The utilization and supplementation to stubble lands for South African Mutton Merino ewes

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Thesis presented in partial fulfillment of the requirements for the degree

MASTER OF SCIENCE AGRICULTURE

(Animal Sciences)

at the University of Stellenbosch

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Stellenbosch

December 2002

DECLARATION

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

Abstract

Title: The utilization and supplementation to stubble lands for South African Mutton Merino ewes.

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An experiment was conducted to determine the effect of the frequency of supplementary feeding on the production of South African Mutton Merino (SAMM) ewes grazing wheat stubble. One hundred and sixty ewes were randomly divided into two groups that consisted of four groups each. Eight camps were grazed for 138 days during which lambing occurred. Four groups of 25 ewes each grazed a 17 ha camp at a stocking density of 5.8 ewes/ha and four groups of 15 ewes each grazed a 12 ha camp at a stocking density of 5.0 ewes/ha. A combination energy/protein supplement was made available to the ewes as a lick. Two of the groups received no supplementary feed (control), two groups received 200 g/ewe/day, two groups received 400 g/ewe every second day and two groups received 600 g/ewe every third day. The smallest decrease in weight during the feeding period was observed in the ewe group that received supplementation every day as well as the ewe group that received supplementation every second day, but no significant differences were observed between these two groups. The smallest decrease in weight over the total feeding period was observed in the three ewe groups that received supplementation ($P < 0.1$), while the ewes that received none (control groups) lost the most weight during the same period. All supplemented groups performed significantly better than the unsupplemented control group in terms of the liveweight change over the feeding as well as the total period. No significant differences occurred in the lambing percentage, weaning percentage, birthweight, 42-day weight and survival rate of the lambs due to the different feeding regimes. It was concluded that supplementation to ewes every third day or every second day is an economically feasible option and will reduce labour and transport costs.

In the second study the effect of stocking density on canola stubble composition and subsequently the production of SAMM ewes on this type of stubble was investigated. Forty-eight ewes were randomly divided into four groups that grazed canola stubble at a stocking density of approximately 1.5, 3.5, 5.5 and 7.5 ewes/ha for 152 days. The ewes did not receive any supplementation and were weighed every 14 days. Parturition occurred during the last week in March 1997 until the first week in May 1997, and the lambs were weighed at birth, and every 14 days thereafter. Stubble samples were collected from the paddocks during the first part of the trial (January and February) and at the end of the trial (April and May) by cutting ten replicate quadrates per paddock and were analysed for dry matter (DM), crude protein (CP), acid detergent fibre (ADF), neutral detergent fibre (NDF) and *in vitro* digestibility of organic matter (IVDOM). The live weight of the ewes at a stocking density of 5.5 ewes/ha decreased significantly, while the ewes at a stocking density of 1.5 ewes/ha gained weight. The ewes at a stocking density of 3.5 ewes/ha had the lowest weight loss ($P = 0.01$). Stocking density did not affect the birthweight of the lambs significantly. The CP concentration of the stubble decreased with an increase in stocking density, while the ADF and NDF concentration of samples were significantly higher at the higher stocking density.

In the third study the supplementation of rumen inert fat or starch on the production of ewes grazing wheat stubble, was investigated. Fifty-six SAMM ewes were randomly divided into four groups of 14 ewes each, grazing the wheat stubble at a stocking density of 4.6 ewes/ha. Each group was supplemented with 250 g/ewe daily for the last six weeks of pregnancy, which was increased to 360 g/ewe during the first four weeks of lactation. Supplementation was supplied on Mondays, Wednesdays and Fridays for a 70-day period. The CP concentration of the supplement varied between 16.7 % and 19.6 %, while the total digestible nutrient (TDN) content varied between 52.0 % and 76.7 %. No significant difference ($P > 0.05$) occurred between the live weights of ewes during the last six weeks of pregnancy, the first four weeks of lactation, or the total feeding period. The ewes in the 50 % fat plus 50 % maizemeal group lost less weight ($P \leq 0.08$) during lactation than the ewes that received maizemeal as their main energy source. The study indicated that there was no significant advantage in the live weight change of the ewes during the experimental period, when compared to the group that received wheat bran (control group).

In the fourth study the economic advantage of supplementation to SAMM ewes grazing wheat- or oat stubble were studied. Three hundred and sixteen ewes were divided into four flocks, of which two grazed oat stubble and two wheat stubble. Each of these four flocks was again subdivided into four subdivisions of which two subdivisions received supplementation and two none. Four subdivisions received 200 g/d for 83 days, and the other four subdivisions received 200 g/d for 44 days after which it was increased to 300 g/d for 37 days (81 days in total). The ewes were weighed monthly. The final bodyweight of the ewes that received supplementation was significantly higher than those that received none. Over the feeding period, the ewes that received supplementation had a significant lower weight loss in comparison to the ewes that did not receive supplementation. The 42-day weight of the lambs improved significantly due to supplementation, but no significant increase was indicated in the birthweight, weaning weight and survival rate of the lambs whose mothers received supplementation.

In the fifth study the influence of supplementary feeding to ewes and creep feeding of their lambs on the production of both the ewes and lambs were studied. One hundred and sixty eight ewes were divided into two groups of 68 and 100 ewes that grazed a 12.9 and 18 ha camp respectively. Each of these ewe groups was subdivided into four groups of which two ewe groups received supplementation and two none. Within each ewe group two groups of lambs received creep feeding and two received none. A two (supplementation of ewes) by two (creep feeding of lambs) factorial design was used. Supplementation was supplied at 200 g/d for the first 69 days and 300 g/d for the next 120 days to ewes. Lambs received an average of 0.58 kg creep feed per day for 96 days. It was concluded that the live weight change (LWC) of the ewes during the experimental period was not affected significantly by creep feeding of their lambs. Ewes that received supplementation maintained higher live weights than their counterparts for most of the feeding period, although final weights at the end of the experimental period did not differ significantly. The average daily gain (ADG) of the lambs whose mothers received supplementation tended to be higher than that of mothers that received no supplementation, while the ADG of the lambs that received creep feeding was significantly higher than the lambs that received none.

In the sixth study the carry-over effect of supplementation in the previous year on the production of the ewes in the following year was studied. Three hundred and sixteen ewes were divided into four flocks, of which two grazed oat stubble and two wheat stubble. Each of these four flocks was again subdivided into four subdivisions of which two subdivisions received supplementation and two none. Four subdivisions received 200 g/d for 83 days, and the other four subdivisions received 200 g/d for 44 days after which it was increased to 300 g/d for 37 days (81 days in total). The ewes were weighed monthly. Results indicated that birth status (lambs born per ewes mated) of lambs showed a tendency to increase in 1999 due to supplementation in 1998, while weaning status was not significantly affected. Due to multiple births in the supplemented groups, the birthweight and weaning weight of lambs was negatively affected by supplementation. The study concluded that supplementary feeding in the previous year did not have significant carry-over effects in the following year. However, the effect may have been influenced by the fact that mature animals were used in the study, while the pasture availability during the non-productive stage will also affect possible carry-over effects.

Samevatting

Titel:	Die benutting en byvoeding van stoppellande aan Suid-Afrikaanse Vleismerino ooie.
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'n Eksperiment is uitgevoer om te bepaal wat die invloed van die frekwensie van byvoeding op die produksie van Suid-Afrikaanse Vleismerino (SAVM) ooie wat koringstoppel bewei, sal wees. Eenhonderd-en-sestig ooie is ewekansig in twee groepe verdeel wat bestaan het uit vier groepe elk. Die agt kampe is vir 138 dae bewei waartydens die ooie ook gelam het. Vier groepe bestaande uit 25 ooie het 'n 17 ha kamp teen 'n weidigtheid van 5.8 ooie/ha bewei en die ander vier groepe bestaande uit 15 ooie het 'n 12 ha kamp teen 'n weidigtheid van 5.0 ooie/ha bewei. 'n Kombinasie energie/proteïen aanvulling in die vorm van 'n lek is aan die ooie beskikbaar gestel. Twee van die groepe het geen aanvullende voeding ontvang nie (kontrole), twee groepe het 200 g/dag/ooi ontvang, twee groepe het 400 g/ooi elke tweede dag ontvang en twee groepe het 600 g/ooi elke derde dag ontvang. Die kleinste daling in liggaamsgewig tydens die voerperiode is waargeneem in die ooie wat elke dag sowel as elke tweede dag byvoeding ontvang het, alhoewel geen betekenisvolle verskille tussen dié twee groepe waargeneem is nie. Die kleinste daling in gewig tydens die totale voerperiode is waargeneem in die drie groepe wat byvoeding ontvang het ($P < 0.1$) terwyl die groepe wat geen byvoeding ontvang het nie (kontrole) die meeste gewig tydens dieselfde periode verloor het. Al die groepe wat byvoeding ontvang het, se liggaamsmassa verandering oor die voerperiode asook die totale periode was betekenisvol beter as die kontrole groep Geen betekenisvolle verskille is gevind by lampersentasie, speenpersentasie, geboortegewig, 42-dae gewig en oorlewing van lammers nie. Daar is bevind dat die byvoeding aan ooie elke derde of elke tweede dag ekonomies geregverdig is en 'n moontlike afname in arbeid- en vervoerkostes mag meebring.

In die tweede studie is die invloed van weidigtheid op die samestelling van kanolastoppel en die produksie van SAVM-ooie op hierdie tipe stoppel ondersoek. Agt-en-veertig ooie is ewekansig in vier groepe verdeel en het kanolastoppel teen 'n weidigtheid van ongeveer 1.5, 3.5, 5.5 en 7.5 ooie/ha vir 152 dae bewei. Die ooie het geen byvoeding ontvang nie en is elke 14 dae geweeg. Die ooie het gelam vanaf die laaste week in Maart 1997 tot die eerste week in Mei 1997. Die lammers is met geboorte geweeg en daarna elke 14 dae. Stoppelmonsters van die kampe is versamel gedurende die eerste deel van die studie (Januarie en Februarie) asook aan die einde van die studie (April en Mei) deur tien kwadrate per kamp te sny en is daarna ontleed vir droë materiaal (DM), ruproteïen (RP), suur bestande vesel (SBV), neutraal bestande vesel (NBV) en *in vitro* verteerbaarheid van organiese materiaal (IVVOM). Die liggaamsgewig van die ooie teen 'n weidigtheid van 5.5 ooie/ha het betekenisvol afgeneem, terwyl die ooie teen die weidigtheid van 1.5 ooie/ha toegeneem het in massa. Die ooie teen 'n weidigtheid van 3.5 ooie/ha het die kleinste gewigsverlies getoon ($P = 0.01$). Die geboortegewig van die lammers is nie betekenisvol deur weidigtheid beïnvloed nie. Die RP-konsentrasie van die stoppel het afgeneem met 'n toename in weidigtheid, terwyl die SBV en NBV-konsentrasie van die monsters betekenisvol hoër was by die hoër weidigtheid.

In die derde studie is die byvoeding van rumen inerte vet of stysel aan ooie wat koringstoppel bewei ondersoek. Ses-en-vyftig SAVM ooie is ewekansig in vier groepe van 14 elk verdeel en het koringstoppel teen 'n weidigtheid van 4.6 ooie/ha bewei. Elke groep het daagliks byvoeding teen 250 g/ooi tydens die laaste ses weke van dragtigheid ontvang, waarna dit vermeerder is tot 360 g/ooi tydens die eerste vier weke van laktasie. Byvoeding is op Maandae, Woensdae en Vrydae vir 70 dae voorsien. Die RP-konsentrasie van die byvoeding het gevarieer tussen 16.7 % en 19.6 % terwyl die totale verteerbare voedingstof (TVV) konsentrasie gevarieer het tussen 52.0 % en 76.7 %. Daar was geen betekenisvolle verskille ($P > 0.05$) tussen die liggaamsmassa van die ooie gedurende die laaste ses weke van dragtigheid, die eerste vier weke van laktasie, of die totale voerperiode nie. Die ooie in die 50 % vet plus 50 % mieliemeel groep het minder gewig ($P \leq 0.08$) gedurende laktasie verloor as die ooie wat mieliemeel as hulle hoof energiebron ontvang het. Die studie het getoon dat daar geen betekenisvolle toename in die liggaamsgewig van die ooie tydens die eksperimentele periode was in vergelyking met die groep wat koringsemels (kontrole) ontvang het nie.

In die vierde studie is die ekonomiese voordeel van byvoeding vir SAVM ooie wat koring- of hawerstoppel bewei het ondersoek. Driehonderd-en-sestien ooie is in vier groepe verdeel,waarvan twee hawerstoppel en twee koringstoppel bewei het. Elk van hierdie vier groepe is herverdeel in vier subdivisies waarvan twee byvoeding ontvang het en twee geen. Vier subdivisies het 200 g/d vir 83 dae ontvang, terwyl die ander vier subdivisies 200 g/d vir 44 dae ontvang het, waarna dit verhoog is na 300 g/d vir 37 dae ('n totaal van 81 dae). Die ooie is maandeliks geweeg. Die finale liggaamsgewig van die ooie wat byvoeding ontvang het betekenisvol hoër was as die ooie wat geen byvoeding ontvang het nie. Tydens die voerperiode het die ooie wat byvoeding ontvang het 'n betekenisvolle laer gewigsverlies getoon in vergelyking met die ooie wat geen byvoeding ontvang het nie. Die 42-dae gewig van die lammers het ook betekenisvol toegeneem, maar geen verskil is waargeneem in die geboortegewig, speengewig en oorlewingstempo van lammers wie se moeders byvoeding ontvang het nie.

In die vyfde studie is die invloed van byvoeding aan ooie en kruipvoeding aan hulle lammers op die produksie van beide die ooie en lammers bestudeer. Eenhonderd-agt-en-sestig ooie is onderskeidelik in twee groepe van 68 en 100 verdeel wat twee kampe van 12.9 en 18 ha respektiewelik bewei het. Elkeen van hierdie groepe is onderverdeel in vier groepe waarvan twee groepe byvoeding ontvang het en twee groepe geen. Binne elke ooi groep het twee groepe lammers kruipvoeding ontvang en twee geen. 'n Twee (byvoeding aan ooie) by twee (kruipvoeding aan lammers) faktoriaal ontwerp is gebruik. Byvoeding aan die ooie is verskaf teen 200 g/d vir die eerste 69 dae en 300 g/d vir die volgende 120 dae. Lammers het 0.58 kg kruipvoer per dag vir 96 dae ontvang. Daar is bepaal dat die liggaamsgewig-verandering van die ooie gedurende die eksperimentele periode nie betekenisvol beïnvloed is deur kruipvoeding van die lammers nie. Ooie wat byvoeding ontvang het het 'n hoer liggaamsgewig vir die grootste deel van die voerperiode gehandhaaf, alhoewel die finale gewigte aan die einde van die eksperimentele periode nie betekenisvol verskil het nie. Die gemiddelde daaglikse toename (GDT) van die lammers wie se moeders byvoeding ontvang het, het geneig om hoër te wees as die lammers wie se moeders geen byvoeding ontvang het nie, terwyl die GDT van die lammers wat kruipvoeding ontvang het was betekenisvol hoër as die lammers wat geen kruipvoeding ontvang het nie.

In die sesde studie is die oordrageffek van byvoeding in die vorige jaar op ooie se produksie in die opvolgende jaar ondersoek. Driehonderd-en-sestien ooie is in vier groepe verdeel,waarvan twee hawerstoppel en twee koringstoppel bewei het. Elk van hierdie vier groepe is herverdeel in vier subdivisies waarvan twee byvoeding ontvang het en twee geen. Vier subdivisies het 200 g/d vir 83 dae ontvang, terwyl die ander vier subdivisies 200 g/d vir 44 dae ontvang het, waarna dit verhoog is na 300 g/d vir 37 dae ('n totaal van 81 dae). Die ooie is maandeliks geweeg. Resultate het aangedui dat die geboortestatus (lammers gebore/ ooie gepaar) van lammers 'n tendens getoon het om toe te neem in 1999 as gevolg van byvoeding in 1998, terwyl speenstatus nie betekenisvol beïnvloed is nie. Byvoeding in 1998 het die geboortegewig en speengewig van lammers verlaag omdat dit 'n groter aantal meerlinggeboortes veroorsaak het. Die studie het bevind dat byvoeding in die vorige jaar nie 'n betekenisvolle oordrageffek in die volgende jaar teweeg gebring het nie. Die resultate mag egter beïnvloed gewees het deurdat volwasse diere in die studie gebruik is, terwyl die beskikbaarheid van weiding tydens die stadium wanneer die ooie nie gereproduseer het nie ook die moontlike oordrageffek kon beïnvloed het.

Contents

Chapter 7

The carry-over effect of supplementation in the previous year on the production of South African Mutton Merino ewes

Acknowledgements

This research was carried out under the auspices of the Western Cape Department of Economic Affairs, Agriculture and Tourism at the Elsenburg Agricultural Research Centre. Permission to use data from the project: Supplementary feeding of sheep grazing grain residues in a Mediterranean Environment (Project leader, T.S. Brand) for post-graduate studies is acknowledged and greatly appreciated.

Also a word of thank to the following persons and institutions that played a role in ensuring the successful completion of this study:

- Dr. **T.S. Brand** for his support, guidance and unwavering faith in me.
- Dr. **A.V. Ferreira** for his positive criticism, support and editing of the manuscript.
- Mr. **A. Durand, F. Franck and B.B. Aucamp** for the technical work at Langgewens Experimental Farm (Moorreesburg) and Elsenburg Experimental Farm (Elsenburg).
- **All the farm labourers** involved in attending to the sheep as well as pastures.
- **Janine Josephs, Suzan September, Anita Botha, Ansie Scholtz and Farieda Martin** for the chemical analysis of samples as well as their friendly assistance.
- .The **Elsenburg Agricultural Research Centre** for the provision of funding to perform the study.
- The **Technology and Human Resources for Industry Program (THRIP)** of the National Research Foundation for financial support.
- The **University of Stellenbosch** for a post-graduate bursary.
- The IT division at Elsenburg, especially **Robbie Serfontein** and **John Clark** for their assistance and help.

- My **parents** for their love, encouragement and endless support as well as the rest of my **family** and **friends** for their interest and encouragement.

- **Frederic Michaud** for his love and moral support.

- **Jesus Christ,** my Lord and Saviour, who directs my life and makes all things possible.

Chapter 1

General introduction

As human population numbers grow and food suitable for human consumption becomes less available to animals, grazing will become more and more important. From an economic as well as a practical point of view, much of the agricultural land in South Africa, and also the rest of the world, can only be utilised by grazing ruminant animals. From this point of view, animal production is inseparable from plant production, especially for pasture production and management. Grazing lands provide most of the feed eaten by livestock, and this is also the cheapest form of animal production. Sheep production in the Western Cape is normally practised in the Swartland and Rûens areas of the province. These areas receive a relatively low precipitation (Figure 1), but are predominantly used for sheep farming in a ley system with crop production.

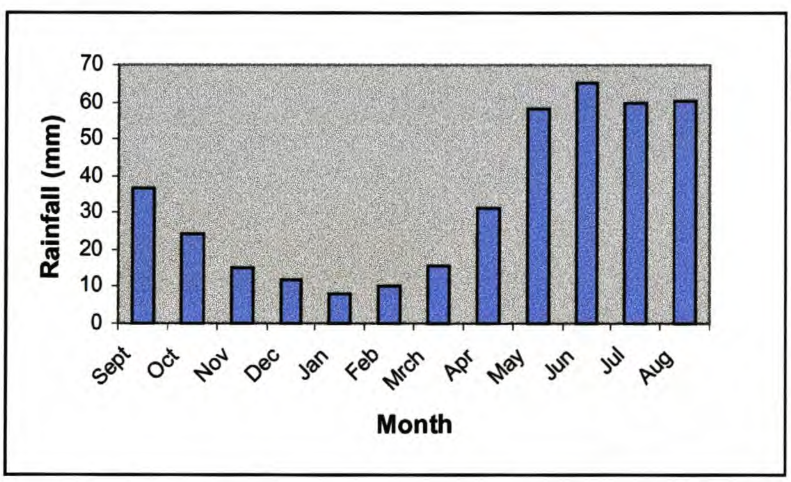

Figure 1 Monthly precipitation for the Swartland area in the Mediterranean rainfall area of South Africa (Cloete *et al.*, 1992)

The use of ruminants for meat, milk, hide and wool or hair production is justified firstly by their ability to digest carbohydrate sources not digested by monogastric species, secondly their ability to use non-protein nitrogen (NPN) to supply themselves with protein through microbial growth in the rumen and finally their efficient utilisation of dietary protein provided that it is protected from rumen fermentation. An understanding of the rumen ecosystem and its inefficiencies provides the knowledge to develop methods for manipulating the end products of digestion in order to meet the needs of the animal. This can be used in a system that aims to optimise the use of available resources and to match livestock production systems to resources that are available locally (Preston & Leng, 1987).

During the summer and autumn months of the Mediterranean wheat-sheep farming areas of South Africa, pregnant and lactating ewes are dependant on cereal stubble. The ability of ruminants to digest cellulose and other structural polysaccharides of plants has caused man for many years to consider the possibilities of using these animals to convert waste materials into useful products. There are two main reasons why the utilization of low-quality roughages by ruminants is important. Firstly, most plant residues constitute only sub-maintenance rations for ruminants, and a period each year of grazing pasture residues severely limits animal production, particularly on an annual basis (Coombe, 1981).

