder cows with a mineral supplement containing 6% P in summer and a urea based protein supplement (with added P) in winter gives comparable results to a ready mixed mineral supplement (5% P and 15% CP) in summer and a urea and cottonseed oilcake based protein supplement (with added CP) in winter but at much reduced costs (see Chapter 10).



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# CHAPTER 10

# EFFECT OF SUPPLEMENTATION REGIMEN AND PRODUCTION ATTAINED ON HERD PROFITABILITY

## 10.1 INTRODUCTION

The economic performance of a beef cow-calf enterprise can be measured in alternative ways. The measures chosen for this study were feed (supplementation) costs, production and profitability. Farmers and animal nutritionists often focus on production measures (conception rate and kilograms weaned) and the means to increase production as it is the measure in the economic performance model that is easy to quantify. Farmers and animal nutritionists also need to emphasize cost management, another component of the profit equation (Ramsey *et al.*, 2005). The management and calculation of supplementation costs per unit animal is, however, a daunting task for many beef farmers as they are overwhelmed by a number of factors: the production season in beef cattle farming is a year (365 days) long and as a result accounting needs to be done year round; animals are not always in the same production stadia; animal numbers are not static; labour constraints and erratic weather.

Supplementary feeding recommendations should, where possible, be studied under realistic and practical grazing conditions with the relevant animal species. Needless to say, any input regarding supplementation must be positively reflected in animal performance and the increase in output must be economically justifiable (De Waal, 1990; Van Niekerk, 1996).Ultimately, the major focus is with the profitability of the cow-calf enterprise. While technology advances have contributed to increased production efficiency and reduced costs, the profitability of cow-calf operations vary extensively (Ramsey *et al.*, 2005). This chapter will deal with the production and reproduction results of the different supplementation regimes as well as their effects on the profitability of a simulated cow-calf beef herd.



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## 10.2 MATEIALS AND METHODS

### 10.2.1 Beef price

Beef prices used (R/kg live weight and R/kg carcass weight) were the actual prices paid for cull cows in December 2014, cull heifers in April 2015 and weaners in Mei 2015. All the marketable weaners were sold to a feedlot and the cull cows and heifers to the local abattoir. Mean weaner calf weights and mean cow weights measured during the course of the study were used to calculate the income from the sale of weaner calves and cull animals.

### 10.2.2 Supplementation cost

The average supplemental intakes (g/animal) realized during the course of the study were used in the calculation of the supplementation costs The September raw material prices of 2014 were used to calculate the cost (R per production group) of supplements offered to the animals in late winter, the February raw material prices of 2015 were used to calculate the average cost of the supplements offered to the animals in summer and the May raw material prices of 2015 were used to calculate the cost of the supplements offered to the animals in winter.

### 10.2.3 Construction of the Hypothetical herd

To construct a hypothetical herd, mean production values derived from the study were used (2011 to 2014). Simulation Herd 1 is a production system using all the Treatment 1 supplements (Young Heifers Treatment 1, Heifers Treatment 1, First-calf-heifers Treatment 1 and Cows Treatment 1). Simulation Herd 2 is a production system using all the Treatment 2 supplements (Young Heifers Treatment 2, Heifers Treatment 2, First-calf-heifers Treatment 2 and Cows Treatment 2) and Simulation Herd 3 is a production system using all the Treatment 3 supplements (Young Heifers Treatment 3, Heifers Treatment 3, First-calf-heifers Treatment 3 and Cows Treatment 3).

The production year for the simulated herds starts on 1 August 2014 and ends on the 31st of July 2015 and thus encumbers a whole production cycle. The herds are made up of 45 young heifers (wean to 22 months old), 45 heifers (22 months to 34 months old), 43 first-calf-heifers and 255 cows. The replacement rate is 15% and cull heifers (heifers not in calf) are marketed after the



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establishment of pregnancy in April (AB grade) and cull cows (C grade) in December so that cows can finish off on natural grazing and to take advantage of the Christmas price peak. Weaner calves are sold in Mei to a feedlot. The fixed values used in the three simulation studies are presented in Table 10.1

**Table 10.1** Fixed values used in the three simulation studies.

| | **Simulation 1** | **Simulation 2** | **Simulation 3** |
|---|---|---|---|
| Percentage cows calved | 91 | 90 | 94 |
| Percentage first-calf-heifers calved | 87 | 97 | 89 |
| Percentage heifers calved | 95 | 95 | 95 |
| Age at first calving | 36 months | 36 months | 36 months |
| Average cow weight | 542 kg | 560 kg | 549 kg |
| Average weaning age | 7 months | 7 months | 7 months |
| Average weaning weight of cows and $2^{nd}$ calf-cows | 223.7 kg | 219.3 kg | 215.7 kg |
| Average weaning weight first-calf-heifers | 226.3 kg | 222.0 kg | 218.0 kg |
| 2½ year weight of heifers | 456 kg | 453 kg | 445 kg |



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## 10.3 RESULTS AND DISCUSSION

Results for the income generated by the different simulated production systems are given in Table 10.2

**Table 10.2** Income generated by the different simulated production systems

| | **Simulation 1** | **Simulation 2** | **Simulation 3** |
|---|---|---|---|
| Calves weaned per 212 cows | 193 | 191 | 199 |
| Calves weaned per 43 2nd calf-cows | 37 | 42 | 38 |
| Calves available for sale (cows and 2nd calf-cows, 15% replacement) | 192 | 195 | 199 |
| Calves weaned per 45 first-calf-heifers | 43 | 43 | 43 |
| Calves available for sale (first-calf-heifers, 15% replacement) | 36 | 36 | 36 |
| Total weaning weight (cows and 2nd calf-cows) | 42 950 kg | 42 764 kg | 42 924 kg |
| Total weaning weight (first-calf-heifers) | 8 147 kg | 7 992 kg | 7 848 kg |
| Income from weaners (@ R19.00 per live weight) (Mei 2015) | R 970 843 | R 964 364 | R 964 668 |
| Income from cull cows, dressing percentage 48% (43 x average cow weight x 48% @ R28.50) (December 2014) | R 318 826 | R 329 414 | R 322 944 |
| Income from cull heifers, dressing percentage 50% (2 x average heifer weight x 50% @ R 28.00 (March 2015) | R 12 768 | R 12 684 | R 12 460 |
| Total income generated | R 1 302 437 | R 1 306 462 | R 1 300 072 |



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Even though there were differences in the conception rate, weaning weight of calves and weight of cows and heifers (Table 10.1) the difference in total income generated between the simulations was negligible. The difference between the highest income (R 1 306 462) generated by Simulation 2 and the lowest income (R 1 300 072) generated by Simulation 3 was a mere R6390.

The costs incurred in supplying the different supplements to the Simulation 1, Simulation 2 and Simulation 3 production systems are given in Table 10.3 to Table 10.5.

**Table 10.3** Supplementation costs of the Simulation 1 production system

| | a | b | c | d | e |
|---|---|---|---|---|---|
| | *n* | Days | Mean supplement intake (g/animal) | Supplement cost (R/kg) | Cost of supplementation (a x b x c x d) |
| Young heifers late winter | 45 | 137 | 657g | R 3.74/kg | R 15 148.51 |
| Young heifers summer | 45 | 106 | 380g | R 3.10 | R 5 619.06 |
| Young heifers winter | 45 | 123 | 192g | R 2.92 | R 3 103.14 |
| Subtotal | | | | | R 23 870.71 |
| Heifers late winter | 45 | 137 | 211g | R 2.70 | R 3 512.20 |
| Heifers summer | 45 | 106 | 60g | R 3.55 | R 1 016.01 |
| Heifers winter | 43 | 123 | 442g | R 3.26 | R 7 621.03 |
| Subtotal | | | | | R 12 149.24 |
| First-calf-heifers late winter | 43 | 137 | 1189g | R 3.74 | R 26 196.45 |
| First-calf-heifers summer | 43 | 106 | 1080g | R 3.10 | R 15 260.18 |
| First-calf-heifers winter | 43 | 123 | 514g | R 3.26 | R 8 862.46 |
| Subtotal | | | | | R 50 319.09 |
| Cows late winter | 255 | 137 | 638g | R 3.04 | R 67 757.13 |
| Cows summer | 255 | 106 | 229g | R 5.04 | R 31 196.94 |
| Cows winter | 255 | 123 | 514g | R 3.26 | R 52 556.45 |
| Subtotal | | | | | R 151 510.52 |
| TOTAL COST | | | | | **R 237 849.56** |