Sheep production in the region normally follows an autumn or winter lambing season, resulting in inadequate feed supply and thus necessitates the provision of additional feed (Brand, 1996). About 460 000 hectares of wheat stubble are available in the region annually (Elsenburg Agricultural Development Institute, 1994). But wheat stubble is characterized by low levels of nitrogen and available carbohydrates, poor digestibility and a high cell wall content (Dann & Coombe, 1987), and therefore wheat stubble cannot supply sufficient nutrients for the high energy and protein needs of the reproducing ewe (Aitchison, 1988). This necessitates the provision of supplementary feeding for ewes grazing wheat stubble to provide additional energy and protein (Aitchison, 1988; Brand *et al.*, 1997a). Supplementary feeding provides the producer with the means to increase the nutrient intake of his livestock when pastures *perse* is inadequate for animal production, and may be used to increase reproduction and fibre growth, promote lactation and ensure the satisfactory growth of young animals. Properly supplemented cereal stubble can be used successfully as a major component of ruminant diets, particularly at or slightly above maintenance feeding levels. Estimates of the digestible energy content of harvested crop residues, whether expressed as total digestible nutrient (TDN) content, or digestibility of dry matter (DM) or organic matter (OM), and derived using *in vitro* or *in vivo* techniques, are generally below or slightly above 50 % (Oh *et al.*, 1971; Kameoka, 1974; Mulholland *et al.*, 1974; Swingle & Waymack, 1977). Mulholland *et al.* (1976a) have reported OM digestibilities of 30 – 40 % for the total available material collected from grazed stubbles of cereal or legume crops. It is generally believed that nitrogen (N) deficiency is the primary limiting factor in the utilization of low-quality residues by grazing ruminants, and this would appear to be true where there is no scope for selection for green herbage. The main effect of NPN supplements on production of cattle or sheep grazing low-quality pastures has been to reduce the rate of weight loss, or enable animals to maintain weight, when unsupplemented animals lost weight, or to promote weight gains when control animals were maintaining weight. In view of the variation in animal response to supplementary feeding, indiscriminate extrapolation of results obtained in other parts of the world may be questioned.

Feed is economically important in sheep production; it accounts for 50 to 65% of the total cost of producing market lambs (Ensminger *et al.*, 1990). Due to the low digestibility of wheat stubble, a reduced intake is seen in grazing ewes (Mulholland *et al.*, 1976b), which led to an insufficient nutrient intake by the ewe. To provide sufficient energy for growth and development of both the ewe and her unborn lamb, ewes in late pregnancy and early lactation require up to three times the energy needed to maintain a non-pregnant animal. The aim of supplementing low-quality stubble when grazed by producing sheep, is to correct ruminal and animal deficiencies in the diet (Dann & Coombe, 1987). To improve utilization of the wheat stubble, additional energy can be supplied by rapidly fermentable carbohydrates (Gomes *et al.*, 1994). Grazing sheep are also able to select the more nutritious parts of the stubble crop. Spilt grain remaining after harvest is eaten rapidly. Although it forms only a small proportion of the dry matter available in the stubble, it forms a high proportion of the diet selected (Aitchison, 1988). According to Cloete & Brand (1990), a higher live weight was maintained by pregnant and lactating ewes when receiving cereal supplements while grazing wheat stubble compared to an unsupplemented control group. The provision of supplementary feed is not always done on the correct scientific basis, due to the fact that it is difficult to assess the adequacy of nutrition of grazing ewes. It is also difficult to determine the nature of supplementation when sheep are grazing different types of pasture (Brand, 1996). Responses to supplementation are biological, but the measure of success is financial and depends on the economic framework in which the operator practices. Supplementation may also be profitable in one region, while in a comparable situation elsewhere it may be uneconomical. In the absence of accurate knowledge of the diet selected by the grazing animal, the producer's decision to supplement is based on a subjective assessment of the value of his pastures, the performance of his stock, and his expectation in terms of financial award (Allden, 1981).

An improvement in the nutritional status of ruminants through supplementation, may lead to better productivity during the period of feeding, so-called current effects, or it may have a change in production potential after supplementation has ended, called residual effects. The decision to feed at one time to confer a benefit at some later stage must be based on a very accurate assessment of the nutritional status of the animal (Figure 1). Broster (1969) found that feeding heifers to prevent weight losses before calving influenced subsequent milk production, but improved nutrition beyond that level did not result in a higher milk production. Wallace (1957) also noted that supplementation in early lactation for subsequent milk production was associated with considerable benefits when cattle went onto poor pasture, but not when turned onto good pasture. The influence of supplementation or reproductive performance of sheep also requires an understanding of the nutritional and physiological stimuli which influence the level at which fertility is affected (Coop, 1964; Morley *et al.*, 1976; Croker *et al.*, 1978).

The low crude protein (CP) content of crop residues and dormant forages limits animal performance. Supplemental CP can increase dry matter intake (DMI) (Elliot & Topps, 1963; Lee *et al.*, 1985) and digestibility (Males, 1987) and improve live weight changes (Hughes *et al.*, 1978; Males, 1987). In a study by Chase & Hibberd (1989) in which the effect of frequency of maize supplementation on the utilization of low-quality grass hay was evaluated, it was concluded that with alternate day supplementation, changes in the ruminal environment was the cause for small, but consistent decreases in digestibility. Daily supplementation often requires a significant commitment of labour and equipment when animals are maintained under extensive grazing conditions. If supplementation frequency can be lessened without adversely affecting performance, savings can be realized via reduced labour and equipment costs (Beaty *et al.*, 1994). Researchers have reported that protein supplements can be fed less frequently than daily without significant negative effects on livestock performance (Melton *et al.*, 1960; McIlvain & Shoop, 1962; Wallace, 1988). Kartchner & Adams (1982) and Wallace (1988) reported performance reductions in response to reduced frequency of supplementation when supplements containing relatively low concentrations of CP (< 10%) were fed. These observations suggest that the ability to infrequently feed supplements may be dependent on the supplement characteristics.

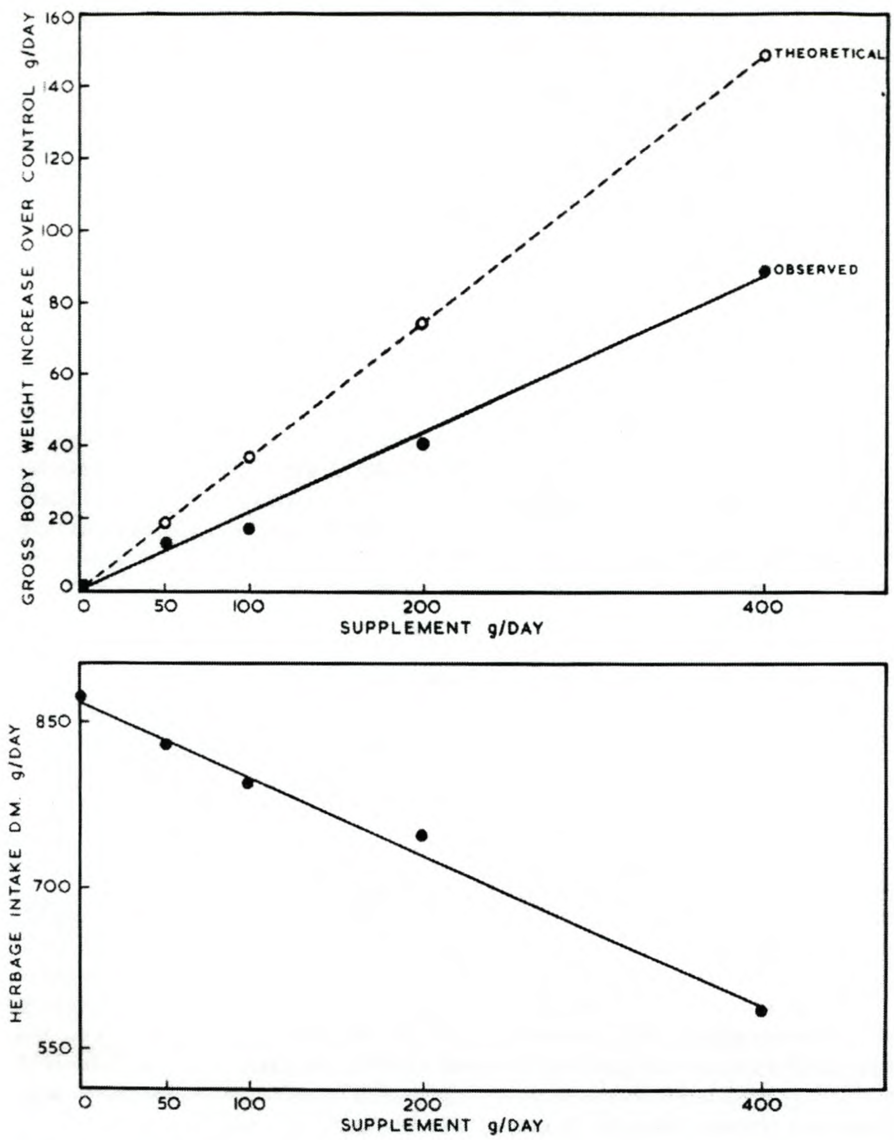

Figure 2 (Upper) The "theoretical" and observed responses to supplementation (Allden, 1981) (Lower) The reduction in herbage intake associated with supplementary feeding (Allden, 1981)

There has been an interest in the inclusion of fats in diets of animals to enhance the total energy intake of the animals. The energy density of a supplementary feed is increased by the inclusion of fats (Brand, 1996). Available sources of fatty acids include oilseeds, oilseed residues and milling byproducts or brans and animal byproducts such as tallow (Preston & Leng, 1987). Fats represent a concentrated source of energy, enhance absorption of fat-soluble vitamins (Palmquist, 1988) and are a source of essential fatty acids. But the inclusion of fat in the diets is not always effective since increasing dietary levels of fat may depress fibre digestion in the rumen, and thus reducing overall energy availability (Palmquist, 1984). Hydrolysis in the rumen releases long-chain fatty acids from dietary fat in the rumen, which is then hydrogenated to give saturated fatty acids that are absorbed in the small intestine (Brand, 1996). Lower fibre digestion in the rumen is probably an effect of these free long-chain fatty acids inhibiting rumen bacteria (Galbraith *et al.*, 1971; Henderson, 1973; Palmquist & Jenkins, 1980). Fat may contribute 7 – 10% of the digestible energy in the rumen (Ruckebusch & Thivend, 1980). Several types of rumen-inert fats have been developed in order to avoid the negative effects of dietary fat on the rumen. These include fats with a melting point above that found in the rumen, coated fats (Bines *et al.*, 1978) and calcium soaps of fatty acids (Schneider *et al.*, 1988; Ferguson *et al.*, 1990). The latter are converted to fatty acids and calcium ions in the acid conditions of the abomasum (Sklan *et al.*, 1989). The negative effects of fat on rumen fermentation are due to either bacteria or a specific toxic effect on cellulolytic microorganisms or the absorption of fatty acids in food particles (Palmquist, 1984). These problems may be avoided by feeding saturated fatty acids, which, due to their high melting point, are relatively inert in the rumen (Clapperton & Steele, 1982), or by converting unsaturated fatty acids to a form in which they are protected from degradation in the rumen, but are available for absorption in the small intestine.

The influence of creep feeding to lambs on the production of sheep grazing winter grain stubble is important in most sheep production systems. Creep feeding of lambs has several advantages. Firstly, it will speed the growth and fattening rate of lambs. Secondly, ewes, especially those under range conditions, may probably not be suckled down to a very poor body condition and may probably maintain milk flow over a longer period of time. Thirdly, creep feeding tends to even up twin lambs and single lambs in live weight. Twin lambs are smaller at birth and usually get less milk per lamb than singles. Fourthly, lambs may be ready for an earlier market which has a price advantage. Finally, it enables many producers to produce fat lambs on range that is unable to produce anything more than feeder lambs unless extra feed is provided (Diggins & Bundy, 1958).

In conclusion, for supplementary feeding systems to provide an economic advantage, substitution of the supplementary feed for paddock feed must be avoided. Conversely, supplementary feed which causes an increase in the intake of paddock feed, or which would increase the efficiency of utilization of digested nutrients are those which would result in an economic advantage. However, supplementary feeding for production responses that are economic is usually primarily concerned with the identification and provision of limiting nutrients.

The gross value of agricultural production in South Africa amounts to approximately R19 million. There are approximately 25 million sheep in South Africa and sheep production yields an average gross income of 12% for the Western Cape (Agricultural Statistics, 2001). Many people in these areas are dependent for an income from this farming enterprise. The mentioned aspects make it probably one of the most important farming enterprises in the province, which therefore needs research attention.

The renewed research initiative was conducted to determine the frequency at which supplementary feeding should be supplied in order to improve production (Chapter 2), the determination of the nutritive value of canola stubble (Chapter 3), the comparison of rumen-inert fat and starch as supplement for producing ewes (Chapter 4), the determination of the economic production parameters when supplementing grazing sheep (Chapter 5), the effect of supplementation to ewes and creep feeding to lambs on production (Chapter 6), and finally the carry-over effect of supplementation in the previous year on production of producing ewes in the next season (Chapter 7).

References

Agricultural Statistics, 2001. National Department of Agriculture. The Directorate: Communication, Private Bag X144, Pretoria, 0001. p. 63.

Aitchison, E., 1988. Cereal straw and stubble as sheep feed. J. Agric. W. Aust. 29.96-101.

Allden, W.G., 1981. Energy and Protein Supplements for Grazing Livestock. In: Grazing animals. (Ed. F.W.H.) Morley), Elsevier, Amsterdam, pp. 289-307.

Beaty, J.L., Cochran, R.C., Lintzenich, B.A., Vanzant, E.S., Morrill, J.L., Brandt, R.T. & Johnson, D.E., 1994. Effect of Frequency of Supplementation and Protein Concentration in Supplements on Performance and Digestion Characteristics of Beef Cattle Consuming Low-Quality Forages. J. Anim. Sci. 72, 2475-2486.

Bines, J.A., Brumby, P.E., Storry, J.E., Fulford, R.J. & Braithwaite, G.D., 1978. The effect of protected lipids on nutrient intakes, blood and rumen metabolites and milk secretion in dairy cows in early lactation. J. Agric. Sci., Camb. 91, 135-150.

Brand, T.S., 1996. The nutritional status and feeding practices of sheep grazing cultivated pasture and crop residues in a Mediterranean environment. Ph.D. Agric thesis. University of Stellenbosch, South Africa.

Brand, T.S., Franck, F., Durand, A. & Coetzee, J., 1997a. Use of varying combinations of energy and protein sources as supplementary feed for lambing ewes grazing cereal stubble. Aust. J. Exp. Agric. 37, 1-9.

Broster, W.H., 1969. Recent research into levels of feeding for dairy cows. In: H. Swan and D. Lewis (Editors), Univ. Nottingham 3rd Nutr. Conf. For Feed Manufacturers. Churchill, London, pp. 53-79.

Chase, C.C. & Hibberd, C.A., 1989. Effect of level and frequency of maize supplementation on the utilization of low-quality grass hay by beef cows. Anim. Feed Sci. Tech. 24, 129-139.

Clapperton, J.L. & Steele, W., 1982. Different forms of fat in the diet of dairy cows. Proc. Nutr. Soc. 41, p. 136A.

Cloete, S.W.P. & Brand, A.A., 1990. Response of S.A. Mutton Merino ewes and their lambs to supplementation with enriched oat, barley, or triticale grain on wheat stubble grazing. S. Afr. J. Anim. Sci. 20, 96-99.

Cloete, S.W.P., Brand, T.S. & van Heerden, J.M., 1992. Sheep production from systems involving cultivated pastures in the Mediterranean area of South Africa. A Perspective. Proc. World and Wool Congress. 6 – 12 August 1992. Buenos Aires, Argentina.

Coombe, J.B., 1981. Utilization of Low-Quality Residues. In: Grazing animals. (Ed. F.W.H. Morley), Elsevier, Amsterdam, pp. 319-331.

Coop, I.E., 1964. Liveweight, flushing and fertility. Sheep Farming Annu. pp. 122-132.

Croker, K.P., Lightfoot, R.J. & Marshall, T., 1978. The fertility of merino ewes fed high protein supplements at joining. Proc. Aust. Soc. Anim. Prod. 12, p. 250.

Dann, P.R. & Coombe, J.B., 1987. Utilization of fodder crops and crop residues. In: Temperate Pastures, their production, use and management. (Eds. L.W. Wheeler, C.G. Pearson and G.E. Robards), Australian Wool Corporation, Australia, pp. 517-525.

Diggins, V. & Bundy, E., 1958. Sheep Production. Prentice-Hall, Englewood Cliffs, N.J., United States of America. p. 131.

Elliot, R.C. & Topps, J.H., 1963. Voluntary intake of low protein diets by sheep. Anim. Prod. 5, 269-276.

Elsenburg Agricultural Development Institute, 1994. Animal Production Research Program. Elsenburg Agricultural Development Institute, Private Bag X1, Elsenburg, 7607, South Africa.

Ensminger, M.E., Oldfield, J.E. & Heinemann, W.W., 1990. In: Feeds & Nutrition. California. p. 875.

Ferguson, J.D., Sklan, D., Chalupa, W. & Kronfeld, D.S., 1990. Effects of hard fats on the in vitro and in vivo rumen fermentation, milk production and reproduction in dairy cows. J. Dairy Sci. 73: 2864-2879.

Galbraith, H., Miller, T.B., Paton, A.M. & Thompson, J.K., 1971. Antibacterial activity of long chain fatty acids and the reversal with calcium, magnesium, ergocalciferol and cholesterol. J. Appl. Bacteriol. 37, 803-813.

Gomes, M.J., Hovell, F.D.De B., Chen, X.B., Mengomasha, E.M. & Fikremariam, D., 1994. The effect of starch supplementation of straw on microbial protein supply in sheep. Anim. Feed Sci. Technol. 49, 277-286.

Henderson, C., 1973. The effects of fatty acids on pure cultures of rumen bacterial. J. Agr. Sci. (Camb.) 81,107-112.

Hughes, J.H., Stephens, D.F., Lusby, K.S., Pope, L.S., Whitman, J.V., Smithson, L.J. & Totusek, R., 1978. Long-term effects of winter supplement on growth and development of Hereford range females. J. Anim. Sci. 47, 805-815.

Kameoka, K., 1974. The utilization of cereal crop residues as livestock feed. Nutritive value, chemical composition. ASPAC Food and Fertilizer Technology Center, Ex. Bull. No. 42, pp.10.

Kartchner, R.J. & Adams, D.C., 1982. Effects of daily and alternate day feeding of grain supplements to cows grazing fall-winter range. Proc. West. Sect. Am. Soc. Anim. Sci. 33, p. 308.

Lee, G.J., Hennessy, D.W., Williamson, P.J., Nolan, J.V., Kempton, T.J. & Leng, R.A., 1985. Responses to protein meal supplements by lactating beef cattle given a low quality pasture hay. Aust. J. Agric. Res. 36, 729-741.

Males, J.R., 1987. Optimizing the utilization of cereal crop residues for beef cattle. J. Anim. Sci. 65, 1124-1130.

McIlvain, E.H. & Shoop, M.C., 1962. Daily versus every-third-day versus weekly feeding of cottonseed cake to beef steers on winter range. J. Range Manage. 15, 143-146.

Melton, A.A., Jones, J.H. & Riggs, J.K., 1960. Influence of frequency of feeding protein supplement upon development and production of range beef females. J. Anim. Sci. (Abstract), 19, p. 1276.

Morley, F.W.B., Axelsen, A. & Cunningham, R.B., 1976. Liveweight at joining and fertility in beef cattle. Proc. Aust. Soc. Anim. Prod. 11, 201-208.

Mulholland, J.G., Coombe, J.B. & Dann, P.R., 1976a. Use of oat, lupin and field pea stubbles by grazing sheep. Aust. J. Exp. Agric. Anim. Husb. 16, 467-471.

Mulholland, J.G., Coombe, J.B., Freer, M. & McManus, W.R., 1976b. An Evaluation of Cereal Stubble for Sheep Production. Aust. J. Agric. Res. 27, 881-893.

Mulholland, J.G., Coombe, J.B. & McManus, W.R., 1974. Intake and liveweight response of sheep fed three ground and pelleted cereal straws. Aust. J. Exp. Agric. Anim. Husb. 14, 449-453.

Oh, J.H., Weir, W.C. & Longhurst, W.M., 1971. Feed values for sheep of cornstalks, rice straw and barley straw as compared with alfalfa. J. Anim. Sci. 32, 343-347.

Palmquist, D.L., 1984. Use of fats in diets for lactating dairy cows. In: Fats in animal nutrition. (Ed.J. Wiseman), Butterworths, London, pp. 357-381.

Palmquist, D.L., 1988. The feeding value of fats. World Animal Science. Ed. By Orskov Rowett Research Institute, Elsevier, pp. 293-311.

Palmquist, D.L. & Jenkins, T.C., 1980. Fat in lactation rations. J. Dairy Sci. (Review), 63, 1-14.

Preston, T.R. & Leng, R.A., 1987. Matching ruminant production systems with available resources in the Tropics and Sub-tropics. Penambul Books, P.O. Box 512, Armidale, New South Wales 2350, Australia.

Ruckebush, Y. & Thivend, P., 1980. Digestive physiology and metabolism in ruminants. A.I.V. Publishing Company, Inc. Westport, Connecticut, USA.