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The total cost incurred in supplying supplements to the Simulation 1 herd was R 237 849.56. The amount spent on the development of a replacement heifer (wean to late pregnancy) was R 800.44 per heifer (R 36 019.95/45). The supplements offered to a first-calf-heifer totaled R1170.21 per first-calf-heifer per annum (p.a.) and the supplements offered to a cow totaled R 594.16 p.a.

**Table 10.4** Supplementation costs of the Simulation 2 production system

| | a | b | c | d | e |
|---|---|---|---|---|---|
| | *n* | Days | Mean supplement intake (g/animal) | Supplement cost (R/kg) | Cost of supplementation (a x b x c x d) |
| Young heifers late winter | 45 | 137 | 299g | R 3.08 | R 5 677.47 |
| Young heifers summer | 45 | 106 | 100g | R 5.03 | R 2 399.31 |
| Young heifers winter | 45 | 123 | 192g | R 2.92 | R 3 103.14 |
| Subtotal | | | | | R 11 179.92 |
| Heifers late winter | 45 | 137 | 211g | R 2.70 | R 3 512.20 |
| Heifers summer | 45 | 106 | 60g | R 3.55 | R 1 016.01 |
| Heifers winter | 43 | 123 | 369g | R 3.39 | R 6 923.79 |
| Subtotal | | | | | R 11 452.00 |
| First-calf-heifers late winter | 43 | 137 | 582g | R 3.08 | R 10 559.97 |
| First-calf-heifers summer | 43 | 106 | 198g | R 5.03 | R 4 539.49 |
| First-calf-heifers winter | 43 | 123 | 428g | R 3.39 | R 7 673.92 |
| Subtotal | | | | | R 22 773.38 |
| Cows late winter | 255 | 137 | 493g | R 3.14 | R 48 156.50 |
| Cows summer | 255 | 106 | 101g | R 3.55 | R 9 691.61 |
| Cows winter | 255 | 123 | 428g | R 3.39 | R 45 508.11 |
| Subtotal | | | | | R 103 356.22 |
| TOTAL COST | | | | | **R 148 761.52** |

The total cost incurred in supplying supplements to the Simulation 2 herd was R 148 761.52. The amount spent on the development of a replacement heifer (wean to late pregnancy) was R 502.93 per heifer (R 22 631.92/45). The supplements offered to a first-calf-heifer totaled R529.61 per first-calf-heifer per annum (p.a.) and the supplements offered to a cow totaled R 405.32 p.a.



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**Table 10.5** Supplementation costs of the Simulation 3 production system

| | a | b | c | d | e |
|---|---|---|---|---|---|
| | *n* | Days | Mean supplement intake (kg/animal) | Supplement cost (R/kg) | Cost of supplementation (a x b x c x d) |
| Young heifers late winter | 45 | 137 | 167g | R 2.70 | R 2 779.80 |
| Young heifers summer | 45 | 106 | 64g | R 3.55 | R 308.83 |
| Young heifers winter | 45 | 123 | 192g | R 2.92 | R 3 103.14 |
| Subtotal | | | | | R 6 191.77 |
| Heifers late winter | 45 | 137 | 211g | R 2.70 | R 3 512.20 |
| Heifers summer | 45 | 106 | 60g | R 3.55 | R 1 016.01 |
| Heifers winter | 43 | 123 | 311g | R 2.92 | R 4 803.05 |
| Subtotal cost | | | | | R 9 331.26 |
| First-calf-heifers late winter | 43 | 137 | 324g | R 2.70 | R 5 153.45 |
| First-calf-heifers summer | 43 | 106 | 105g | R 3.55 | R 1 698.99 |
| First-calf-heifers winter | 43 | 123 | 436g | R 2.92 | R 6 733.53 |
| Total cost | | | | | R 13 585.97 |
| Cows late winter | 255 | 137 | 483g | R 2.70 | R 45 558.73 |
| Cows summer | 255 | 106 | 104g | R 3.55 | R 9 979.48 |
| Cows winter | 255 | 123 | 347g | R 2.92 | R 31 780.27 |
| Subtotal | | | | | R 87 318.48 |
| TOTAL COST | | | | | **R 116 427.48** |