Schneider, P., Sklan, D., Chalupa, W. & Kronfeld, D.S., 1988. Feeding calcium salts of fatty acids to lactating cows. J. Dairy Sci. 71, 2143-2150.

Sklan, D., Bogin, E., Avidar, Y. & Gur-Arie, S., 1989. Feeding calcium soaps of fatty acids to lactating cows: effect on production, body condition and blood lipids. J. Dairy Res. 56, 675-681.

Swingle, R.S. & Waymack, L.B., 1977. Digestibility by steers of grain sorghum stover and wheat straw supplemented with NPN. J. Anim. Sci. 44, 112-117.

Wallace, J.D., 1988. Supplemental feeding options to improve livestock efficiency on rangelands. In: R.S. White and R.E. Short (Ed.) Achieving Efficient Use of Rangeland Resources. Montana Agric. Exp. Sta., Bozeman, pp. 92-100.

Wallace, L.R., 1957. Concentrate feeding of dairy cattle. Proc. Ruakura Farmers Conf. Week, pp. 166-177.

Chapter 2

The effect of frequency of supplementation on the production of South African Mutton Merino ewes grazing wheat stubble

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Abstract

A trial was conducted to determine to what extent the frequency of supplementary feeding would affect the production of sheep while grazing wheat stubble in the winter rainfall region of South Africa. One hundred and sixty SA Mutton Merino ewes were randomly divided into two groups that consisted of four camps each. They grazed eight camps of wheat stubble for a period of 138 days during which parturition occurred. One hundred ewes (four groups of 25 each) grazed a 17 ha camp at a stocking density of 5.8 sheep/ha and 60 ewes (four groups of 15 each) grazed a 12 ha camp at a stocking density of 5.0 sheep/ha. A weekly rotation within each of the two camps was followed to eliminate the camp effect. An energy and protein combination supplement was made available to the ewes as a lick. Two groups received no supplementary feed, two groups received 200 g/ewe/day, two groups received 400 g/ewe every second day, and two groups received 600 g/ewe every third day. During the feeding period, the smallest decrease in the weight of the ewes was observed in the groups that received supplementary feed every day as well as every second day ($P \leq 0.01$), while no significant differences were observed between these two groups. Over the total feeding period, the smallest decrease in weight was observed in the groups that received supplementary feed ($P < 0.1$) in comparison with the control groups. Lambing percentage, weaning percentage, birthweight, 42-day weight and survival rate of the lambs were not affected significantly. This implies that supplying this type of supplementary feed to ewes only every third day or at least every second day is a viable option, whereby production is not harmed, and a reduction in labour and transport costs may be established.

Keywords: Bodyweight, SA Mutton Merino ewes, supplementation frequency, wheat stubble

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Introduction

Straw and other grain residues comprise more than 50% of the total dry matter production of a cereal crop and are a significant proportion of the material available for grazing. During the dry summer months in the winter rainfall region of South Africa, supplementation on wheat stubble lands grazed by producing sheep is essential. Wheat stubble is characterized by low levels of nitrogen and available carbohydrates, poor digestibility and a high cell wall content (Dann & Coombe, 1987). Wheat stubble cannot supply sufficient nutrients to fulfill the high protein and energy needs of the reproducing ewe (Aitchison, 1988; Brand *et al.*, 2000), and this necessitates the provision of supplementary feeding for ewes grazing wheat stubble so as to provide additional energy and protein (Aitchison, 1988; Brand *et al.*, 1997a). Due to the low digestibility of wheat stubble, there is a reduced intake of the available stubble (Mulholland *et al.*, 1976), which results in a larger decrease in the nutrient intake by the ewe.

Mature Merino wethers that grazed wheat stubble for 95 days, for example lost weight at a mean rate of 90 $g.d^{-1}$ (Messenger *et al.*, 1971). Supplemental feeding is a means to promote productivity by supplying limiting nutrients during deficient periods (Huston *et al.*, 1999). The energy supply can be successfully supplemented with a rapidly fermentable carbohydrate, like maize meal to improve the utilization of the wheat stubble (Gomes *et al.*, 1994), while non-protein nitrogen (NPN) sources may improve the digestibility and intake of low quality grain residues (Perdok *et al.*, 1988). Undegradable protein is normally necessary to improve milk production of the ewe as well as birthweight and early growth rate of lambs (Brand *et al.*, 1997b).

Protein and energy supplements are normally provided daily (Thomas *et al.*, 1992). The daily provision of supplementary feed however requires large management inputs that may not always be feasible. It entails increased transport expenditure, especially where large areas of land are used, and is labour intensive (Kartchner & Adams, 1982). It is attractive to reduce the frequency of feeding supplements (Allden, 1981; Beaty *et al.*, 1994), due to lower labour costs and the potential for all the animals in the flock to get an opportunity to feed. Several studies have shown no detrimental effects on animal performance when protein supplements are fed at 48 h (Hunt *et al.*, 1989), 72 h (McIlvain & Shoop, 1962) or 96 h (Coleman & Wyatt, 1982) intervals. Utilization of the grazing may also be improved, since the animals would spend less time at the feeding troughs. A stampede to the feeding troughs which could lead to ewes becoming separated from their lambs, may also be avoided by less frequent feeding periods. With less frequent feeding, a more uniform feed intake is established, the weaker sheep also have the opportunity to feed at the troughs and therefore sheep losses are lower and wool production higher (Van Niekerk *et al.*, 1967). Most day-of-supplementation research has been conducted on cattle. No significant difference on cattle performance when fed a supplement composed of cottonseed cake on alternate days was recorded (McIlvain & Shoop, 1962; Melton & Riggs, 1964). However, Kartchner & Adams (1982) found that feeding grain on alternate days decreased cow weight change relative to daily feeding. They suggested that the decreased performance might be a result of a decreased ruminal pH due to the feeding of grain every second day, which reduced forage intake and digestion.

Less frequent feeding may have disadvantages like the excessive intake of urea, acidosis caused by excessive starch intake, as well as suboptimal urea utilization which is caused by inconsistent ammonia levels in the rumen (Leng, 1990). Collins & Pritchard (1992) reported that alternate day supplementation with plant protein concentrates can be used when ruminants are consuming low crude protein forages like wheat straw (ca 3 % CP). Huston *et al.* (1997) also found that the most variable data were observed in the daily-fed group of cows due to aggressive competition during short consumption periods. Cows fed less frequently showed a reduced variation in production. On the other hand, certain evidence indicates that frequent feeding is more favourable than intermittent feeding for weight gain in sheep and cattle (Mochrie *et al.*, 1956), except in drought conditions (Franklin *et al.*, 1955; Briggs, 1956, 1968; Rakes *et al.*, 1961; Robards, 1970). These studies also indicated that frequent feeding might be more important to young animals than to mature animals.

The objective of this study was to quantify the effect of the frequency of feeding a supplementary energy and protein lick on the production of South African Mutton Merino ewes during late pregnancy and early lactation while grazing wheat stubble.

Materials and Methods

A total of 160 ewes were randomly divided into two groups consisting of four camps each. Four groups (of 25 each) consisting of 100 ewes grazed a 17 ha camp at 5.8 sheep/ha and four groups (of 15 each) consisting of 60 ewes grazed a 12 ha camp at 5.0 sheep/ha from 7 December 1995 until the second week in May 1996. The two camps were adjoining each other. To eliminate the effect of the camps, weekly rotation of sheep within each of the two camps was practised. The supplementary energy and protein loose lick (Table 1) was supplied in the morning as follows: Two groups of ewes received 200 g/ewe daily, two groups received 400 g/ewe on alternate days, two groups 600 g/ewe every third day and two control groups received none. The ewes receiving supplementation on alternate days or every third day, was given free access for the whole period.

The composition of the supplementation was determined according to previous experiments with sheep grazing wheat stubble where nutrient intake (Brand *et al.*, 1997b) and the response to different types of supplementary feed (Brand *et al.*, 1997a) were determined. The ewes were weighed every 14 days, while the lambs were weighed at birth, as well as every fortnight thereafter. The supplementary feed was supplied from eight weeks pre-partum to six weeks post-partum. Lambing took place from the second week in April 1996 until the second week in May 1996.

Table 1 Components and chemical composition (on a dry matter basis) of the supplement supplied to SA Mutton Merino ewes at different feeding frequencies while grazing wheat stubble

Item	Content (%)
Components	
Barley meal	57.1
Fish meal	14.3
Sweet lupins	7.8
Urea	3.7
Feed lime	1.4
Molasses meal	1.1
Mineral-vitamin premix[a]	0.3
Sulphur	0.15
Taurotac[b]	0.15
Salt	14.0
Chemical composition (dry matter)	
Dry matter	85.4
Crude protein	21.6
Crude fiber	4.6
Ether extract	2.6
Ash	6.7
Total digestible nutrients	65.1
Metabolizable energy (MJ/kg)	11.3
Calcium	1.57
Phosphorus	0.81
Magnesium	0.15
Sulphur	0.30

[a] Mineral-vitamin premix/2 kg pack: Vitamin A, 6 000 000 I.U.; Vitamin D_3, 500 000 I.U.; Vitamin E, 5000 I.U.; Vitamin B_1, 2800 mg; Fe, 50 g; Mn, 40 g; Zn, 50 g; I, 1 g; Co, 1 g; Se, 100 mg.
[b] a growth promotor

All treatment means were compared by the Least Significant Difference (LSD) method. In line with recommendations by Snedecor & Cochran (1980), the LSD test was only used when it was protected by a significant F-value in the analysis of variance table. Statistical analysis was performed on groups of animals and not individual animals, and every group was regarded as an experimental unit. In the analysis of final bodyweight, initial bodyweight was included as a covariant. Ewe and lamb data were corrected for multiple births by linear model procedures.

Results and Discussion

Production results of ewes subjected to different feeding frequencies are presented in Table 2. During the feeding period, the smallest decrease in weight ($P \leq 0.01$) was observed in the groups that received supplementary feed daily as well as every second day. During the total period, the smallest decrease in weight ($P < 0.1$) was observed in the groups that received supplementary feed daily as well as every second or third day. Huston *et al.* (1999) observed that ewes fed at 7-day intervals lost more ($P < 0.05$) weight than the 1 day and 4 day-interval groups. In the present study the lambing percentage, weaning percentage, birthweight, 42-day weight and survival rate of the lambs were not affected significantly ($P \geq 0.18$) by the frequency of supplementary feeding. However, according to the data, the lambing and weaning percentage of the ewes that received supplementation every day and every third day tended to be higher than the ewes receiving supplementation every second day. Ewes that were supplemented every third day had the highest bodyweight loss of all supplemented groups during the feeding period ($P \leq 0.01$). All supplemented groups performed significantly better than the unsupplemented control group in terms of the live weight change over the feeding as well as the total period. The lack of significant differences in the lambing and weaning percentage of the ewes in groups that received supplementation daily as well as every third day, indicate that from an economical point of view, supplementation could be provided every third day. Faichney (1968) reported a significant improvement in bodyweight gain in sheep due to an increased frequency of feeding (100g lucerne pellets was fed to sheep at 3hr intervals for 24 hrs), whereas Kartchner & Adams (1982) reported a gain of 64.4 kg with dry pregnant crossbred cows fed daily and a decrease of 31.3 kg with cows fed on alternate days when grazing autumn winter veld. McIlvain & Shoop (1962) concluded that the weight gains of steers tended to decrease as feeding interval increased, when steers were fed cottonseed cake (41 % CP) while grazing on winter veld. In contrast, studies on cattle have shown that a supplement of cottonseed cake can be fed on alternate days, every third day or even weekly without decreasing animal performance compared to a daily feeding schedule (McIlvain & Shoop, 1962; Melton & Riggs, 1964).

Table 2 Production results of SA Mutton Merino ewes grazing wheat stubble continuously for 138 days at 5.8 sheep/ha (100 ewes) and 5.0 sheep/ha (60 ewes) respectively and receiving supplementary feed at different frequencies (daily, alternate days, and every third day)

Measurement	Everyday	Every second day	Every third day	Control	SE	P
Ewes:						
Initial bodyweight	69.9	70.0	69.6	69.7	1.5	0.99
Final bodyweight	62.7[a]	63.9[a]	62.3[a]	55.2[b]	1.4	0.01
Change in weight:						
Feeding period	-10.9[ab]	-10.0[a]	-12.8[b]	-17.5[c]	0.9	0.01
Change in weight:						
Total period	-7.3	-6.1	-7.4	-14.5	1.9	0.09
Lambing %[+]	161	139	160	139	12.0	0.39
Weaning %[++]	116	103	127	100	11.5	0.29
Lambs:						
Birthweight	4.3	4.5	4.1	4.2	0.1	0.18
42-day weight	7.9	7.1	6.7	6.9	0.5	0.36
Survival rate %[+++]	78	82	82	80	7.0	0.98

[a,b,c] values in rows bearing different superscript letters shows significant ($P \leq 0.05$) differences
[+] prolificacy
[++] lambs weaned per ewes lambing
[+++] lambs weaned per lambs born

Except for birthweight, Hodge *et al.* (1981) also found that frequency of feeding did not significantly affect production or final live weight where sheep were fed oats, lupins or a mixture of oats and lupins. Godfrey *et al.* (1993) observed that with an increasing interval of feeding, there was a decrease in performance (live weight gain and wool growth) irrespective of the source (barley or lupins) of supplement, which indicates that there is some trade-off between the attractive management option of feeding less frequently and the efficiency with which a supplement is utilised. In a study by Thomas *et al.* (1992), with ewes on winter grazing, it was found that ewes which received supplements on alternate days, lost more weight ($P < 0.10$) than ewes that received supplements on a daily basis. The percentage of lambs born per ewe lambing was higher ($P < 0.10$) for ewes receiving no supplements compared to ewes receiving supplements daily or on alternate days. However, no difference ($P > 0.10$) was detected in the percentage of lambs weaned per ewe, which indicates that alternate-day supplementation of pregnant ewes grazing winter veld appears to be a viable management option for sheep producers.

From Table 2 it is evident that under these circumstances, providing supplementary feed every second or even every third day, will not impair production. It will also have the advantage of reducing labour and transport costs. Beaty *et al.* (1994) also concluded that supplementation three times weekly seems to be a viable management option with minimal consequences in terms of cow performance. Huston *et al.* (1997) similarly found that sheep grazing low quality forage can be supplemented as infrequently as once a week with effective results. However, caution must be taken to prevent individual ewes from over-eating or high ingestion levels of starch as well as toxicosis caused by certain ingredients such as urea.

Conclusion

The data show that the highest decrease ($P < 0.1$) in bodyweight of ewes occurred in the control groups, which received no supplementary feed. Supplementary feed provided each day as well as every second day caused the smallest decrease in bodyweight during the feeding period ($P \leq 0.01$). There was no significant difference between weight loss over the total grazing period of ewes that received supplements daily and ewes that received supplements every second or third day. This kind of supplementary feed may be supplied every third or at least every second day, consequently cutting labour and transport costs in half without affecting animal performance. It is, however, clear that conflicting results occurred in the literature with regard to the frequency of supplementary feeding. The type of supplementary feeding probably plays an important role. Non-protein nitrogen supplementation requires short time intervals (Leng, 1990), while natural protein sources may be provided at longer time intervals (McIlvain & Shoop, 1962; Melton & Riggs, 1964). Previous studies with oesophageally fistulated sheep grazing wheat stubble revealed selection of plant material with a high crude protein content (mean value of 161 ± 40 g/kg for a 5 month grazing period) (Brand *et al.*, 2000), which may eliminate the requirement for NPN supplementation on this kind of grazing. Other local studies support these findings where NPN supplementation *per se* had no effect on production of sheep grazing wheat stubble (Brand *et al.*, 1997a).

Acknowledgements

This study was funded by the Elsenburg Agricultural Research Centre and financial contributions by the Technology and Human Resources for Industry Program (THRIP) of the National Research Foundation of South Africa.

References

Aitchison, E., 1988. Cereal straw and stubble as sheep feed. J. Agric. W. Aust. 29, 96-101.

Allden, W.G., 1981. Energy and Protein Supplements for Grazing Livestock In: Grazing Animals. (Ed. F.W.H. Morley), Elsevier, Amsterdam, pp. 289-307.

Beaty, J.L., Cochran, R.C., Lintzenich, B.A., Vanzant, E.S., Morrill, J.L., Brandt, R.T. & Johnson, D.E., 1994. Effect of frequency of supplementation and protein concentration in supplements on performance and digestion characteristics of beef cattle consuming low-quality forages. J. Anim. Sci 72, 2475-2486.

Brand, T.S., Franck, F., Durand, A. & Coetzee, J., 1997a. Use of varying combinations of energy and protein sources as supplementary feed for lambing ewes grazing cereal stubble. Aust. J. Exp. Agric. 37, 1-9.

Brand, T.S., Franck, F., Durand, A. & Coetzee, J., 1997b. Intake and production of ewes grazing oat stubble supplemented with sweet lupin (*Lupinus albus*) seed. Small Rumin. Res. 26, 93-103.

Brand, T.S., Franck, F., Durand, A. & Coetzee, J., 2000. The intake and nutritional status of sheep grazing wheat stubble. Small Rumin. Res. 35, 29-38.

Briggs, P.K., 1956. The utilization of low quality roughage by sheep. Proc. Aust. Soc. Anim. Prod. 1, 72-79.

Coleman, S.W. & Wyatt, R.D., 1982. Cottonseed meal or small grains forages as protein supplements fed at different intervals. J. Anim. Sci. 55, 11-17.

Collins, R.M. & Pritchard, R.H., 1992. Alternate day supplementation of corn stalk diets with soybean meal of corn gluten meal fed to ruminants. J. Anim. Sci. 70, 3899-3908.

Dann, P.R. & Coombe, J.B., 1987. Utilization of fodder crops and crop residues. In: Temperate Pastures, their production, use and management. (Eds. L.W. Wheeler, C.G. Pearson, and G.E. Robards), Australian Wool Corporation, Australia, pp. 517-525.

Faichney, G.J., 1968. The effect of frequency of feeding on the utilization of roughage diets by sheep. Aust. J. Agric. Res. 19, 813-819.

Franklin, M.C., Briggs, P.K. & McClymont, G.L., 1955. The utilization of low-quality pasture. J. Aust. Inst. Agric. Sci. 21, 216-228.

Godfrey, S.I., Rowe, J.B., Speijers, E.J. & Toon, W., 1993. Lupins, barley, or barley plus virginiamycin as supplements for sheep at different feeding intervals. Aust. J. Agric. Res. 33, 135-140.

Gomes, M.J., Hovell, F.D. De B., Chen, X.B., Nengomasha, E.M. & Fikremariam, D., 1994. The effect of starch supplementation of straw on microbial protein supply in sheep. Anim. Feed Sci. Technol. 49, 277-286.

Hodge, R.W., Bogdanovic, B. & Sweatman, D., 1981. Wool production of Merino sheep fed daily or twice weekly on oats or lupins. Aust. J. Exp. Agric. Anim. Husb. 21, 277-279.

Hunt, C.W., Parkinson, J.F., Roeder, R.A. & Falk, D.G., 1989. The delivery of cottonseed meal at three different time intervals to steers fed low-quality grass hay: Effects on digestion and performance. J. Anim. Sci. 67, 1360-1366.

Huston, J.E., Engdahl, B.S. & Bales, K.W., 1999. Supplemental feeding interval for adult ewes. Sheep & Goat Research Journal. 15, 87 – 93.

Huston, J.E., Lippke, H., Forbes, T.D.A., Holloway, J.W., Machen, R.V., Warrington, B.G., Bales, K., Engdahl, S., Hensarling, C., Thompson, P. & Spiller, D., 1997. Effects of frequency of supplementation of adult cows in Western Texas. Proc. West. Sect. Amer. Soc. Anim. Sci. 49, 236-238.

Kartchner, R.J. & Adams, D.C., 1982. Effects of daily and alternate day feeding of grain supplements to cows grazing fall-winter range. Proc. West. Sect. Am. Soc. Anim. Sci. (Abstract), 33, 308.

Leng, R.A., 1990. Factors affecting the utilization of poor quality forages by ruminants particularly under tropical conditions. Nutr. Res. Rev. 3, 277-303.

McIlvain, E.H. & Shoop, M.C., 1962. Daily versus every third day versus weekly feeding of cottonseed cake to beef steers on winter range. J. Range Manage. 15, 143-146.

Melton, A.A. & Riggs, J.K., 1964. Frequency of feeding protein supplement to range cattle. Tex. Agr. Exp. Sta. Bull. BI025.

Messenger, J.J., Donale, I.M. & Brown, D.C., 1971. Urea-salt block supplementation of adult Merino wethers grazing wheat stubble in western South Australia. Aust. J. Exp. Agric. Anim. Husb. 11, 153-155.

Mochrie, R.D., Thomas, W.E. & Lucas, H.L., 1956. Influence of frequency of feeding equalized intakes on animal response. J. Anim. Sci. (Abstract), 15, 1256.

Mulholland, J.G., Coombe, J.B., Freer, M. & McManus, W.R., 1976. An evaluation of cereal stubbles for sheep production. Aust. J. Agric. Res. 27, 881-893.

Perdok, H.B., Leng, R.A., Birds, S.H., Habib, G. & Van Houten, M.F.J., 1988. In: Increasing Small Ruminant Productivity in Semi-arid Areas. (Eds. E.F. Thomson and F.S. Thomson) ICARDA, Syria, pp. 81-91.