The total cost incurred in supplying supplements to the Simulation 3 herd was R 116 427.48. The amount spent on the development of a replacement heifer (wean to late pregnancy) was R 344.96 per heifer (R 15 523.03/45). The supplements offered to a first-calf-heifer totaled R315.95 per first-calf-heifer per annum (p.a.) and the supplements offered to a cow totaled R 342.43 p.a.



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## 10.4 CONCLUSIONS

The financial advantages of the different supplementation treatments offered to a cow-calf production system are summarized in Table 10.6 in which the results of the present study were extrapolated to three simulated herds of 300 animals.

**Table 10.6** Summary of the effects of different supplementation regimens on the economics of a hypothetical herd of reproducing beef cows in the south-eastern Free Sate (2014 to 2015)

| Measurement | Supplementation Treatment Simulation | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| Income generated | R 1 302 437 | R 1 306 462 | R 1 300 072 |
| Cost of supplementation | R 237 850 | R 148 762 | R 116 427 |
| Nett income above supplementation cost | R 1 064 587 | R 1 157 700 | R 1 183 645 |
| Difference in income above supplement cost | - | R 93 113 | R 119 058 |

Table 10.6 clearly illustrates the financial advantages of supplementing a cow-calf herd grazing *Elionorus*-sour-grassland which is managed according to the rangeland management system developed by Van der Westhuizen (2014) with the Treatment 3 supplements. The profit realized by the cow-calf herd supplemented with Treatment 3 supplements was R 119 058 more than that of the herd supplemented with the Treatment 1 supplements and R 25 945 more than that of the herd supplemented with the Treatment 2 supplements.

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# CHAPTER 11

# SUMMARY AND RECOMMENDATIONS

Many changes have occurred in the beef cattle industry as a result of the application of scientific principles by farmers. However, the survey of supplementation and management practices of commercial beef farmers in the Zastron district indicates that the application of some of these principles is far from optimum. The reason for the lack of application is however debatable.

In some cases research has been done that shows the biological consequences of scientific principles without consideration of their economic consequences. It is believed that the current economic realities could be a major driver in the lack of the application of the mentioned scientific principles. Tougher economic conditions have brought to life a greater awareness in belt tightening amongst farmers. Cash strapped farmers have started rationing supplements, stopped investing in genetic material and are cutting on veterinary expenses. The number of farmers who did not apply the very basic of these principles is as follows ($n$ = 48): 15 (31%) farmers did not invest in genetic material and bred their own bulls; 20 (42%) farmers did not have their bulls tested for fertility; 18 (38%) farmers did not have their bulls tested for venereal diseases; 14 (29%) farmers did establish pregnancy; 10 (21%) farmers did not have a set breeding season and 20 (42%) farmers did not have a system to identify an individual animal. The question that arises is at what point does belt tightening start to impact production, reproduction and ultimately profitability?

Information available to the farmer on methods to improve the efficiency of their cow-calf beef production system has never been as easily accessible; however it would appear that some farmers who do not have a formal agricultural education background to be indifferent to this information as seven of the eight farmers whose supplementation regimen could be regarded as inadequate by animal nutritionists did not have any agricultural training (Chapter 5).

The levels of supplementation used in this study were chosen to be similar to the levels commonly recommended by animal nutritionists and employed by some of the farmers in the survey.



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Development and selection of replacement beef heifers is probably one of the most important performance selections a farmer has to make as the development system used could affect herd retention rate and cow longevity. How heifers are developed can increase the cost of the beef operation as over feeding heifers increases feed costs and underfeeding could reduce future heifer performance. The heifers in this study were developed extensively to calve as three-year-olds. Even though significant differences in body weight swere measured between the treatment groups on several occasions throughout the three year study period all three Young Heifer Supplementation Treatment Groups were able to attain target breeding weight (60 to 65% of mature body weight) eight months prior to the onset of the breeding season. However, when considering the differences in the cost of the supplementation treatments, substantial differences were found. The cost of the supplements offered to the YH1 Treatment Group (production supplement throughout the year) amounted to R466 per heifer per year, the YH2 Treatment Group (cotton-oil-cake and urea based protein and mineral supplement in winter and a mineral supplement with 15% protein in summer) R288 per heifer per year and the YH3 Treatment Group (urea based protein and mineral supplement in winter and a mineral supplement in summer) was R145 per heifer per year.

The body weights at the start of the breeding season (November) of all three Heifer Supplementation Treatment Groups over the entire 3-year study period fell well within the optimum weight range that calls for feeding heifers to a prebreeding weight that represents 60 to 65% of the heifer's projected mature weight. In Year 1 and Year 2 all three Heifer Supplementation Treatment Groups were able to reach the target breeding BCS at the start of the breeding season (November). At the beginning of the breeding season of Year 3 the BCS of the three Heifer Supplementation Treatment groups ranged between 3.2 and 3.5 which were far below the target breeding BCS of 5 to 6. As grazing conditions improved the BCS increased and heifers were able to attain the ideal breeding BCS of between 5 and 6 by the end of the breeding season. The total average cost of developing the YH1 and H1 Supplementation Treatment Groups from wean to late pregnancy (wean – 34 months old) was R717.38, the YH2 and H2 Supplementation Treatment Groups was R457.44 and the YH3 and H3 Supplementation Treatment Groups was R344.71. The conclusion made is that a heifer development system using a urea based protein supplement in winter and a mineral supplement in summer is sufficient.



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However, as this system relies on a recovery of lost body weight gain during subsequent grazing periods, the provision of sufficient amounts of roughage during the re-alignment phase is imperative to the success of this system.

There is a general consensus amongst many research workers that the lactating first-calf-heifer is likely to benefit (in terms of reproductive performance) from supplementary feeding with a production supplement before and after calving. The results reported here are not in accordance with this accepted belief.

The 1CH1 Treatment Group were offered a winter production supplement from late pregnancy (August) to early lactation (mid-December), a summer production supplement during the mating season (until March) and a cotton-oil-cake and urea based protein supplement after weaning (April). The supplements offered amounted to R1 032 per first-calf-heifer per year. The 1CH2 Treatment Group were offered a cotton-oil-cake and urea based protein supplement from late pregnancy to early lactation, a mineral supplement with 15% protein during the mating season and a urea and cotton-oil-cake based protein supplement after weaning. The supplements offered amounted to R483 per first-calf-heifer per year. The 1CH3 Treatment Group were offered a urea based protein supplement from late pregnancy to early lactation, a mineral supplement during the breeding season a urea based protein supplement after weaning. The supplements offered amounted to R265 per first-calf-heifer per year.

The results of the first-calf-heifer study could not establish a relationship between conception rate and mean body weight before calving (August), weight at the end of the breeding season (March), weight gain or loss over the breeding season or BCS. These results are not unique and the reason it is believed is that the animals were operating within their optimum weight range. The higher conception rate (97%) of the 1CH2 Treatment Group and heavier weaning weight (226.3 kg) of the 1CH1 Treatment Group were not sufficient to compensate for the higher cost of their supplements (Table 11.1).

Table 11.1 summarizes the production and reproduction levels of the First-calf-heifer Supplementation Treatment Groups as well as the costs incurred in supplying the supplementation treatments.