Rakes, A.H., Lister, E.E. & Reid, J.T., 1961. Some effects of feeding frequency on the utilization of isocaloric diets by young and adult sheep. J. Nutr. 75, 86-92.

Robards, G.E., 1970. The effect of sequence of feeding roughage on liveweight of merino wethers. Proc. Aust. Soc. Anim. Prod. 8, 506-510.

Snedecor, G.W. & Cochran, W.G., 1980. Statistical Methods, 7th edn. Iowa State University Press, Ames, Iowa, pp.593.

Thomas, V.M., Hoaglund, C.M. & Kott, R.W., 1992. Influence of daily versus alternate-day supplementation on the production of gestating ewes grazing winter range. Sheep Research Journal. 8, 85-90.

Van Niekerk, B.D.H., Basson, W.D. & Mulder, A.M., 1967. Die invloed van voedingsfrekwens en van ureumaanvullings op skape onder droogtetoestande. S. Afr. Tydskr. Landbouwet. 10, pp. 687-696.

Chapter 3

The effect of stocking density on canola stubble composition and production of South African Mutton Merino ewes

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Abstract

The nutritive value of canola (*Brassica napus*) stubble for grazing South African Mutton Merino (SAMM) ewes in the Mediterranean rainfall area of South African was assessed. Ewes were allowed to graze continuously on canola stubble in an area of 11.2 ha during the summer and autumn (19 December to 20 May 1997) for a period of 152 days. The 48 ewes were randomly divided into four groups to graze on canola stubble at four different stocking densities (approximately 1.5, 3.5, 5.5 and 7.5 ewes/ha). No supplement was supplied during the experimental period. Ewes were weighed every fortnight, while lambs were weighed at birth, and thereafter every fortnight. The ewes were sheared before the trial started and again when the trial ended. Lambing took place from the last week in March 1997 until the first week in May 1997. Samples of the paddocks were taken at the onset of the trial and again when the trial ended by cutting 10 replicate quadrates per paddock. Samples were analysed for dry matter (DM), crude protein (CP), acid detergent fibre (ADF), neutral detergent fibre (NDF) and *in vitro* digestibility of organic matter (IVDOM). There was a significant decrease in the live weight of the ewes at a stocking density of 5.5 ewes/ha, while ewes at a stocking density of 1.5 ewes/ha gained weight while those at a stocking density of 3.5 ewes/ha showed the lowest weight loss ($P = 0.01$). Wool production was the highest at 1.5 ewes/ha ($P = 0.001$). Birthweight of the lambs was not significantly affected by stocking density ($P > 0.1$). Crude protein concentration of hand collected stubble samples decreased significantly with an increase in stocking density. The ADF and NDF concentrations of samples were significantly higher at the higher stocking density compared to those at the lower stocking density.

Keywords: Canola stubble, chemical composition, hand collected samples, SA Mutton Merino ewes

Introduction

Approximately 22 000 tons of Canola seed is harvested annually in the Mediterranean rainfall area of South Africa (Protein Research Trust, 2001). Although crop residues constitute a substantial source of potential food for ruminants, in practice only a small part of the available material is used for animal production. This is due to intense selection against indigestible material by animals, especially sheep. However, low-quality residues are important due to their availability and therefore potential contribution to animal production (Coombe, 1981). Efficient utilization may be achieved by harvesting these residues as conserved fodder, but the economic justification will depend on cheap, effective methods of improving their nutritive value.

Stubble is characterized by low levels of nitrogen (N) and available carbohydrates, a high cell wall content and poor digestibility (Dann & Coombe, 1987), rendering it unsuitable to meet the high nutrient requirements for sheep during late pregnancy and lactation. The nitrogen content of stubbles in the pasture is therefore too low to sustain adequate microbial growth in the rumen. This may restrict the digestion of dietary fibre, and with it the sheep's ability to digest the roughage diet efficiently. Stubble available in wet areas will be of lower quality than those from drier areas, particularly late in the season when rain may have reduced its digestibility (Aitchison, 1988).

When grazing low-quality pasture residues, the most widely reported effect is weight loss in mature animals and failure of young animals to achieve satisfactory growth. It is generally accepted that low animal productivity on poor quality residues is due to a low intake of digestible energy caused by low intake and digestibility, which are due to changes in the chemical composition of the plant as it matures (Coombe, 1981). The problem of inadequate nutrient content may be aggravated by the reduced intake capacity of the late pregnant ewe (Weston & Hogan, 1986), resulting in problems like inadequate milk supply in ewes, pregnancy toxaemia, low viability and poor pre-weaning growth in lambs. In animals grazing crop stubble, maintenance or even some gain in weight is usually followed by weight loss, due to the initial selection for spilled grain, weeds that have grown under the crop or the more digestible parts of the crop residues. The extent of this loss depends on the type of crop (Dann & Coombe, 1987). Although the nutrient composition, availability and grazing potential of wheat stubble and stubble from other small grain types are well known (Brand *et al.*, 1997b; Brand *et al.*, 2000), no information on the composition and utilization of canola stubble is available. Pregnant and lactating ewes derive their nutrients from stubbles during summer and early autumn before the onset of the first autumn rains.

This study was conducted to investigate the nutrient composition and nutritive value of canola stubble, as well as the weight change of pregnant and lactating SAMM ewes grazing on canola stubble at different stocking densities.

Materials and Methods

An experiment was conducted at the Langgewens Experimental Farm in the Swartland area of the winter rainfall region of South Africa (33°17′S, 18°42′E, altitude 177m). The area has a Mediterranean climate and receives 78 % of the average annual precipitation of 395 mm during the winter. A total of 48 mature ewes of the South African Mutton Merino breed were synchronized with Repromap® (Medroxyprogesterone acetate, 60 mg) sponges and mating was initiated from 11 November 1996 with two rams. A sowing density of 6 – 8 kg/ha of the canola cultivar Oscar was used. An area of 11.2 ha of a canola stubble field was divided into four paddocks and continuously grazed from 19 December 1996 to 20 May 1997. All ewes were randomly divided into four groups, which grazed at a stocking density of approximately 1.5, 3.5, 5.5 and 7.5 ewes/ha respectively. The ewes were weighed every 14 days, while the lambs were weighed at birth, and thereafter at 14 day intervals. Water and feed were not withheld prior to weighing. The ewes were sheared before the trial started on 23 September 1996 and again on 29 May 1997 when the trial ended. Lambing occurred from the last week in March 1997 until the first week in May 1997. The paddocks were sampled during the first part of the trial (January and February 1997; Period 1) and at the end of the trial (April and May 1997; Period 2), by cutting 10 replicate quadrates (1.0 by 0.25 m) per paddock at ground level. Samples collected on the different days were pooled and oven dried to determine dry matter (t/ha). Samples were analysed for dry matter (DM), crude protein (CP) (AOAC, 1984), acid detergent fibre (ADF) (Van Soest, 1963) and neutral detergent fibre (NDF) concentration (Van Soest & Wine, 1967). *In vitro* digestibility of organic matter (IVDOM) was determined by the technique described by Tilley & Terry (1963) as modified by Engels & Van der Merwe (1967). All treatment means were compared by the Least Significant Difference (LSD) method (Snedecor & Cochran, 1980). The LSD test was only applied when significant F values were observed. In the analysis of final bodyweight, initial bodyweight was included as a covariant. Data analysis was done with Statgraphics 5.0 (Statistical Graphics Inc., 1991).

Results and Discussion

The influence of stocking density on production of the ewes is presented in Table 1. The highest decrease in weight change ($P \leq 0.01$) was observed in the group that grazed at a stocking density of approximately 5.5 ewes/ha, while the group grazing at a stocking density of 1.5 ewes/ha gained weight ($P = 0.01$). The lowest decrease in weight loss was observed in the group grazing at a stocking density of 3.5 ewes/ha. The group with the highest fleece weight ($P \leq 0.001$) grazed at a stocking density of 1.5 ewes/ha. The birthweight of the lambs was not significantly affected by stocking density ($P > 0.1$).

Table 1 Production results of SA Mutton Merino ewes grazing canola stubble continuously for 152 days at approximately 1.5, 3.5, 5.5 and 7.5 ewes/ha respectively

Parameter measured	Stocking density (ewes/ha)					
	1.5/ha	3.5/ha	5.5/ha	7.5/ha	SEM	P
Number of animals	4	11	15	18		
Initial bodyweight, kg	75.1	75.1	75.1	75.1	1.37	0.36
Final bodyweight, kg	80.9	67.9	62.2	64.8	2.68	0.01
Bodyweight change, kg	$+5.6^{c}$	-6.5^{b}	-12.8^{a}	-10.3^{ab}	2.67	0.01
Fleece weight, kg	3.0^{a}	2.1^{b}	2.2^{b}	2.0^{b}	0.21	0.001
Lambs:						
Birthweight, kg	3.8	4.0	3.7	3.6	0.28	0.18

Values in rows not followed by the same superscript differ ($P < 0.05$).

The influence of stocking density on the live weight of South African Mutton Merino ewes grazing canola stubble is indicated in Figure 1. It is evident that ewes grazing at the low stocking density maintained their weight. The weight of the ewes decreased considerably as soon as the stocking density was increased to 3.5 ewes/ha and more. It was only from day 98 of grazing that the ewes on higher stocking densities lost remarkably more weight than the 1.5 ewes/ha density. This weight loss can partly be attributed to the fact that lambing occurred from day 95. This may imply that when stocking density were increased, the ewes would be able to maintain their weight if shorter intervals of grazing were practised. When compared to barley stubble, a stocking density of 5 ewes/ha yielded a lower loss of live weight (2.8 kg) (Brand *et al.*, 1997a), than canola stubble grazed at respectively 3.5 and approximately 5.5 ewes/ha (-6.5 and –12.8 kg). Fleece weight was the highest in the ewes grazing at a stocking density of 1.5 ewes/ha.

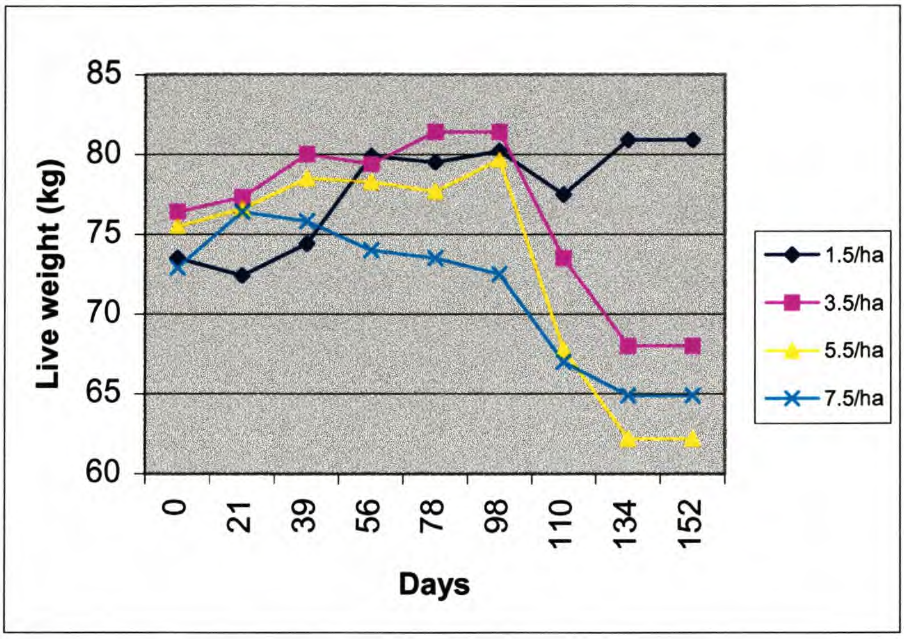

Figure 1 The influence of stocking density (ewes/ha) on the live weight of South African Mutton Merino ewes grazing canola stubble

The influence of stocking density on dry matter (DM) yield and chemical composition of canola stubble during Period 1 (January and February 1997) and Period 2 (April and May 1997) is presented in Tables 2 & 3. Dry matter availability declined from 3.4 t/ha during Period 1 to 2.8 t/ha for Period 2. Dry matter concentration stayed relatively constant during Period 1 and Period 2. Crude protein concentration showed a significant decline from 1.5 ewes/ha to 7.5 ewes/ha during Period 1 ($P = 0.001$). During Period 2, CP concentration also showed a significant decline ($P = 0.001$) from 1.5 ewes/ha to 7.5 ewes/ha. Linear regression techniques with chemical composition as dependent variable and stocking density as independent variable were used to describe the relationship between chemical composition of canola stubble and stocking density. During Period 1, CP concentration tended ($P = 0.001$) to decrease with 0.36 % for every ewe/ha increase ($SE_b = 0.06$) in stocking density. During Period 2, CP concentration tended to ($P = 0.001$) decrease with 0.17 % for every ewe/ha increase ($SE_b = 0.09$) in stocking density. During Period 1, ADF concentration showed a tendency ($P = 0.06$) to increase and during Period 2 ADF and NDF concentrations showed a significant increase ($P = 0.001$) due to an increase in stocking density. This was probably due to the fact that the animals first select the more palatable parts of the straw (Aitchison, 1988), which have a higher digestibility than the stem material (Pearce, 1983). The IVDOM concentration of the pastures was unaffected by stocking density during Period 1, while during Period 2, it declined from 242 g/kg DM at a stocking density of 1.5 ewes/ha to 197 g/kg DM at a stocking density of 7.5 ewes/ha (P = 0.005). This was in agreement with the general view in the literature that the digestibility of grazed stubble decreases with increasing length of grazing (Orsini & Arnold, 1986). In a study by Brand *et al.* (2000), it was found that the IVDOM intake of producing ewes at a lower stocking rate appeared to increase from mid-pregnancy (922 g d^{-1}) to late pregnancy (1028 g d^{-1}) and lactation (1225 g d^{-1}), with an opposite tendency at the higher stocking rate from mid-pregnancy (820 g d^{-1}) to late pregnancy (661 g d^{-1}) and lactation (658 g d^{-1}).

Table 2 The influence of stocking density on chemical composition (g/kg DM) of canola stubble collected by hand (Period 1; January and February 1997)

	Stocking density (ewes/ha)				Mean	SEM	P
	1.5	3.5	5.5	7.5			
DM	943^{a}	935^{b}	939^{ab}	943^{a}	940	0.20	0.01
Ash	103^{a}	74^{ab}	62^{b}	45^{b}	71	1.26	0.008
CP	55^{a}	48^{a}	38^{b}	35^{b}	44	0.28	0.001
ADF	634^{b}	655^{ab}	654^{ab}	664^{a}	652	0.85	0.06
NDF	778	814	792	809	798	2.30	0.63
IVDOM	268	281	238	253	260	1.81	0.32

Values in rows not followed by the same superscript differ (P < 0.10).

Table 3 The influence of stocking density on chemical composition (g/kg DM) of canola stubble collected by hand (Period 2; April and May 1997)

	Stocking density (ewes/ha)				Mean	SEM	P
	1.5	3.5	5.5	7.5			
DM	949^{a}	945^{ab}	943^{b}	946^{ab}	945	0.21	0.21
Ash	92^{b}	157^{a}	63^{b}	114^{ab}	107	1.96	0.006
CP	52^{a}	51^{a}	52^{a}	41^{b}	49	0.19	0.001
ADF	655^{bc}	669^{b}	642^{c}	691^{a}	664	0.71	0.001
NDF	809^{b}	833^{a}	833^{a}	840^{a}	829	0.58	0.001
IVDOM	242^{a}	252^{a}	251^{a}	197^{b}	236	1.32	0.005

Values in rows not followed by the same superscript differ (P < 0.10).

Table 4 compares the DM-yield and chemical composition of canola stubble determined in the present study with values obtained from other types of grain stubble residues collected under similar conditions in other studies on the same experimental farm. The CP and ADF content of the canola stubble were higher than the three other types of stubble, while the mean TDN content of the canola stubble was lower than the value obtained with the different types of grain stubble. The stocking density of the four types of stubble as illustrated in a study by Brand (2001) differed, which make direct comparisons difficult. When considering the stocking density of canola- (1.5 ewes/ha), wheat- (2 ewes/ha) and oat stubble (2.5 ewe/ha), it is clear that in the absence of supplementary feed, canola stubble would yield better results than other types of stubble, with an increase in weight of 5.6 kg. When a stocking density of approximately 5.5 ewes/ha on canola stubble in the present study is compared to a stocking density of 5 ewes/ha on barley stubble, a higher weight loss (-12.8 kg) occurred in the ewes on the canola stubble, compared to a loss of 2.8 kg in the ewes on the barley stubble.

Table 4 A comparison between the DM-yield (kg/ha) and chemical composition (g/kg DM) of canola stubble and other types of grain residues

Type of	DM Yield	Chemical composition				Reference
stubble		CP	TDN	NDF	ADF	
Canola	3162	46.5	319	814	658	Present study
Wheat	1510	26.5	429	836	618	Brand *et al.*, 2000
Barley	2037	30.6	433	813	617	Brand *et al.*, 1997b
Oats	1787	23.3	408	810	589	Brand *et al.*, 1997a
Average	2124	32.2	401	817	619	

Conclusion

The data show that the highest decrease in bodyweight occurred in the ewes grazing canola stubble at stocking densities of 5.5 to 7.5 ewes/ha. Weight gain was observed in ewes that grazed at a stocking density of 1.5 ewes/ha. This indicates that a low stocking density should be followed on canola stubble for the live weight of ewes to be maintained under circumstances of no supplementary feed. The average DM-yield and chemical composition for stubble determined in the present study could help nutritionists to calculate more accurately the supplementary feed needed for optimal production in ewes grazing canola stubble. If a shorter period of grazing on canola stubble is implemented (e.g. 98 days), a higher stocking density can be maintained without a great weight loss in the ewes. As soon as the stocking density on the canola stubble is increased, weight loss in the ewes occurred, and the advantage of grazing canola stubble without supplementation may be decreased.

Acknowledgements

This study was funded by the Elsenburg Agricultural Research Centre and financial contributions by the Technology and Human Resources for Industry Program (THRIP) of the

National Research Foundation. Thanks is due to Ms. A. Scholtz, ms. F. Martin, mrs. A. Botha and mrs. S. September for chemical analysis of samples.

References

Aitchison, E., 1988. Cereal straw and stubble as sheep feed. J. Agric. W. Aust. 29, 96-101.

AOAC, 1984. Official methods of analysis. (14th ed.). Association of Official Analytical Chemists, Arlington, Virginia, USA.

Brand, T.S., 2001. The use of Canola in animal feeding. Elsenburg J. pp. 25-27.

Brand, T.S., Franck, F., Durand, A. & Coetzee, J., 1997a. Use of varying combinations of energy and protein sources as supplementary feed for lambing ewes grazing cereal stubble. Aust. J. Exp. Agric. 37, 1-9.

Brand, T.S., Franck, F., Durand, A. & Coetzee, J., 1997b. Intake and production of ewes grazing oat stubble supplemented with sweet lupin (*Lupinus albus*) seed. Small Rumin. Res. 26, 93-103.

Brand, T.S., Franck, F., Durand, A. & Coetzee, J., 2000. The intake and nutritional status of sheep grazing wheat stubble. Small Rumin. Res. 35, 29-38.

Coombe, J.B., 1981. Utilization of Low-Quality Residues. In: Grazing Animals. (Ed. F.W.H. Morley), Elsevier, Amsterdam, pp. 319-334.

Dann, P.R. & Coombe, J.B., 1987. Utilization of fodder crops and crop residues. In: Temperate Pastures, their Production, Use and Management. (Eds. L.W. Wheeler, C.G. Pearson and G.E. Robards), Australian Wool Corporation, Australia, pp. 517-525.

Engels, E.A.N. & Van der Merwe, F.J., 1967. Application of an *in vitro* technique to South African forages with special reference to the effect of certain factors on results. S. Afr. J. Agric. Sci. 10, 983-990.

Orsini, J.P.G. & Arnold, G.W., 1986. Predicting the liveweight changes of sheep grazing wheat stubble in a Mediterranean environment. Agric. Systems. 20, 83-103.

Pearce, G.R., 1983. Variability in the composition and *in vitro* digestibility of cereal straws. In: Robards, G.E., Packham, R.G. (Eds.), Feed information and animal production, Commonwealth Agricultural Bureau, pp. 417-420.

Protein Research Trust, 2001. Canola workshop. Protein Research Trust. Elsenburg, South Africa.

Snedecor, G.W. & Cochran, W.G., 1980. Statistical Methods. (7th ed.). Iowa State University Press, Ames, Iowa, pp.593.

Statistical Graphics Ins., 1991. Statgraphics 5.0. Statistical Graphics Inc., Rockville, MD, pp. 15-33.

Tilley, J.M.A. & Terry, R.A., 1963. A two-stage technique for the *in vitro* digestion of forage crops. J. Brit. Grass. Soc. 18, 104-111.

Van Soest, P.J., 1963. Use of detergents in the analysis of fibrous feeds. II. A rapid method of determination of fibre and lignin. J.A.O.A.C. 46, 819-835.

Van Soest, P.J. & Wine, R.H., 1967. Use of detergents in the analyses of fibrous feeds. IV. Determination of cell wall constituents. J.A.O.A.C. 50, 50-55.

Weston, R.H. & Hogan, J.P., 1986. Nutrition of herbage-fed ruminants. In: The pastoral industries of Australia. (Eds. G. Alexander and O.B. Williams), Sydney University Press, Sydney, Australia, pp. 233-268.