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**Table 11.1** Three year average production and reproduction levels as well as cost of supplementation of the First-calf-heifer Supplementation Treatment Groups

| | 1CH1 | 1CH2 | 1CH3 |
|---|---|---|---|
| First-calf-heifers re-bred | 87% | 97% | 89% |
| Average weaning weight of first-calf-heifers | 226.3 kg | 222.0 kg | 218.0 kg |
| Cost of supplementation (R/animal/year) | R 1 033 | R 483 | R 265 |

When using the production and reproduction results of the First-calf-heifer Supplementation Treatment Groups of this study, supplementation prices of August 2014 to July 2015 and May 2015 weaner calf prices on a simulated herd of 300 cows with a replacement rate of 15% the effects of the supplements offered on profitability are more clearly portrayed (see Tables 9.2 to 9.5). The income above supplementation cost generated by the simulated 1CH1 Treatment Group was R 104 474 compared to the R 129 074 of the simulated 1CH2 Treatment Group and the R 135 526 of the simulated 1CH3 Treatment Group. It is thus recommended that first-calf-heifers that calve at the age of three be supplemented with a mineral supplement in summer and a urea based protein and mineral supplement in winter as this supplementation regimen brought about the most profit. It is however doubted whether these results could be replicated under conditions of poor rangeland management.

The Cow Supplementation Treatment Groups were offered the following supplements: C1 Treatment Group was offered a cotton-oil-cake and urea based protein and mineral supplement in winter and a mineral supplement containing 15% protein in summer amounting to R540 per cow per year, the C2 Treatment Group a urea and cotton-oil-cake based protein and mineral supplement in winter and a mineral supplement in summer amounting to R 395 per cow per year, the C3 Treatment Group a urea based protein and mineral supplement in winter and a mineral supplement in summer amounting to R322 per cow per year.

The three year average production and reproduction levels attained by the Cow Supplementation Treatment groups are summarized in Table 11.2



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**Table 11.2** Three year average (2011 to 2014) production and reproduction levels attained by the Cow Supplementation Treatment groups as well as supplementation costs

| | C1 | C2 | C3 |
|---|---|---|---|
| Conception rate | 91 | 90 | 94 |
| Average weaning weight | 223.7 kg | 219.3 kg | 215.7 kg |
| Inter calving period | 387 days | 378 days | 387 days |
| Cost of supplementation (R/animal/year) | R540 | R395 | R322 |

As with the first-calf-heifers it is believed that all three supplementation treatments allowed the animals to operate within their optimum weight range as the differences in production and reproduction rates achieved by the Cow Supplementation Treatment Groups were not significant. The cows supplemented with a urea based protein and mineral supplement in winter and a mineral supplement in summer (C3) were able to operate within their optimum weight range, however, at a much lower cost (Table 11.2). There was a tendency, though not significant, for conception rate to increase as body weight increased from before calving to the end of the breeding season (August to March) as well as having a higher BCS at the end of the breeding season.

Using the production and reproduction data collected during this study, supplement prices for 2014 to 2015 and May 2015 weaner calf prices on a hypothetical cow-calf herd of 300 animals, the effects of the different supplementation treatments on the profitability of the whole production system is clearly shown (Table 11.3) (see Chapter 10).

**Table 11.3** Summary of the effects of different supplementation regimens on the economics of a hypothetical herd of reproducing beef cows in the south-eastern Free Sate (2014 to 2015)

| Measurement | Supplementation Treatment Simulation | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| Income generated | R 1 302 437 | R 1 306 462 | R 1 300 072 |
| Cost of supplementation | R 237 850 | R 148 762 | R 116 427 |
| Nett income above supplementation cost | R 1 064 587 | R 1 157 700 | R 1 183 645 |
| Difference in income above supplement cost | - | R 93 123 | R 119 058 |



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Table 11.3 clearly illustrates the financial advantages of supplementing a cow-calf herd grazing *Elionorus*-sour-grassland which is well managed with the Treatment 3 supplements (urea based protein and mineral supplement in winter and mineral supplement in summer). The profit realized by the cow-calf herd supplemented with the Treatment 3 supplements was R 119 058 more than that of the herd supplemented with the Treatment 1 supplements and R 25 945 more than that of the herd supplemented with the Treatment 2 supplements.



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