Chapter 4

Rumen inert fat or starch as supplementary energy sources for reproducing ewes grazing wheat stubble

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Abstract

A trial was conducted to determine the efficiency of utilization of rumen inert fat as a supplementary energy source for reproducing South African Mutton Merino (SAMM) ewes (n = 56) grazing wheat stubble. The ewes were randomly divided into four groups of 14 ewes each, with every group representing a treatment. The wheat stubble paddock was divided into four paddocks of equal sizes, and the ewes grazed these paddocks at a stocking density of 4.6 ewes/ha from the 1 November 1992 until May 1993 after the break of the season. The ewes were rotated between the paddocks on a weekly basis. Each group received 250 g of supplementary feed per head daily for the last six weeks of pregnancy, and this was increased to 360 g during the first four weeks of lactation. Supplementation was supplied on Mondays, Wednesdays and Fridays for a 70-day period. Supplementary feed contains either inert fat, starch (maize meal), a combination of inert fat and starch or wheat bran as an energy source. The crude protein (CP) content of the supplements varied between 16.7 % and 19.6 %. No significant difference ($P > 0.05$) occurred between the live weights of ewes during the last six weeks of pregnancy, the first four weeks of lactation, or the total feeding period. The ewes receiving the 50 % fat plus 50 % maize meal tended to lose less weight ($P \leq 0.08$) during lactation than the ewes that received maize meal as their main energy source. No significant difference occurred in the absolute live weight of ewes over the experimental period. A lack of response to inert fat as supplementary source in the live weight of the ewes was observed during the total experimental period, when compared to the control group which received wheat bran.

Keywords: SA Mutton Merino ewes, rumen inert fat, supplementary energy source, wheat stubble

Introduction

Wheat stubble is the dominant forage available during summer in the Mediterranean sheep farming areas of South Africa, like the Swartland region. Europe produces about 330 million tons of cereal straw annually (Cañeque *et al.*, 1998), and about 460 000 ha of wheat stubble are available in South Africa annually (Brand, 1996). During the early summer period, cereal stubble generally provides adequate nutrition for sheep, but serious deficiencies may occur during the late summer, autumn and early winter months (Brand *et al.*, 2000). Autumn and winter lambing seasons are followed in this region, which implies that ewes in the critical physiological stages of pregnancy and lactation are dependent on wheat stubble. However, wheat stubble contains low levels of carbohydrates and nitrogen, has a poor digestibility and high cell wall content (Dann & Coombe, 1987). This implies that wheat stubble is unable to meet the high nutrient requirements of the reproducing ewe (Aitchison, 1988; Brand *et al.*, 1997), and therefore supplementary feed is essential. The low digestibility of wheat stubble as well as the decrease in the physical capacity of the rumen of the pregnant ewe, results in a reduced intake of available wheat stubble (Mulholland *et al.*, 1976). Therefore, the aim of supplementing the diet is to correct ruminal and animal deficiencies in the diet (Dann & Coombe, 1987). In a study by Gomes *et al.* (1994) it was indicated that by including a rapidly fermentable carbohydrate like maize meal in the diet of ewes grazing wheat stubble, the energy supply could be successfully supplemented. A higher live weight was also obtained with pregnant and lactating ewes that received cereal supplements while grazing wheat stubble compared to an unsupplemented group (Cloete & Brand, 1990).

Fats represent an excellent source of dietary energy for inclusion in ruminant diets. It contains an average of 37 MJ/kg gross energy, all of which is available as digestible energy, and about 0.80 of which (30 MJ/kg) is available as net energy. The efficiency of utilization of dietary lipid for body fat synthesis is also more than double that of carbohydrates (Thornton & Tume, 1984). The energy density of a diet can be increased without reducing forage to concentrate ratio (Grummer *et al.*, 1990) by the inclusion of fats in the diet. On the other hand, fat has the disadvantage of reducing the digestibility of fibre in the rumen when it is fed in excess of 2-3 % of the feed dry matter (Palmquist, 1988), because it protects fibre from being fermented (Harfoot *et al.*, 1974), as well as being toxic to cellulolytic bacteria (El Hag & Miller, 1972). Holter *et al.* (1993) found that when lactating dairy cows were supplemented with a bypass protein-fat supplement, forage and total dry matter intake (DMI) were reduced significantly, which negated the potential nutritional value of the supplement. Therefore, if more than 6 % fat is to be included, it must either be protected from ruminal fermentation or converted to soaps (Palmquist & Jenkins, 1982; Kotzè, 1992) if they are to be used as supplements in ruminant diets. Depending on the diet, fat may contribute 7-10 % of the digestible energy in the rumen (Ruckebusch & Thivend, 1980). The high acidity in the duodenum combined with detergent action of bile acids, lysolecithin and fatty acids causes saturated fatty acids to be more digestible in ruminants than in non-ruminants (Palmquist & Jenkins, 1980).

A trial was conducted to quantify the effect of rumen inert fat, maize meal or a combination of these energy sources in combination with a low degradable protein source as supplementary feed for pregnant and lactating ewes when grazing wheat stubble.

Materials and Methods

A trial was conducted at the experimental farm, Langgewens, in the Swartland area of the winter rainfall region of South Africa (33°17′S, 18°42′E, altitude 177m). Fifty-six South African Mutton Merino (SAMM) ewes were synchronized with Repromap® (medroxyprogesterone acetate, 60 mg) sponges and then mated from 1 November 1992. The ewes grazed wheat stubble for five months at a stocking density of 4.6 ewes/ha. The ewes were randomly divided into four paddocks of equal sizes, and rotated between paddocks on a weekly basis. Each ewe received 250 g supplementary feed daily for the last six weeks of pregnancy and during the first four weeks of lactation this was increased to 360 g per ewe. The supplementary feed mixtures contained a standard amount of molasses and fishmeal with either wheat bran (control group), maize meal, bypass fat or a combination of maize meal and bypass fat as an energy source. The rumen inert fat source was Morlac® (Marine Oil Refiners, Dido Valley, Simon's Town, RSA). The supplementary feed was provided as licks in troughs on Mondays, Wednesdays and Fridays, and the ewes were weighed every fortnight. The experiment ended in May after the break of the season.

An analysis of variance was used to detect differences in live weight changes in the different groups of ewes. The live weight of the ewes was used as a covariant at the onset of the experiment, to correct subsequent live weight data by analysis of covariance (Statgraphics 5.0, 1991). The physical composition of the four diets received by the ewes for 70 days are presented in Table 1.

Table 1 Ingredient composition of four supplements presented as supplementary licks to SA Mutton Merino ewes during the last six weeks of pregnancy and the first four weeks of lactation while grazing wheat stubble for 150 days at a stocking density of 4.6 ewes/ha

Raw materials	Treatments			
	Control	Maize meal	Bypass fat (Morlac®)	50 % Bypass fat plus 50 % maize meal
Molasses	50	50	50	50
Fishmeal	50	50	50	50
Wheat bran	100	0	50	25
Maize meal	0	100	0	50
Bypass lipids (Morlac®)	0	0	50	25
Salt	50	50	50	50
Total (kg)	250	250	250	250

Results and Discussion

The chemical composition and total digestible nutrient (TDN) content of the supplements are presented in Table 2. The crude protein (CP) concentration of the diet varied between 16.7 % and 19.6 %, whereas the TDN concentration varied between 52.0 % and 76.7 %.

Table 2 Calculated chemical composition on an air dry basis (%) of supplementary feed sources provided to SA Mutton Merino ewes grazing wheat stubble

	Supplements			
Composition	Control	Maize meal	50 % Bypass fat plus 50 % maize meal	Bypass fat (Morlac®)
Crude protein	19.60	17.21	16.96	16.70
Crude fibre	5.60	2.36	2.88	3.40
Total digestible nutrients	52.00	60.40	68.50	76.60
Calcium	1.12	1.07	1.09	1.10
Phosphorus	0.95	0.68	0.73	0.77

The live weight changes of the SAMM ewes over the 150-day trial period are presented in Table 3. It is evident from Table 3 that no significant differences ($P > 0.05$) were observed between the live weight of ewes during the last six weeks of pregnancy, the first four weeks of lactation, or the total feeding period. The ewes in the group that received 50 % fat plus 50 % maize meal lost less weight than the ewes that received maize meal as their main energy source ($P \leq 0.08$). There was also no significant difference in the live weight change (LWC) of ewes over the experimental period (Figure 1). Similar to our results, Horton *et al.* (1992) found that Ca soaps had no effect on apparent digestibility of organic matter (OM), CP or crude fibre (CF) when fed to lactating ewes.

Table 3 Live weight changes (kg) of SA Mutton Merino ewes during the feeding period (November 1992 until May 1993)

	Live weight change					
Item	Control	Maize meal	Bypass fat	50 % Bypass fat plus 50 % maize meal	SEM	P
Initial bodyweight	73.9	73.9	73.9	73.9	1.0	0.71
Final bodyweight	68.2	64.9	68.4	69.5	2.0	0.31
Weight change:						
Last six weeks of pregnancy	+4.5	+4.2	+5.8	+4.3	0.5	0.70
First four weeks of lactation	-9.2	-12.3	-10.5	-7.6	0.7	0.08
Total feeding period (10 weeks)	-4.6	-8.1	-4.8	-3.3	0.9	0.28

In the study by Horton *et al.* (1992) it was also found that with the inclusion of rumen inert fat at 7.5 to 29.6 % of NRC (1985) energy requirements of lactating ewes no effect on bodyweight changes of lactating ewes or their lambs was noted. Failure of rumen inert dietary lipid to improve weight change in lactating ewes may be due to its effect on forage consumption and fat absorption.

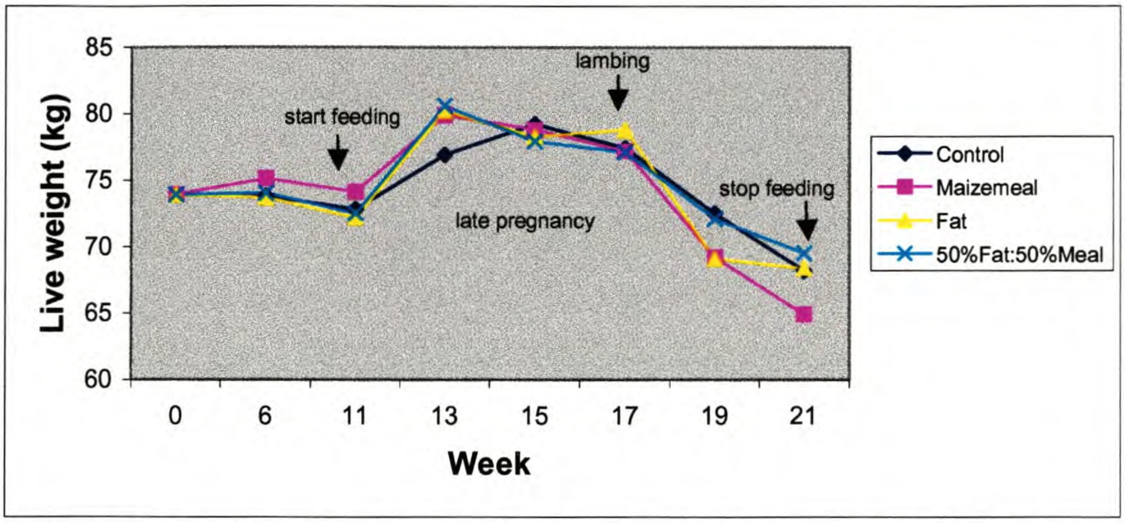

Figure 1 Live weight of SA Mutton Merino ewes grazing wheat stubble for 150 days at a stocking density of 4.6 ewes/ha and supplemented with different energy sources during late pregnancy and early lactation.

When compared to the control group, which received wheat bran as supplement, the experiment indicated a lack of response in the live weight of the ewes due to supplementary maize meal and rumen inert fat. Wheat bran is a high-quality product (13.5-15 % CP; Boucque & Fiems, 1988), probably matching responses achieved by either maize meal of rumen inert fat. In a study by Horton *et al.* (1992) it was also concluded that in spite of increasing the energy density of the diet, hay intake and fat absorption were depressed by the inclusion of rumen inert fats, and therefore no beneficial effects of lactating ewes on milk production, milk composition, bodyweight change in ewes or nursing lambs were found. In contrast to these results Sklan (1992) found that live weight of ewes increased after lambing from 65.4 kg to 75.1 kg at 90 days in ewes given calcium soaps of fatty acids (CSFA). In a study by Perez-Hernandez *et al.* (1986), it was found that each of twin lambs reared by ewes receiving a basal diet containing 145 g CP and 10 MJ metabolizable energy (ME) per kg dry matter with a lipid source, supplemented with 200 g/day of the lipid source, were on average 1.0 kg heavier at 5 weeks of age than those from ewes receiving the basal diet alone.

Conclusion

A lack of response in ewe live weight due to supplementary maize meal and bypass fat was indicated by this study, which shows that supplementary energy either in the form of starch or rumen fat was without advantages in this study. In a study done by Cronjè & Oberholzer (1990) it was also found that supplementation with as little as 100 g/d whole maize reduced roughage intake due to substitution. Animal response to supplementary feed is however to a great extent also dependent on the quality of the available pasture and production results due to supplementation may change according to pasture quality. The main reason for a lack of response on the starch containing a bypass fat as found in this study may probably be due to the fact that wheat bran provided in the control group probably matched responses achieved by the test sources.

Acknowledgements

This study was funded by the Elsenburg Agricultural Research Centre and financial contributions by the Technology and Human Resources for Industry Program (THRIP) of the National Research Foundation.

References

Aitchison, E., 1988. Cereal straw and stubble as sheep feed. J. Agric. W. Aust. 29, 96-101.

Boucque, C.H.V. & Fiems, I.O., 1988. Feeds and feedstuffs in Europe. II.4 Vegetable by-products of Agro-industrial origin. Livest. Prod. Sci. 19, 97-135.

Brand, T.S., 1996. The nutritional status and feeding practices of sheep grazing cultivated pasture and crop residues in a Mediterranean environment. Ph.D. Agric thesis. University of Stellenbosch, South Africa.

Brand, T.S., Franck, F., Durand, A. & Coetzee, J., 1997. Use of varying combinations of energy and protein sources as supplementary feed for lambing ewes grazing cereal stubble. Aust. J. Exp. Agric. 37, 1-9.

Brand, T.S., Franck, F., Duranc, A. & Coetzee, J., 2000. The intake and nutritional status of sheep grazing wheat stubble. Small Rumin. Res. 35, 29-38.

Cañeque, V., Velasco, S., Sancha, J.L., Manzanares, C. & Souza, O., 1998. Effect of moisture and temperature on the degradability of fiber and on nitrogen fractions in barley straw treated with ureal. Anim. Feed Sci. Tech. 74, 241-258.

Cloete, S.W.P. & Brand, A.A., 1990. Response of S.A. Mutton Merino ewes and their lambs to supplementation with enriched oat, barley, or triticale grain on wheat stubble grazing. S. Afr. J. Anim. Sci. 20, 96-99.

Cronjè, P.B. & Oberholzer, E., 1990. Calcium soap: A potential energy supplement for the grazing ruminant. Technical Communication – Dept. of Agric. Development, South Africa. 223, 3-9.

Dann, P.R. & Coombe, J.B., 1987. Utilization of fodder crops and crop residues. In: Temperate Pastures, their production, use and management. (Eds. L.W. Wheeler, C.G. Pearson and G.E. Robards), Australian Wool Corporation, Australia, pp. 517-525.

El Hag, G.A. & Miller, T.B., 1972. Evaluation of whisky distillery by-products: Reduction in digestibility of malt distillers grains by fatty acids and the interaction with calcium and other reversal agents. J. Sci. Food Agric. 23, 247-255.

Gomes, M.J., Hovell, F.D.De B., Chen, X.B., Mengomasha, E.M. & Fikremariam, D., 1994. The effect of starch supplementation of straw on microbial protein supply in sheep. Anim. Feed Sci. Technol. 49, 277-286.

Grummer, R.R., Hatfield, M.L. & Dentine, M.R., 1990. Acceptability of fat supplements in four dairy herds. J. Dairy Sci. 73, 852-857.

Harfoot, C.G., Crouchman, M.L., Noble, R.C. & Moore, J.H., 1974. Competition between food particles and rumen bacteria in the uptake of long chain fatty acids and triglycerides. J. Appl. Bact. 37, 633-641.

Holter, J.B., Hayes, H.H., Kierstead, N. & Whitehouse, J., 1993. Protein-fat bypass supplement for lactating dairy cows. J. Dairy Sci. 76, 1342-1352.

Horton, G.M.J., Wohlt, J.E., Palatini, D.D. & Baldwin, J.A., 1992. Rumen-protected lipid for lactating ewes and their nursing lambs. Small Rumin. Res. 9, 27-36.

Kotzè, W.F., 1992. Evaluation of encapsulated fat in ruminant rations. Ph.D. Agric thesis. University of the Orange Free State, South Africa.

Mulholland, J.G., Coombe, J.B., Freer, M. & McManus, W.R., 1976. An evaluation of cereal stubbles for sheep production. Aust. J. Agric. Res. 27, 881-893.

NRC, 1985. Nutrient requirements of Sheep. (6th ed.). National Academy Press, Washington, D.C.

Palmquist, D.L., 1988. The Feeding Value of Fats. Feed Science. 12, 293-311.

Palmquist, D.L. & Jenkins, T.C., 1980. Fat in lactation rations: Review. J. Dairy Sci. 63, 1-14.

Palmquist, D.L. & Jenkins, T.C., 1982. Calcium soaps as fat supplement in dairy cattle feeding. Proc. XIIth World Congress on Diseases of Cattle, Amsterdam. p. 477.

Perez-Hernandez, M., Robinson, J.J., Aitken, R.P. & Fraser, C., 1986. The effect of dietary supplements of protected fat on the yield and fat concentration of ewe's milk and on lamb growth rate. British Society of Animal Production. 42, 455-465.

Ruckebusch, Y. & Thivend, P., 1980. Digestive physiology and metabolism in ruminants. A.I.V. Publishing Company, Inc. Westport, Connecticut, USA.

Sklan, D., 1992. A note on production responses of lactating ewes to calcium soaps of fatty acids. Anim. Prod. 55, 288-291.

Statistical Graphics Inc., 1991. Statgraphics 5.0. Statistical Graphics Inc., Rockville, MD, pp. 15-33.

Thornton, J.M.A. & Tume, R.K., 1984. Fat deposition in ruminants. In: Ruminant physiology – concepts and consequences. (Eds. S.K. Baker, J.M. Gowthorne, J.T. MacKintosh and J.B. Purser), University of Western Australia, Perth, p. 289.

Chapter 5

The effect of supplementary licks to stubble lands on the economic production parameters of grazing sheep

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Abstract

A trial was conducted to determine the economic advantage of the provision of a supplementary protein-energy lick to South African Mutton Merino (SAMM) ewes grazing either wheat- or oat stubble. Four groups of ewes in production, of which two grazed oat stubble and two grazed wheat stubble, were studied. Each of these four groups was again divided into four subdivisions, of which two subdivisions in every group received supplementation and the other two received none. Four subdivisions, of which two grazed oat stubble and two wheat stubble, received 200 g/d from the 6 March 1998 until the 28 May 1998, and the other four subdivisions, of which two also grazed oat stubble and two wheat stubble, received 200 g/d from 5 March 1999 until 18 April 1999. This was increased to 300 g/d from 19 April 1999 until 25 May 1999. The ewes were weighed on a monthly basis. The final live weight of the ewes that received supplementation differed significantly ($P \leq 0.002$) from those that received none. The change in weight over the feeding period differed significantly ($P \leq 0.02$) with a weight loss of 4.7 kg in ewes that received no supplementation. Lambing percentage was not affected significantly, but weaning percentage was 18 % higher in ewes receiving supplementation ($P \leq 0.05$). The 42-day weight of the lambs improved significantly ($P \leq 0.04$), but birthweight, weaning weight and survival rate of the lambs were not affected significantly.

Keywords: Economical supplementation, SA Mutton Merino ewes, oat stubble, wheat stubble

Introduction

The Swartland area of the winter rainfall region of South Africa is a cereal growing area with many farms producing autumn lambs. Pregnant and lactating ewes depend on crop residues during summer and early autumn before the first autumn rains. Cereal stubble refers to plant material that is available in the land under crops after the grain has been harvested. This includes crop residues, dead plant material, spilt grain and green herbage as a result of the germination of weed seeds and spilt grain after rainfall (Dann & Coombe, 1987). Straw and other available material generally comprise more than 50 % of the total dry matter production of a cereal crop and may be a significant proportion of the material available for grazing during the summer months in mixed farming enterprises (Mulholland *et al.*, 1976a). Low animal productivity on poor quality residues is due to a low intake of digestible energy caused by low intake and low digestibility, which are in turn due to changes in the chemical composition of the plant as it matures (Coombe, 1981). Cereal stubble has a low protein (Coombe, 1981) and digestibility value (Purser, 1983), and cannot maintain the ewes without supplementation over the dry period (Weston & Hogan, 1986; Aitchison, 1988; Brand *et al.*, 1992).

The problem of inadequate nutrient content of the pasture may be aggravated by a limited intake capacity of the late pregnant ewe (Weston & Hogan, 1986), owing to the rapid growth of the fetus during this period (Rattray, 1977). To provide sufficient energy for the growth and development of both the ewe and her unborn lamb, ewes in late pregnancy and early lactation require up to three times the energy needed to maintain a non-pregnant ewe (Aitchison, 1988). The insufficient intake of nutrients by the reproducing ewe could lead to pregnancy toxaemia, inadequate milk supply, as well as a low viability and poor pre-weaning growth in lambs. This necessitates the provision of supplementary feed to provide additional energy and protein when pregnant/lactating ewes graze on stubble (Rowe, 1986; Aitchison, 1988; Brand *et al*, 1992, 1997a). The main aim of providing supplementation to ruminants fed low-quality pasture like cereal stubble is to correct deficiencies in the diet, which may occur at rumen or animal level, or both, and to increase the intake of the pasture (Dann & Coombe, 1987).

A nitrogen (N) deficiency is the primary limiting factor in the utilization of low-quality residues by grazing ruminants, especially when there is no scope for the selection of green herbage (Coombe, 1981). The provision of concentrate supplements to ruminants grazing pasture is associated with reduced herbage intake levels (Taylor & Wilkinson, 1972) and depressed cell wall digestion (Doyle, 1987). Crabtree & Williams (1971) found that straw intake increased in sheep when up to 25 % concentrate was fed and thereafter declined. However, the rate of substitution is dependant on the level of concentrate feeding as well as the quantity and quality of the available grazing material (CSIRO, 1990). Sheep grazing stubbles seems to select intensely for green material (Mulholland *et al.*, 1976b). Many trials have been conducted to find the optimal supplementation for sheep grazing cereal stubble. Cloete & Brand (1990) found that pregnant and lactating ewes that received cereal supplements while grazing wheat stubble obtained a higher live mass than the unsupplemented group. With the correctly formulated supplementation, the production of sheep has been improved dramatically, but whether the supplementation is economically viable is still quite unknown.

A trial has therefore been conducted to investigate the economic justification of supplemental feeding of SAMM ewes grazing oat and wheat stubble respectively.

Materials and Methods

An experiment was conducted at the experimental farm, Langgewens, in the Swartland area of the winter rainfall region of South Africa (33°17'S, 18°42'E, altitude 177m). The Swartland area receives 78 % of the average annual precipitation of 395 mm during the winter, and has a Mediterranean climate. Three hundred South African Mutton Merino (SAMM) ewes were used in the experiment. Four flocks of sheep were used over a two year period (Table 1). Two of the groups grazed oat stubble while the other two groups grazed wheat stubble. The first group grazed a 20 ha oat stubble camp (30 December 1997 to 28 May 1998) at a stocking density of 5.0 ewes/ha. The second group grazed an 11.8 ha wheat stubble camp (30 December 1997 to 28 May 1998) at a stocking density of 4.7 ewes/ha. The third group grazed a 21 ha wheat stubble camp (22 January 1999 to 31 May 1999) at a stocking density of 4.8 ewes/ha, and the fourth group grazed a 14 ha oat stubble camp (22 January 1999 to 31 May 1999) at a stocking density of 4.3 ewes/ha. Each group was subdivided into four groups of which two subdivisions received supplementation and two received none. To eliminate the effect of the camps, weekly rotation of sheep between camps was practised.

Supplementation for the first two groups commenced on 6 March 1998 and ended on 28 May 1998. These two groups received 200 g/d. Supplementation for the other two groups commenced on the 5 March 1999 and ended on 25 May 1999. These groups received 200 g/d from 5 March until 18 April, after which it was increased to 300 g/d from 19 April to 25 May (Table 1). Supplementation was given during the last four weeks of pregnancy and the first eight weeks of lactation in the form of a lick (Table 2). Data was analysed by analysis of variance with supplementation level and year as factors. No significant interactions occurred. Procedures as described by Snedecor & Cochran (1980) were followed.

Table 1 Details of experiments performed with SA Mutton Merino ewes grazing cereal stubble

Experiment no.:	1	2	3	4
Year	1998	1998	1999	1999
Type of stubble	Oat	Wheat	Wheat	Oat
Paddock size (ha)	20	11.8	21	14
Number of ewes	100	56	100	60
Number of groups	4	4	4	4
Stocking density	5.0	4.7	4.8	4.3
Stubble grazing				
Starting date	30 Dec.	30 Dec.	22 Jan.	22 Jan.
End date	28 May	28 May	25 May	25 May
Number of days	150	150	124	124
Supplementation				
Starting date	6 March	6 March	5 March	5 March
End date	28 May	28 May	25 May	25 May
Number of days	83	83	81	81
Amount (g/ewe/day)	200 g/d[+]	200 g/d[+]	200 g/d[++]	200 g/d[++]
			300 g/d	300 g/d
Total supplementation(kg/ewe)	16.6	16.6	19.9	19.9
Lambing date	12 Apr.	12 Apr.	12 Apr.	12 Apr.
Weaning date	10 Sep.	10 Sep.	25 Aug.	25 Aug.

[+] 200 g/d from 6 March 1998 until 28 May 1998
[++] 200 g/d from 5 March 1999 until 18 April 1999
300 g/d from 19 April 1999 until 25 May 1999

Table 2 The physical and chemical composition of the supplementary lick supplied to producing SA Mutton Merino ewes while grazing grain stubble during the dry summer periods

Item	Content (%)
Physical composition(air dry)	
Barley meal	57.00
Cottonseed oil-cake meal	22.10
Urea	3.70
Feed lime	1.55
Molasses meal	1.50
Sulphur	0.15
Salt	14.00
Chemical composition (dry matter)	
Dry matter	85.5
Crude protein	17.4
Crude fibre	6.7
Ether extract	2.2
Ash	4.8
Total digestible nutrients	63.7
Metabolizable energy (MJ/kg)	8.0
Calcium	0.6
Phosphorus	0.4
Magnesium	0.3
Sulphur	0.3

Results and Discussion

The influence of supplementation on the production of SAMM ewes grazing wheat- and oat stubble, respectively, is presented in Table 3. It is evident from Table 3 that the final bodyweight of the ewes that received supplementation differed significantly ($P \leq 0.002$) from the ewes that did not receive any supplementation. The bodyweight change in the ewes that received supplementation was less than the ewes that received no supplementation ($P \leq 0.02$). In a study by Gardner *et al.* (1993) two experiments were conducted to determine live weight change (LWC) and wool production of Merino wethers grazing dry annual pastures supplemented with lupin, barley grain or silage. The study concluded that in the first experiment the wethers gained weight during supplementation. The wethers receiving no supplements also gained weight. In the second experiment an increase in LWC (P < 0.01) was observed with supplementation compared with no supplement. Live weight change during the first 71 days of feeding increased (P < 0.01) as the proportion of lupin in the supplement increased, with no effects observed during the final 70 days of supplementation. Lambing percentage was not affected significantly (P = 0.44), but the weaning percentage was 18 % higher in ewes receiving supplementation (P ≤ 0.05). In a study by Brand *et al.* (1997b) during which the intake and production of ewes grazing oat stubble and supplemented with sweet lupin seed was investigated, it was found that the bodyweight loss of ewes during the first 6 weeks of lactation was reduced (P < 0.05) by 2.0 % for each 100 g increase in supplementary lupin seed provided.

Table 3 The influence of supplementation on the production of SA Mutton Merino ewes grazing wheat- and oat stubble

Parameter measured	Treatment		SEM	P
	No supplementation	Supplementation		
Number of groups	8	8	-	-
Initial bodyweight/group, kg	56.7	56.7	0.68	NS
Final bodyweight/group, kg	53.9^a	59.4^b	0.97	0.002
Bodyweight change (feeding period), kg	-18.7^a	-14.0^b	1.23	0.02
Lambing %	140	155	7.74	0.44
Weaning %	102^a	120^b	5.87	0.05
Weaning lamb weight/ewe, kg	19.8	22.8	1.44	0.17
Wool production, kg/ewe	3.04	3.24	0.12	0.34

Values in rows not followed by the same superscript differ (P ≤ 0.05)

The influence of supplementation on the production of the lambs is given in Table 4. The 42-day weight of the lambs whose mothers received supplementation, was improved significantly (P ≤ 0.04), while birthweight and weaning weight was not affected significantly. The survival rate of the lambs tended (P ≤ 0.11) to increase (an increase of 8.9 %) with the provision of supplementary feed to the ewes. Brand *et al.* (1997b) found no significant differences between supplementary groups in terms of lamb birthweight, lamb growth rate up to 42 days or in ewe wool growth rate when ewes were supplemented with sweet lupin while grazing oat stubble.

Table 4 The influence of supplementation on the production of SA Mutton Merino lambs

Parameter measured (n = 16 groups)	Treatment		SEM	P
	No supplementation	Supplementation		
Number of groups	8	8	-	-
Birthweight, kg	4.16	4.39	0.18	0.40
42-day weight, kg	6.77[a]	8.07[b]	0.39	0.04
Weaning weight, kg	29.9	30.4	1.22	0.78
Survival rate (%)	66.0	74.9	3.67	0.11

Values in rows not followed by the same superscript differ ($P \leq 0.05$)

Brand *et al.* (1997a, 2000) indicated that ewes grazing wheat stubble at a stocking density of 5.8 ewes/ha, and supplemented from eight weeks pre-partum to six weeks post-partum, lost 10.9 kg, and ewes grazing oat stubble and supplemented for six weeks, lost 7.2 kg. An acceptable level of nutrition over the last 8 weeks of gestation will result in an increase in ewe bodyweight of about 10 % in ewes with single fetuses and 18 % in ewes carrying twins (Russel, 1984). The NRC (1985) suggests a bodyweight loss of 2.3 % (singles) and 5.5 % (twins) for lactating ewes on adequate nutrition.

In a study by Mulholland *et al.* (1976b) in which oat, barley and wheat stubble was evaluated for sheep production, it was found that the LWC and wool production of young crossbred wethers were significantly influenced by the availability of green plant material and by stocking density, but not by supplementation. Barley stubble gave the best gains in the first year, barley and wheat in the second year, and oats and barley in the third year.

Conclusion

From the present study, it is evident that supplementary feeding is necessary to overcome the limitations in the nutritive value of cereal stubble, especially where reproduction results in increased requirements of ewes grazing cereal stubble. There was a significant increase in the bodyweight of the ewes that received supplementation in comparison to the ewes that received none. Lambing percentage was not affected significantly, but weaning percentage was significantly higher in the supplemented groups. The 42-day weight of the lambs was significantly improved, while birthweight, weaning weight and survival rate of the lambs were not affected significantly. Responses of ewes due to supplementation will not always be economical but should not be evaluated in terms of wool and/or lamb production over a short period. Response in live weight change may have a major effect on reproduction of the ewe in the following year as well as on the lifetime production of the ewe and the lamb. Compensatory growth may also have a significant effect, if pasture is abundant in the follow-up period (Brand, 1996). However, based on only the production results of the present study, supplementary feeding might prove economically feasible.

Acknowledgements

This study was funded by the Elsenburg Agricultural Research Centre and the Technology and Human Resources for Industry Program (THRIP) of the National Research Foundation of South Africa.

References

Aitchison, E., 1988. Cereal straw and stubble as sheep feed. West. Aust. J. Agr. 29, 96-101.

Brand, T.S., 1996. The nutritional status and feeding practices of sheep grazing cultivated pasture and crop residues in a Mediterranean environment. Ph.D Agric Thesis, University of Stellenbosch, Stellenbosch, South Africa.

Brand, T.S., Brand, A.A., Cloete, S.W.P. & Durand, A., 1992. Untreated, urea-enriched and thermal ammoniated oat grain as supplementary feed for pregnant and lactating S.A.Mutton Merino ewes grazing wheat stubble. S.Afr. J. Anim. Sci. 22, 58-63.

Brand, T.S., Franck, F., Durand, A. & Coetzee, J., 1997a. Use of varying combinations of energy and protein sources and supplementary feed for lambing ewes grazing cereal stubble. Aust. J. Exp. Agric. 37, 1-9.

Brand, T.S., Franck, F., Durand, A. & Coetzee, J., 1997b. Intake and production of ewes grazing oat stubble supplemented with sweet lupin (*Lupinus albus*) seed. Small Rumin. Res. 26, 93-103.

Brand, T.S., Franck, F., Durand, A. & Coetzee, J., 2000. The intake and nutritional status of sheep grazing wheat stubble. Small Rumin. Res. 35, 29-38.

Cloete, S.W.P. & Brand, A.A., 1990. Response of S.A. Mutton Merino ewes and their lambs to supplementation with enriched oat, barley, or triticale grain on wheat stubble grazing. S. Afr. J. Anim. Sci. 20, 96-99.

Coombe, J.B., 1981. Utilization of Low-Quality Residues. In: Grazing Animals. (Ed. F.W.H. Morley), Elsevier, Amsterdam, pp. 319-334.

Crabtree, J.R. & Williams, G.L., 1971. The voluntary intake and utilization of roughage-concentrate diets by sheep. Anim. Prod. 13, 71-82.

CSIRO, 1990. Feeding standards for Australian livestock: Ruminants. CSIRO Publications. Victoria, Australia. p. 266.

Dann, P.R. & Coombe, J.B., 1987. Utilization of fodder crops and crop residues. In: Temperate Pastures, their production, use and management. (Eds. L.W. Wheeler, C.G. Pearson, and G.E. Robards), Australian Wool Corporation, Australia, pp. 517-525.

Doyle, P.T., 1987. Supplements other than forages. In: Nutrition of herbivores. (Eds. J.B. Hacker and J.H. Termouth), Academic Press, Sydney, Australia, p. 429.

Gardner, J.J., Doyle, P.T., Rowe, J.B., Hetherington, R., Spicer, P., McQuade, N. & Crowhurst, M., 1993. Supplementation of young Merino sheep grazing annual pastures with lupin, barley grain, or silage. Aust. J. Exp. Agric. 33, 403-409.

Mulholland, J.G., Coombe, J.B. & Dann, P.R., 1976a. Use of oat, lupin and field pea stubbles by grazing sheep. Aust. J. Exp. Agric. Anim. Husb. 16, 467-471.

Mulholland, J.B., Coombe, J.B., Freer, M. & McManus, W.R., 1976b. An evaluation of Cereal Stubbles for Sheep Production. Aust. J. Agric. Res. 27, 881-893.

NRC, 1985. Nutrient requirements of Sheep. (6th ed.). National Academy Press, Washington, D.C.

Purser, D.B., 1983. The nutritional value of stubbles. In: Proceedings of a Stubble Seminar. Rural and Allied Industrial Council, Perth, Western Australia, pp. 13-26.

Rattray, P.V., 1977. Nutrition and reproductive efficiency in reproduction in domestic animals. (Eds. H.H. Cole and P.T. Cupps), Academic Press, New York.

Rowe, J.B., 1986. Supplementary feed for sheep. J. Agric. West. Aust. 27, 100-108.

Russel, A.J.F., 1984. Means of assessing the adequacy of nutrition of pregnant ewes. Livest. Prod. Sci. 11, 429-436.

Snedecor, G.W. & Cochran, W.G., 1980. Statistical Methods. (7th ed.). Iowa State University Press, Ames, Iowa, pp.593.

Taylor, J.C. & Wilkinson, J.M., 1972. The influence of level of concentrate feeding on the voluntary intake of grass and on live weight gain by cattle. Anim. Prod. 14, 85-96.

Weston, R.H. & Hogan, J.P., 1986. Nutrition of herbage-fed ruminants. In: The pastoral industries of Australia. (Eds. G. Alexander and O.B. Williams), Sydney University Press, Sydney, Australia, pp. 233-268.

Chapter 6

The influence of supplementary feeding to ewes and creep feeding to lambs on the production of sheep grazing winter grain stubble

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Abstract

A trial was conducted to determine the effect of creep feeding of suckling lambs and supplementation of their dams on the production of the ewes and lambs while grazing wheat stubble. Eight experimental units of South African Mutton Merino (SAMM) ewes were used in a two (supplementation of ewes) by two (creep feeding of lambs) factorial design. One replication was used. Two groups, consisting of 68 and 100 ewes grazed a 12.9 and 18 ha camp respectively. Each of these groups was divided into four groups of which two groups received supplementation and two groups none. Within each ewe group two groups of lambs received creep feeding and two groups none. To eliminate the effect of the camps, weekly rotation between camps was practised. Supplementation supplied at 200 g/d commenced on 22 February 2000 until 2 May 2000, after which it was increased to 300 g/d from 3 May 2000 until 31 August 2000. The live weight change (LWC) of the ewes that received supplementation during the total experimental period ($P = 0.11$) as well as during the feeding period ($P = 0.24$) was not affected significantly. The average daily gain (ADG) of the lambs showed a tendency to be higher when their mothers received supplementation, in contrast to the mothers who received none ($P = 0.06$). There was no significant difference in the LWC of the ewes whose lambs received creep feeding during the total experimental period ($P = 0.57$) or feeding period ($P = 0.66$). The ADG of the lambs that received creep feeding was significantly higher ($P \leq 0.001$) than the lambs that received none.

Keywords: Creep feeding, SA Mutton Merino ewes, supplementation, wheat stubble

Introduction

The Swartland area situated in the winter rainfall region of South Africa is a cereal growing area with many farms producing autumn lambs. Pregnant and lactating ewes are therefore dependent on crop residues during the summer and early autumn before appearance of the first autumn rains. Cereal stubble refers to plant material that is available on the land after harvesting the grain and green herbage as a result of the germination of weed seeds and spilt grain following rain (Dann & Coombe, 1987). During the dry summer months, supplementation on wheat stubble lands grazed by reproducing sheep is essential. Wheat stubble is characterized by low levels of nitrogen and available carbohydrates, poor digestibility and a high cell wall content (Dann & Coombe, 1987). Wheat stubble cannot supply sufficient nutrients to fulfill the high protein and energy needs of the reproducing ewe (Aitchison, 1988; Brand *et al.*, 2000), and this necessitates the provision of supplementary feeding for ewes grazing wheat stubble to provide additional energy and protein (Aitchison, 1988; Brand *et al.*, 1997a). Due to the low digestibility of wheat stubble, there is a reduced intake of the available stubble (Mulholland *et al.*, 1976), which results in a larger decrease in the nutrient intake by the ewe.

Creep feeding is the practice of providing nursing lambs the opportunity to eat feeds other than those of dam's milk or forage. The provision of creep feeding is most likely to be economically viable when provided at a time when pastures begin to decline in quality or quantity, in twin or triplet suckled lambs, or when the growth potential of the lamb is not being met with milk and natural forage. Early exposure to grain diets improved acceptance of these feeds later in life (Thorhallsdottir *et al.*, 1990). The availability of scientific-based information regarding the efficiency of utilization of creep feeding by lambs grazing wheat stubble is limited.

This study was conducted to evaluate the influence of creep feeding of suckling lambs and supplementation of their dams on the production of the ewes and their lambs while grazing wheat stubble.

Materials and Methods

An experiment was conducted at the experimental farm, Langgewens, in the Swartland area of the winter rainfall region of South Africa. The area receives 78 % of the average annual precipitation of 395 mm during the winter (33°17′S, 18°42′E, altitude 177m) and has a Mediterranean climate. One-hundred-and-sixty eight South African Mutton Merino (SAMM) ewes were synchronized with Repromap® (medroxyprogesterone acetate, 60 mg) sponges and mated from 18 November 1999 with 3 % rams. One hundred ewes were divided into four groups grazing an 18 ha wheat stubble camp at a stocking density of 5.5 ewes/ha. The remaining 68 ewes were also divided into four groups grazing a 12.9 ha wheat stubble camp at a stocking density of 5.3 ewes/ha. To eliminate the effect of the camps, weekly rotation of sheep between camps was practised. Every group was subdivided into four groups of which two groups of lambs received creep feed and two groups of lambs received none. Supplementation for the ewe groups, supplied at 200 g/d, commenced on 22 February 2000 until 2 May 2000 (69 days), after which it was increased to 300 g/d from 3 May 2000 until 31 August 2000 (120 days) (Table 1). Supplementation was supplied in the form of a loose lick (Table 2). Creep feeding to the lambs consisted of the same ingredients as the supplementation of the ewes and was supplied to the lambs from 24 May 2000 until 28 August 2000 (96 days). The lambs received an average of 0.58 kg creep feed/lamb/day.

All treatment means were compared by the Least Significant Difference (LSD) method. In line with recommendations by Snedecor & Cochran (1980), the LSD test was only used when it was protected by a significant F-value in the analysis of variance table. Initial live weight of ewes was used as a covariant in analysis of the data. Ewe and lamb data were corrected for multiple births by linear model procedures.

Table 1 Details of experiments performed with SA Mutton Merino ewes grazing cereal stubble

Experiment number	1	2
Year	1999/2000	1999/2000
Type of stubble	Wheat	Wheat
Paddock size (ha)	18	12.9
Number of ewes	100	68
Number of groups	4	4
Stocking density	5.5	5.3
Stubble grazing:		
Starting date	22 Nov. 1999	22 Nov. 1999
End date	31 Aug. 2000	31 Aug. 2000
Number of days	282	282
Supplementation of ewes		
Starting date	22 Feb. 2000	22 Feb. 2000
End date	31 Aug. 2000	31 Aug. 2000
Number of days	190	190
Creep feeding of lambs		
Starting date	24 May 2000	24 May 2000
End date	28 Aug. 2000	28 Aug. 2000
Number of days	96	96
Amount		
69 days	200 g/d[+]	200 g/d[+]
120 days	300 g/d[++]	300 g/d[++]

[+] 200 g/d from 22 February 2000 until 2 May 2000
[++] 300 g/d from 3 May 2000 until 31 August 2000

Table 2 The physical and chemical composition of the supplementary lick supplied as supplementary feed to producing SA Mutton Merino ewes and creep feed to suckling lambs while grazing grain stubble during the dry summer period

Item	Content (%)
Physical composition (air dry)	
Barley meal	57.00
Cottonseed oil-cake meal	22.10
Urea	3.70
Feed lime	1.55
Molasses meal	1.50
Sulphur	0.15
Salt	14.00
Chemical composition (dry matter)	
Dry matter	85.5
Crude protein	17.4
Crude fibre	6.7
Ether extract	2.2
Ash	4.8
Total digestible nutrients	63.7
Metabolizable energy (MJ/kg)	9.6
Calcium	0.6
Phosphorus	0.4
Magnesium	0.3
Sulphur	0.3

Results and Discussion

Production results of ewes and lambs respectively receiving supplementation and creep feeding, or none, are presented in Table 3 and 4. From Table 3 it is clear that the LWC of the ewes receiving supplementation during the total experimental period ($P = 0.11$) as well as during the feeding period ($P = 0.24$) was not affected significantly. The ADG of the lambs tended to be higher in the lambs whose mothers received supplementation, in contrast to the mothers who received none ($P = 0.06$). From Table 4 it is evident that there was no significant difference in the LWC of the ewes whose lambs received creep feeding during the total experimental period ($P = 0.57$) or the feeding period ($P \leq 0.66$). However, the ADG of the lambs that received creep feeding was significantly ($P \leq 0.001$) higher than the lambs that received none.

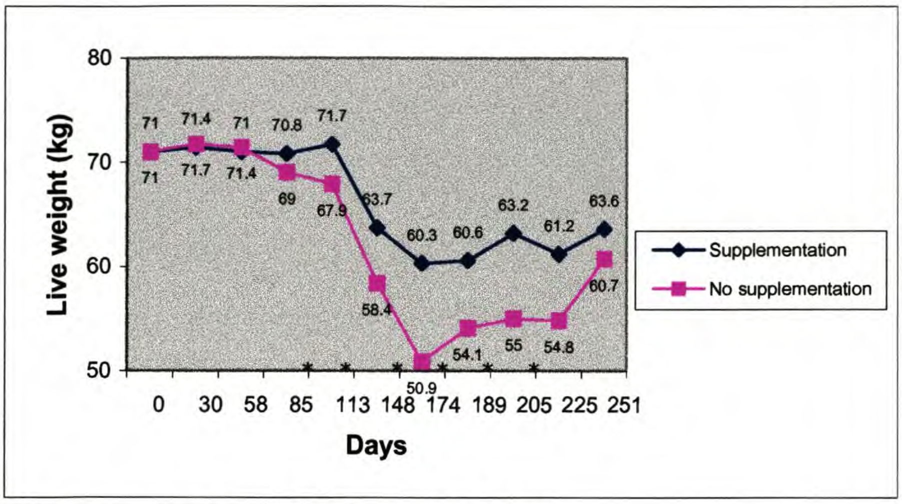
Table 3 The influence of supplementation on the production results of SA Mutton Merino ewes and their lambs grazing wheat stubble

Parameter measured	Treatment		SEM	P
	Supplementation	No supplementation		
Ewes:				
Initial bodyweight, kg	71.0	71.0	0.85	0.35
Final bodyweight, kg	63.6	60.7	1.40	0.11
Weight change, total experimental period, kg	-7.5	-10.4	1.40	0.11
Weight change, feeding period, kg	-7.2	-9.6	1.50	0.24
Lambs:				
Initial bodyweight, kg	4.50	4.50	0.10	0.97
Final bodyweight, kg	34.6	32.4	0.87	0.07
Average daily gain, kg/d	0.24	0.22	0.006	0.06

Table 4 The influence of creep feeding on the production results of SA Mutton Merino ewes and their lambs grazing wheat stubble

Parameter measured	Treatment		SEM	P
	Creep feeding	No creep feeding		
Ewes:				
Initial bodyweight, kg	71.0	71.0	0.85	0.46
Final bodyweight, kg	62.7	61.6	1.40	0.57
Weight change, total experimental period, kg	-8.4	-9.5	1.40	0.57
Weight change, feeding period, kg	-7.9	-8.8	1.5	0.66
Lambs:				
Initial bodyweight, kg	4.5	4.5	0.10	0.03
Final bodyweight, kg	36.5^{a}	30.6^{b}	0.93	0.001
Average daily gain, kg/d	0.25^{a}	0.20^{b}	0.007	0.001

Values in rows not followed by the same superscript differ ($P \leq 0.05$)



* denotes a significant difference (P ≤ 0.01)

Figure 1 Live weight change of SA Mutton Merino ewes grazing wheat stubble and receiving supplementation or not (total experimental period)

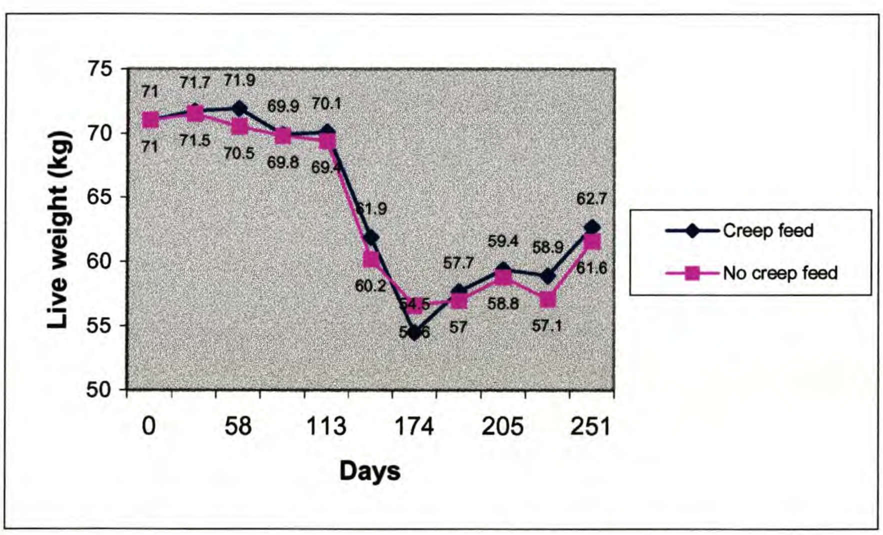
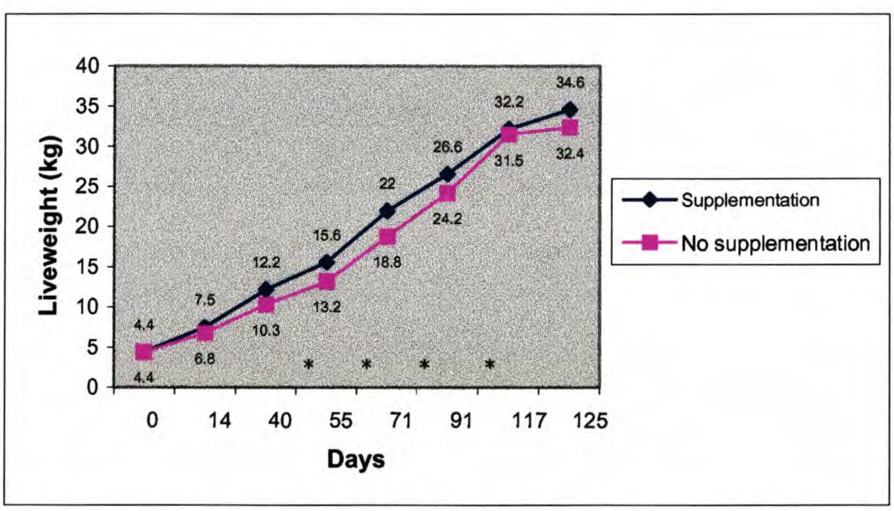


Figure 2 Live weight change of SA Mutton Merino ewes grazing wheat stubble with lambs that received creep feeding or not (total experimental period)

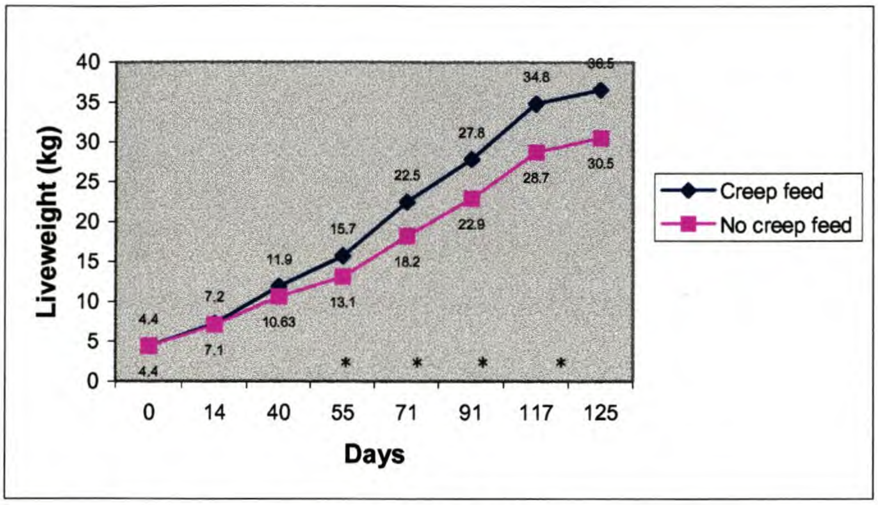
Figure 1 illustrates the LWC of the ewes that received supplementation in contrast to those that received none (total experimental period). The ewes receiving supplementation showed a significant difference in live weight (P ≤ 0.01) from day 85 to day 225 of feeding. No significant difference was observed in the LWC of the ewes whose lambs received creep feeding or none (P > 0.1) (Figure 2).

Figures 3 & 4 illustrate the LWC of lambs whose mothers received supplementation or none, as well as lambs that received creep feeding or none. It is evident from Figure 3 that supplementation of ewes positively affected ($P \leq 0.03$) the LWC of lambs between day 40 and 91. Figure 4 illustrates that creep feeding positively ($P \leq 0.01$) affected the LWC of lambs between day 55 and 125 of the experiment. These results are in contrast with results of Thomas *et al.* (1989) who found that creep feeding had no effect ($P > 0.05$) on lamb's gains from birth to turnout on summer pasture and creep fed lambs gained 7.60 kg compared to 6.90 kg for non-creep fed lambs. During the pasture phase of the above-mentioned experiment, the creep fed lambs gained ($P < 0.001$) more total weight and had greater ($P < 0.001$) daily gains than those not creep fed during the experimental period. Jordan & Marten (1968) found increased weight gains of unweaned lambs fed grain on pasture compared to unweaned non-grain fed lambs. Carter & Copenhaver (1965) obtained an ADG of 0.27 kg for suckling lambs creep fed maize and protein supplement on bluegrass-white clover pasture during two dry years, in contrast to 0.18 kg for the third year, which was wet.



* denotes a significant difference ($P \leq 0.03$)

Figure 3 Live weight change of SA Mutton Merino lambs with mothers that received supplementation or not



* denotes a significant difference ($P \leq 0.05$)

Figure 4 Live weight change of SA Mutton Merino lambs which received creep feeding or not

In a study conducted by Thorhallsdottir *et al.* (1990), lambs exposed with their mothers to rolled barley consumed more rolled barley after exposure than lambs exposed to rolled barley without their mothers. This is due to the fact that lambs learn to eat novel foods by participating with a social model, such as their mothers. It may be difficult for a young lamb to adapt to separation from its mother and have an adequate consumption of a food to cause a post-weaning response. In a study by Ortega-Reyes *et al.* (1992), it was reported that lambs exposed with their mothers to an 80 % whole barley, 20 % protein-mineral pellet (WB-PMP) at six to eight weeks of age for eight days had a higher ($P < 0.05$) intake of WB-PMP during the first two weeks in the feedlot compared with lambs not exposed to WB-PMP. In addition, 21 % of the lambs exposed to WB-PMP for eight days reached slaughter condition at seven weeks in the feedlot. None of the control lambs reached slaughter condition until after seven weeks in the feedlot.

Conclusion

From the results it is evident that supplementation, as provided in this study, tended ($P = 0.11$) to increase the final live weight of the ewes, while supplemented ewes maintained higher bodyweights during the supplementary period. Supplemented ewes also tended to produce heavier lambs ($P \leq 0.07$) at 125 days of age. Creep feeding of lambs improved their ADG significantly ($P \leq 0.001$). Creep feeding of lambs however did not affect the bodyweight of the ewes. Supplementation of ewes probably led to a higher milk production and consequently a higher weaning weight of their lambs. Supplementation of ewes may also be important in the reproduction of ewes in the next year due to a carry-over effect (Brand, 1996). The study however indicates that the highest direct advantage to be gained by the provision of supplementary feed to sheep grazing wheat stubble lands, may probably be by means of the provision of creep feed to the lambs.

Acknowledgements

The Elsenburg Agricultural Research Centre for funding the project. The Technology and Human Resources for Industry Program (THRIP) of the National Research Foundation of South Africa for financial contributions to the project.

References

Aitchison, E., 1988. Cereal straw and stubble as sheep feed. J. Agric. W. Aust. 29, 96-101.

Brand, T.S., 1996. The nutritional status and feeding practices of sheep grazing cultivated pasture and crop residues in a Mediterranean environment. Ph.D. Agric thesis. University of Stellenbosch, South Africa.

Brand, T.S., Franck, F., Durand, A. & Coetzee, J., 1997a. Use of varying combinations of energy and protein sources as supplementary feed for lambing ewes grazing cereal stubble. Aust. J. Exp. Agric. 37, 1-9.

Brand, T.S., Franck, F., Durand, A. & Coetzee, J., 2000. The intake and nutritional status of sheep grazing wheat stubble. Small Rumin. Res. 35, 29-38.

Carter, R.C. & Copenhaver, J.S., 1965. Intensive lamb production methods. Virginia Agric. Exp. Sta. Livestock Res. Rpt.

Dann, P.R. & Coombe, J.B., 1987. Utilization of fodder crops and crop residues. In: Temperate Pastures, their production, use and management. (Eds. L.W. Wheeler, C.G. Pearson, and G.E. Robards), Australian Wool Corporation, Australia, pp. 517-525.

Jordan, R.M. & Marten, G.C., 1968. Effect of weaning, age at weaning and grain feeding on the performance and production of grazing lambs. J. Anim. Sci. 19, 1307-1315.

Mulholland, J.G., Coombe, J.B., Freer, M. & McManus, W.R., 1976. An evaluation of cereal stubbles for sheep production. Aust. J. Agric. Res. 27, 881-893.

Ortega-Reyes, L., Provenza, F.D., Parker, C.F. & Hatfield, P.G., 1992. Drylot performance and ruminal papillae development of lambs exposed to a high concentrate diet while nursing. Small Rumin. Res. 7, 101-112.

Snedecor, G.W. & Cochran, W.G., 1980. Statistical Methods. (7th ed.). Iowa State University Press, Ames, Iowa, pp.593.

Thomas, V.M. & Kott, R.E., 1989. Influence of creep feeding on lamb performance during a drought. Sheep Res. J. 5, 1-4.

Thorhallsdottir, A.G., Provenza, F.D. & Balph, D.F., 1990. Ability of lambs to learn about novel foods while observing or participating with social models. Appl. Anim. Behav. Sci. 25, 25.

Chapter 7

The carry-over effect of supplementation in the previous year on the production of South African Mutton Merino ewes

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Abstract

A trial was conducted to determine the carry-over effect of supplementation in a previous year on the production of South African Mutton Merino ewes (SAMM) in the following year while grazing cereal stubble. Three hundred and sixteen ewes were divided into four flocks, of which two grazed oat stubble, and two grazed wheat stubble. Each of these four flocks was again subdivided into four groups, of which two subdivisions received supplementation, and two received none. Four subdivisions received 200 g/d from the 6 March 1998 until the 28 May 1998, while the other four subdivisions received 200 g/d from the 5 March 1999 until the 18 April 1999. This was increased to 300 g/d from 19 April 1999 until the 25 May 1999. The ewes were weighed on a monthly basis. Due to supplementation in 1998, birth status (lambs born per ewes mated) showed a tendency ($P = 0.07$) to increase in 1999, while weaning status (lambs weaned per ewes mated) was not significantly ($P = 0.43$) affected by supplementation in the previous year. Both birthweight and weaning weight of lambs were negatively ($P \leq 0.05$) affected by supplementation in the previous year, possibly due to the tendency for the higher birth rate achieved. The initial live weight of the ewes as well as kilogram weaned lamb/ewe was unaffected by supplementary feeding in the previous year.

Keywords: Birth status, SA Mutton Merino ewes, supplementation, weaning status

Introduction

The Swartland area of the winter rainfall region of South Africa is predominantly a wheat-sheep farming area with the available forage during summer and autumn being dominated by cereal stubble.

The stubble constitute a major part of the diet of pregnant and lactating ewes during the summer and early autumn months, and due to low digestibility (Purser, 1983) and protein (Coombe, 1981), supplementation has to be provided in most cases to prevent weight loss of ewes (Weston & Hogan, 1986; Aitchison, 1988; Brand *et al.*, 1992a). Inadequate provision of nutrients also cause an inadequate milk supply in ewes as well as poor pre-weaning growth in lambs. The low productivity of animals grazing cereal stubble is also associated with a low digestibility (Dann & Coombe, 1987), which results in a reduced intake (Mulholland *et al.*, 1976) of the available material. Inadequate nutrient content may be aggravated by the reduced intake capacity of the late pregnant ewe (Weston & Hogan, 1986).

The main objective of supplementing the diets of ruminants, which are grazing low-quality pastures, like cereal stubble, is to correct ruminal or animal deficiencies in the diet (Dann & Coombe, 1987). However, in may cases producers did not provide supplementary feed to ewes due to economical considerations. The direct advantages of supplementary feeding to cereal stubble is described well, while the carry-over effect of the provision of supplementation to stubble lands in the previous year on the production of ewes in the following year is a field where little research has been documented. Nutrition of the female from the foetal stage until she reaches maturity, may influence the reproductive performance by affecting firstly the time or age of onset of the first estrus, secondly by affecting the fertility and fecundity at this first estrus, or lastly by residual effects on reproductive performance during the remainder of the reproductive life (Gunn, 1983).

This study was conducted to determine the influence of supplementation in the previous (1998) year on the productive performance of SAMM ewes and lambs in the following year (1999), while grazing wheat stubble lands during both years.

Materials and Methods

An experiment was conducted at the experimental farm, Langgewens, which is situated in the Swartland area of the winter rainfall region of South Africa. The area has a Mediterranean climate and receives 78 % of the annual precipitation during the winter (33°17′S, 18°42′E, altitude 177m). Three hundred and sixteen South African Mutton Merino (SAMM) ewes were divided into four flocks (Table 1). The project was done over a two-year period. In 1998 two flocks of sheep grazing respectively oats and wheat residues were divided into four groups each. The first group grazed a 20 ha oat stubble camp at a stocking density of 5.0 ewes/ha and the second group grazed an 11.8 ha wheat stubble camp at a stocking density of 4.7 ewes/ha. Every group was subdivided

Figure 5
The first gay and lesbian march in Cape Town (1993). The police escorted the marchers instead of arresting or harassing them.

Figure 6
The 1993 Cape Town march. Some participants wore T-shirts stating ‘No liberation without Gay and Lesbian liberation’.

into four groups of which two subdivisions received supplementation and two received none. The two groups received supplementation from the 6 March 1998 until the 28 May 1998 at a rate of 200 g/d. In 1999 two flocks of sheep similarly grazing respectively oats and wheat residues were divided into four groups each. The first group grazed a 21 ha wheat stubble camp at a stocking density of 4.8 ewes/ha, and the second group grazed a 14 ha oat stubble camp at a stocking density of 4.3 ewes/ha. Each group was subdivided into four groups again of which two subdivisions received supplementation and two received none. These groups received supplementation from the 5 March 1999 until the 18 April 1999 at a rate of 200 g/d, after which it was increased to 300 g/d from 19 April until 25 May (Table 1). Supplementation was given during the last four weeks of pregnancy until the first eight weeks of lactation in the form of a lick (Table 2). During both years the four groups of sheep within each flock were rotated between the four camps to eliminate any possible camp effects.

The effect of the feeding treatment in the previous year (1998) on production in the following (1999) year was detected by Least significant difference (LSD) and analysed according to a two (supplementary feed or none in the previous year) by two (supplementary feeding or none in the current year) factorial design. The LSD test was only used when a significant F-value in the analysis of variance table was observed (Snedecor & Cochran, 1980). Ewe and lamb data were corrected for multiple births by linear model procedures where applicable.

Table 1 Details of experiments performed with SAMM ewes grazing cereal stubble

Experiment no.:	1	2	3	4
Year	1998	1998	1999	1999
Type of stubble	Oat	Wheat	Wheat	Oat
Paddock size (ha)	20	11.8	21	14
Number of ewes	100	56	100	60
Stocking density	4	4	4	4
Stubble grazing	5.0	4.7	4.8	4.3
Starting date	30 Dec.	30 Dec.	22 Jan.	22 Jan.
End date	28 May	28 May	25 May	25 May
Number of days	150	150	124	124
Supplementation				
Starting date	6 March	6 March	5 March	5 March
End date	28 May	28 May	25 May	25 May
Number of days	83	83	81	81
Amount (g/ewe/day)	200 g/d[+]	200 g/d[+]	200 g/d[++]	200 g/d[++]
			300 g/d	300 g/d
Total supplementation (kg/ewe)	16.6	16.6	19.9	19.9
Lambing date	12 Apr.	12 Apr.	12 Apr.	12 Apr.
Weaning date	10 Sep.	10 Sep.	25 Aug.	25 Aug.

[+] 200 g/d from 6 March 1998 until 28 May 1998
[++] 200 g/d from 5 March 1999 until 18 April 1999
300 g/d from 19 April 1999 until 25 May 1999

Table 2 The physical and chemical composition of the supplementary lick supplied to producing SA Mutton Merino ewes while grazing grain stubble during the dry summer period

Item	Content (%)
Physical composition (air dry)	
Barley meal	57.00
Cottonseed oil-cake meal	22.10
Urea	3.70
Feed lime	1.55
Molasses meal	1.50
Sulphur	0.15
Salt	14.00
Chemical composition (dry matter)	
Dry matter	85.5
Crude protein	17.4
Crude fibre	6.7
Ether extract	2.2
Ash	4.8
Total digestible nutrients	63.7
Metabolizable energy (MJ/kg)	8.0
Calcium	0.6
Phosphorus	0.4
Magnesium	0.3
Sulphur	0.3

Results and Discussion

The effect of dietary treatment in both the previous year (1998) and the following year (1999) on production parameters obtained were assessed and are presented in Table 3. The data revealed no significant interactions between years and the dietary effect of each year was presented separately. It is evident that the number of lambs born showed a tendency to improve with supplementation provided in 1998 ($P = 0.07$), but the number of lambs weaned per ewes mated was not significantly affected ($P = 0.43$) by the supplementation provided in 1998. The birthweight ($P = 0.003$) as well as weaning weight ($P = 0.005$) of the lambs whose mothers received supplementation in 1998 was lower than those that did not receive supplementation. This was probably due to the increase ($P \leq 0.07$) in the number of twin lambs in the ewes that received supplementation the previous year. The initial bodyweight ($P = 0.23$) as well as the kilogram weaned lamb/ewe ($P = 0.81$) was unaffected by supplementation in the previous year.

The number of lambs born per ewes mated ($P = 0.89$) as well as the number of lambs weaned per ewes mated ($P = 0.64$) was also not affected significantly by the treatment provided in 1999. The initial bodyweight of the ewes ($P = 0.05$) that received supplementation was significantly higher than those that did not receive supplementation, due to the fact that the supplemented ewes had to rear multiple lambs. The kilogram weaned lamb/ewe ($P = 0.63$), as well as the birthweight ($P = 0.16$) and weaning weight ($P = 0.29$) of the lambs was higher in the lambs whose mothers received supplementation in 1999, although it was not significantly affected.

The treatment in terms of supplying adequate nutrition through pasture to the ewes in the rest of their reproduction cycle (e.g. the dry period) will have an undoubted influence on the carry-over effect of supplementation on the reproductive performance of the ewe. If there is adequate pasture with a high quality, a possible carry-over effect on the production of the ewes may probably be neutralized. In a study conducted by Gibb & Baker (1988), where the performance of young steers receiving stack-treated ammoniated hay or untreated hay, were evaluated with and without supplementation, it was concluded that over the summer period at pasture, the mean daily live weight gains showed no carry-over effects of winter treatment and the final live weights still reflected the effects of treatment the previous winter ($P < 0.05$). In the steers that received untreated hay there was an indication of compensatory growth, although the differences were not significant.

Table 3 The effect of supplementation in both the previous (1998) and present (1999) year on production of SA Mutton Merino ewes in the following year (mean ± SE)

Production (1999)	Treatment in 1998		SEM	P
	No supplementation	Supplementation		
Ewes:				
Initial bodyweight, kg	68.86	70.54	1.01	0.23
Weaning lamb weight/ewe+++	28.79	30.00	1.37	0.81
Lambs:				
Birthweight, kg	4.94[a]	4.42[b]	0.12	0.003
Weaning weight, kg	27.95[a]	25.00[b]	0.75	0.005
Birth status+	1.09	1.37	0.10	0.07
Weaning status++	0.94	1.05	0.10	0.43
Production (1999)	**Treatment in 1999**		**SEM**	**P**
	No supplementation	Supplementation		
Ewes:				
Initial bodyweight, kg	71.03	68.36	0.98	0.05
Weaning lamb weight/ewe+++	26.71	32.42	1.37	0.63
Lambs:				
Birthweight, kg	4.56	4.80	0.12	0.16
Weaning weight, kg	25.93	27.02	0.76	0.29
Birth status+	1.22	1.24	0.10	0.89
Weaning status++	0.96	1.02	0.09	0.64

\+ Lambs born/ewes mated
\++ Lambs weaned/ewes mated
\+++ Weaning weight of lambs x weaning status
Values in rows not followed by the same superscript differ ($P < 0.05$).

Hughes *et al.* (1978) studied the long-term effect of a winter supplement on (supplied at low, moderate, high and very high levels) the productivity of range cows for ten consecutive winters. In the first four calf crops, high levels of supplement resulted in earlier ($P < 0.025$) calving dates. Increasing supplement from the low to high levels resulted in larger birthweights in calf crops from year one ($P < 0.001$), two ($P < 0.025$), three ($P < 0.025$) and nine ($P < 0.025$). There was a decline in the calving percentages of calf crops from year two and three, but all treatment groups had similar values in calf crop from year four and succeeding calf crops. In the present study, the birthweight of the lambs from unsupplemented ewes were higher than those of the supplemented ewes during treatment in 1998 due to an increase in the twinning rate of the supplemented ewes. Supplementation in 1999 however, produced heavier lambs than the unsupplemented ewes. Although the very high level cows had a high calving percentage (0.93) in calf crop one, Hughes *et al.* (1978) found that the weaning percentage for this group was only 0.66, which was significantly less than the low (0.82) and high (0.82) level groups. The low weaning percentage for the very high group was due to the fact that about 33 % of the calves were stillborn, due to dystocia in the obese heifers. Even though the low level group had the same weaning percentage value as the high level group, kilograms of calf weaned per cow exposed were considerably lower, probably due to the differences in milk production of the dams. The low and moderate levels of supplementation during the first winter were apparently sufficient to support adequate conception in the first breeding season. These lower levels of supplementation, coupled with the stress of pregnancy and lactation, appeared to be inadequate to support normal estrus and reproduction. In the present study, the kilogram weaned lamb/ewe in 1999 was not affected significantly by treatment in both years (1998 and 1999), although it was higher in the supplemented ewes in 1999.

Baker & Gibb (1995) studied the performance of Friesian steer calves when reared over winter on a silage (S) or on a silage plus concentrate (SC) diet. It was found that the dietary treatment during the winter had no significant carry-over effect on performance during the grass-feeding period and there was no indication of compensatory growth by the steers that received silage alone. Short *et al.* (1996) conducted a four-year experiment to determine the effects of protein supplementation, age at weaning and calf sire breed on cow and calf performance during fall grazing. Some carry-over effects of treatments were observed the next spring in cow weight, condition score, and birthweight ($P < 0.01$), but there were no effects by the next fall on weaning weight or pregnancy rates.

The lack of response in the live weight of ewes in the present study could be accounted for by the fact that mature ewes were used. In a study by Allden (1979), an unrestricted level of feeding for the first eight weeks of life prior to a lengthy period of restriction was very effective in establishing a high reproductive potential, compared to restricted nutrition from birth. This emphasizes the importance of nutrition early in life. This was also indicated by Reardon & Lambourne (1966), who indicated that there may be a critical development period which is very sensitive to nutrition and which will greatly affect the genetic potential achieved by the ewes later in their life.

Conclusion

In conclusion, it is evident that supplying supplementary feed in the previous year did not have a significant carry-over effect on production in the following year. Although there was a tendency for ewes to produce more lambs when receiving supplementation the previous year, the number of lambs weaned did not improve significantly, rendering it economically unjustifiable to provide supplementation in order to obtain a significant carry-over effect. A probable carry-over effect on the production of the ewes will also be smaller if adequate pasture is supplied in the dry period. The animals used in the study were mature, while young growing animals may probably be more exposed to a possible carry-over effect.

Acknowledgements

The Elsenburg Agricultural Research Centre for providing funds for the experiment. The Technology and Human Resources for Industry Program (THRIP) for financial contributions to the project.

References

Aitchison, E., 1988. Cereal straw and stubble as sheep feed. West. Aust. J. Agr. 29, 96-101.

Allden, W.G., 1979. Undernutrition of the Merino sheep and its sequelae. V. The influence of severe growth restriction during early post-natal life on reproduction and growth in later life. Aust. J. Agric. Res. 30, 939-948.

Baker, R.D. & Gibb, M.J., 1995. The performance and changes in body composition of steers offered cut grass or grazing following three patters of nutrition in winter. Anim. Sci. 60, 419 – 427.

Brand, T.S., Brand, A.A., Cloete, S.W.P. & Durand, A., 1992a. Untreated, urea-enriched and thermal ammoniated oat grain as supplementary feed for pregnant and lactating South African Mutton Merino ewes grazing wheat stubble. S. Afr. J. Anim. Sci. 22, 58 – 63.

Coombe, J.B., 1981. Utilization of Low-Quality Residues. In: Grazing Animals. (Ed. F.W.H. Morley), Elsevier, Amsterdam, pp. 319-334.

Dann, P.R. & Coombe, J.B., 1987. Utilization of fodder crops and crop residues. In: Temperate Pastures, their Production, Use and Management. (Eds. L.W. Wheeler, C.G. Pearson and G.E. Robards), Australian Wool Corporation, Australia, pp. 517-525.

Gibb, M.J. & Baker, R.D., 1988. Performance of young steers offered stack-treated ammoniated hay or untreated hay with or without a supplement. Anim. Prod. 47, 223 – 229.

Gunn, R.R., 1983. The influence of nutrition on the reproductive performance of ewes. In: Sheep production. (Ed. W. Haresign), Butterworths, London, pp. 99-110.

Hughes, J.H., Stephens, D.F., Lusby, K.S., Pope, L.S., Whiteman, J.V., Smithson, L.J. & Totusek, R., 1978. Long-term effect of winter supplement on the productivity of range cows. J. Anim. Sci. 47, 816 – 827.

Mulholland, J.B., Coombe, J.B., Freer, M. & McManus, W.R., 1976. An evaluation of cereal stubbles for sheep production. Aust. J. Agric. Res. 27, 881 – 893.

Reardon, T.F. & Lambourne, L.J., 1966. Early nutrition and lifetime reproductive performance of ewes. Proc. Aust. Soc. Anim. Prod. 6, 106-108.

Short, R.E., Grings, E.E., MacNeil, M.D., Heitschmidt, R.K., Haferkamp, M.R. & Adams, D.C., 1996. Effects of time of weaning, supplement and sire breed of calf during the fall grazing period on cow and calf performance. J. Anim. Sci. 74, 1701 – 1710.

Snedecor, G.W. & Cochran, W.G., 1980. Statistical Methods. (7th ed.). Iowa State University Press, Ames, Iowa, pp. 593.

Weston, R.H. & Hogan, J.P., 1986. Nutrition of herbage fed ruminants. In: The Pastural Industries of Australia. (Eds F. Alexander and O.B. Williams.), Sydney University Press, Sydney, pp. 233-268.

Chapter 8

General conclusion and future perspective

Low quality plant residues e.g. cereal stubble, are produced yearly in vast quantities in the Mediterranean rainfall area of South Africa. The main objectives of research on stubble utilization have been to minimize the loss in possible grazing for animal production associated with yearly cycles of growth and senescence of pastures and to fully exploit the potential of the crop residues as animal feed. The development of improved supplementation techniques based on observations of the actual diet of the animal, or combined with methods to reduce the discrimination against dead forage shown by grazing animals, as well as the use of animals best suited to utilise low quality roughage diets appear to offer the best prospects of reaching these objectives (Coombe, 1981).

The management of grazing systems is much more complex than the simple application of techniques such as rotational grazing and determining the optimum time of weaning. It includes components such as climate, soil, plants, animals, parasites and disease control. Central to this is the sheep producer, who is the driving force behind all these systems. The profitability of the producer's enterprise will depend solely on his efficiency of management, the prices and current costs associated with the enterprise, as well as the economy of his country and other countries he trades with (Morley, 1981). While the agricultural land in South Africa decreases, supplementation on the remaining land will probably start to play a more important role in sheep farming.

It is difficult to improve the utilization of pastures by grazing animals, while decisions on supplementary feeding is very complex. Supplementation do not only depend on biological and logistic variables, but also economic variables, and therefore generalizations on supplementation are slow to emerge. Biological variables include factors such as:

(i) The physiological state of the animal and anticipated needs e.g. pregnant and lactating animals deserve a higher priority than other classes of stock.

(ii) The present condition and health of the animals. This is complicated by compensatory gains by the animals.

(iii) The decision of whether the supplement is a true supplement or a substitute for pasture.

(iv) The consequences when supplementation is not supplied.

The logistic problems of supplementation lies mainly in the problem of obtaining feed, storing it and the ability to feed it to animals in proportion to their needs. Grazing animals cannot be rationed as accurately as individuals, and therefore the amounts consumed by different animals will vary a great deal. This is one of the problems that will have to be addressed in the future, and will probably involve complex and costly equipment.

The value of supplementary feeding depends entirely on the objectives the producer wants to achieve. For example, to increase stock production or the survival rate of lambs. Supplementation is especially useful at critical times such as parturition or weaning to decrease production loss and increase production rates. It may also be of indispensable value in finishing animals for the market so that they can achieve reasonable prices. This is especially true in the case of young lambs that have not reached an acceptable market weight at the time when grazing deteriorates. However, this can lead to large feed costs that would only be economically feasible if feed is affordable and price differentials are substantial. When supplementing ruminants, advantage should be taken of their unique ability to convert carbohydrate sources - cellulose, hemicellulose, pectin as well as non-protein nitrogen (NPN) – to nutrients through microbial fermentation (Van Soest, 1982). Supplementary feeding should stimulate intake and fermentation of these structural carbohydrates like pasture. Supplementation should also stimulate and maximize microbial protein production, which is a cheap source of protein for the animal (Allden, 1981). By creating more favourable conditions in the rumen for the micro-organisms, supplements will increase both feed intake and digestibility of low-quality roughages (Louw, 1978).

Responses to supplementation are inversely related to the level of productivity attained when pasture is the sole source of the diet (Allden, 1981). When abundant pasture is supplemented with energy-rich concentrates, the animal's intake of herbage is depressed. The value of the supplement must therefore be discounted by the nutrient worth of the herbage displaced. The substitution effect is diminished when pastures are sparse but by no means eliminated. These effects may account for the results of studies in which the nett effect on animal production of supplementary feeding with energy concentrates is small (Alder *et al.*, 1956; Corbett & Boyne, 1958; Holmes & Sykes, 1961; Dodsworth

& Ball, 1962; Laird & Walker-Love, 1962; Leaver *et al*., 1968). Once feeding ends, the gains of the unsupplemented animals may be greater than for previously supplemented animals. This may occur whether animals graze good or poor quality swards, compensation being slower when feed quality restricts growth (Allden & Young, 1964). The level of supplementation should not be too high and substitution of the pasture must be avoided. The most important functions of the supplement should be firstly to stimulate intake from the pasture by supplementing deficient nutrients in the pasture, and thereby improving microbial function in the rumen, and secondly supplementation should assist with a higher stocking density which leads to a higher production per unit of pasture utilised (Brand, 1996).

In the first study (Chapter 2) the effect of frequency of supplementation was investigated. The results indicated that the highest decrease in bodyweight was observed in the ewes that received no supplements (control group), while the smallest decrease in bodyweight occurred in the ewes that received supplementation daily or every second day. The production results indicate that the frequency of supplementation can be limited to every second day without negatively affecting production, while also saving on labour and transport costs. There are, however, conflicting results in the literature regarding the frequency of supplementation, while the type of supplementary feeding also plays an important role.

In the second study (Chapter 3) the composition of canola stubble and the production of South African Mutton Merino ewes on this type of stubble were investigated. It was concluded that at a low stocking density (approximately 1.5 ewes/ha), ewes are able to maintain their bodyweight without any supplementation, but as soon as stocking density increases, the advantage of grazing canola stubble without supplementation is lost.

In the third study (Chapter 4) a supplementary energy source in the form of rumen inert fat or starch was studied to determine its effect on production of reproducing ewes grazing wheat stubble. A lack of response in the live weight of the ewes indicated that starch and fat had no advantages as a supplementary energy source in this study.

In the fourth study (Chapter 5) the economic production parameters of supplementary licks to stubble lands were measured to determine the economic advantage of a supplementary protein-energy lick to ewes grazing wheat- or oat stubble. The supplementary lick increased the bodyweight of the ewes significantly, as well as the 42-day weight of the lambs, but birthweight, weaning weight and survival rate of the lambs were not significantly affected. Although responses to supplementation will not always be economically feasible, it should not be evaluated over a short period due to possible carry-over effect and compensatory growth that could occur in the period following supplementation.

In the fifth study (Chapter 6), the influence of supplementation on the production of ewes and creep feeding of lambs were studied. The study concluded that supplementation of the ewes tended to increase the live weight of the ewes, while the supplemented ewes produced heavier lambs. The average daily gain of the lambs also improved significantly with the supplementation of creep feed.

In the last study (Chapter 7), the carry-over effect of supplementation in a previous year on the production of SAMM ewes in the following year while grazing cereal stubble, was studied. Birth status in 1999 tended to increase due to supplementation in 1998, while weaning status was not affected significantly by supplementation in the previous year. Due to the tendency of multiple births, birthweight and weaning weight of lambs were negatively affected by supplementation in the previous year.

In conclusion, it is evident that the responses to supplementation are not always consistent. The result of supplementation will be affected by factors such as physiological and production stage of the ewe, her condition, and the number of fetuses carried or lambs nourished by the ewe. The quantity and quality of cereal stubble, as well as the stocking density will determine the amount and type of supplementation needed. The desired level of production will also be a determining factor in the economic viability of supplementation.

Recent research includes a lot of knowledge regarding the nutritive value of grain residues as well as animal response to different types of supplementary feed. Research performed in the later years also take economic considerations into account where earlier studies were done to achieve biological advantages without the consideration of economical realities. In future research it will be important to take into account all the nutritional qualities of the pasture in a specific paddock and supply supplementary nutrients according to the specific deficiencies. Economic realities will in future probably prevent the provision of supplementary feeding on a general basis. A lot of recent studies revealed that the provision of supplementary licks to sheep is in most cases uneconomical. A fine balance exists between the amount and type of supplementary feeding provided over the period, the availability of the pasture in the rest period and the potential income of the end products. Computer based models with reliable technical and economical data may be helpful in future to optimize production conditions and to increase profit margins for the mutton producer.

References

Alder, F.E., Head, M.J. & Berting, J.F.F., 1956. Carbohydrate supplements for beef cattle on grass/clover and grass/lucerne mixtures. Proc. Br. Soc. Anim. Prod. pp. 79-89.

Allden, W.G., 1981. Energy and Protein Supplements for Grazing Livestock. In: Grazing animals. (Ed. F.W.H. Morley), Elsevier, Amsterdam, pp. 289 - 301.

Allden, W.G. & Young, R.S., 1964. The summer nutrition of weaner sheep: herbage intake following periods of differential nutrition. Aust. J. Agric. Res. 15, 989-1000.

Brand, T.S., 1996. The nutritional status and feeding practices of sheep grazing cultivated pasture and crop residues in a Mediterranean environment. Ph.D. Agric thesis. University of Stellenbosch, South Africa.

Coombe, J.B., 1981. Utilization of Low-Quality Residues. In: Grazing animals. (Ed. F.W.H. Morley), Elsevier, Amsterdam, pp. 319-334.

Corbett, J.L. & Boyne, A.W., 1958. The effects of a low-protein food supplement on the yield and composition of milk from grazing dairy cows and on the composition of their diet. J. Agric. Sci. (Camb.) 51, 95-107.

Dodsworth, T.L. & Ball, C., 1962. Studies on the feeding of supplements to beef cattle on grass. Anim. Prod. 4, 221-226.

Holmes, W. & Sykes, J.D., 1961. The influence of supplementary feeding in the summer period on feed intake and profitability on dairy cows. Proc. 8th Int. Grassl. Congr., Reading, U.K. pp. 688-692.

Laird, R. Jr. & Walker-Love, J., 1962. Supplementing high-yielding cows at pasture with concentrated fed at a level determined by milk yield and season. J. Agric. Sci. 59, 233-244.

Leaver, J.D., Campling, R.C. & Holmes, W., 1968. Use of supplementary feeds for grazing dairy cattle. Dairy Sci. (Abstr.), 30, 355-361.

Louw, G.N., 1978. Die aanwending van voedselbronne vir diereproduksie. S. Afr. J. Anim. Sci. 8, 79-84.

Morley, F.W.H., 1981. Management of Grazing Systems. In: Grazing Animals. (Ed. F.W.H. Morley), Elsevier, Amsterdam, pp.379-400.

Van Soest, P.J., 1982. Nutritional ecology of the ruminant. O & B Books, Corvallis, Oregon, USA.