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**WOOL SHEEP PRODUCTION SYSTEMS FOR THE  
WESTERN HIGHVELD OF SOUTH AFRICA**

by

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**Thesis submitted to the Faculty of Agriculture,  
Department of Animal Science,  
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**In fulfilment of the requirements  
for the degree**

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**BLOEMFONTEIN**

**May, 2000**

## Preface

This thesis is presented in four parts, which included the investigation of *Digitaria eriantha* (Smuts finger grass), the evaluation of three wintering treatments for Merino sheep in an autumn and spring lambing season, respectively, as well as the performance of their progeny. Finally, an economical evaluation was done on results obtained with the respective lambing seasons. Although care was taken to avoid repetition, it was inevitable in some cases, mainly due to the magnitude and nature of this trial, e.g. two lambing seasons.

The author is indebted to a large number of people who were involved in the execution and evaluation of both the trials (Smuts finger grass and three wintering treatments). The extent and nature of these trials necessitated substantial inputs from all those involved, both in terms of time and effort.

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To our Heavenly Father, gratitude for his love and mercy, as well as the granting of the opportunity, health and endurance to complete the work. ...."Alles, alles is genade, onverdiende guns alleen!"

I hereby declare that the thesis presented for the degree Ph. D. at the University of the Orange Free State, is my independent work and has not been previously presented by me for a degree at any other university or faculty.



BGJ van Vuuren

POTCHEFSTROOM

May, 2000.

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**LIST OF ABBREVIATIONS**

ADG	Average daily gain
<i>ad lib.</i>	Ad libitum (free access)
CP	Crude protein
CV	Coefficient of variation
DM	Dry matter
g	gram
GI	Gross income
GM	Gross margin
GPI	Gross product income
HPC	High protein concentrate
ha	hectare
kg	kilogram
IVDMD	<i>In vitro</i> dry matter digestibility
LAN	Limestone ammonium nitrate
LSU	Large stock unit
Lta	Long term average
ME	Metabolisable energy
MJ	Megajoule
mm	millimetres
N	Nitrogen
P	Phosphorus
SSU	Small stock unit

## GENERAL INTRODUCTION

A decrease in sheep numbers, diminishing area of land available for agricultural production, as well as the increase in population growth, resulted in an increasing need for agricultural products. This stressed the need for increased production per unit area of land. Van Zyl & Sartorius Von Bach (1993) stated that inefficiency in any form could no longer be tolerated in South African agriculture. Le Riche (1982) alleged that the availability of natural resources for food production is a matter of growing concern in the majority of the food producing countries. Due to industrial development and decentralisation, high potential agricultural land becomes, to a greater extent, inaccessible for agricultural production. An increase in the population growth, as well as increased production from marginal areas, necessitates a more intensive utilisation of the available land. Both these factors will contribute to a rise in the degree of soil erosion, which will in turn contribute to less efficient production. Together with the population growth, a rise in living standards also exist in a large part of the population resulting in the fact that preference is given to food sources originating from animals (Le Riche, 1982; Verbeek, 1982). This aspect will furthermore contribute to an increasing demand for animal products. According to Van Marle (1982) the loss of high potential agricultural land, especially where intensification of agriculture and animal production is possible, will eventually result in the fact that increased production will only be possible by:

- Enhancement in the effectiveness of production. Increasing the production efficiency can be brought about by better utilisation of available sources, adapted farming systems and the elimination of problem areas. This enhanced production is applicable to both intensive and extensive systems.
- Vertical intensification of production.

Luitingh (1978) advocated integrated production system research and stated that a great need exists for the formulation or the establishment of efficient and economical livestock production systems. He also concluded that it is more a question of the global concept of production systems, rather than the introduction of fragmented knowledge in the broad scientific field. Together with this, it is also a matter that the collaboration between animal scientists and colleagues of related disciplines, especially pasture scientists, is essential. Engels (1983) stressed this point regarding pasture-related research further. He also emphasised that in any research program where the nutritional potential of grazing is investigated, the interests of both biological entities, viz. the grazing animal and the plants should be considered. Morand-Fehr & Boyasoglu (1999) alleged that sheep and goat research, which has made clear progress in recent years, will need to organise itself in order to solve the complex problems that arise at all levels of production. These authors stressed that a strong effort has to be made to improve research efficiency and particularly technology transfer. Therefore, the animal- and pasture scientist should plan and execute their research in close collaboration with regard to the optimal utilisation of the grazing. These research results should also be more understandable, more

easily assimilated and practically implementable by the producer (farmer). Continued research on farming systems development and continued adaptation are of vital importance in production systems in order to be of higher efficiency for the better utilisation of the resources and to be able to meet the ever increasing demand for products (Van Marle, 1974).

An effective research program remains the source of new information to address problems and enabling farming enterprises to be run successfully and profitably (Van Rooyen, 1979). Kerr & Mooney (1988) stated that when farming systems are abstracted for analysis, the purpose is to facilitate explorations into the likely effects of new technology refinements of existing practices.

In any farming enterprise management is the key to success. Record keeping, including performance testing, is a basic requisite for the decision making process (Siertsema, 1975). Van Wyk (1980) stated that more purposeful management-extension must play an important role in raising the technical level, as well as the profitability, of sheep production. McClymont (1976) propagates adapted systems, which are economically sound, ecologically sound, and socially acceptable to the ultimate practitioners.

Where, in the past, research problems were investigated in isolation (components), this currently requires an holistic approach (systems). Animal production is interwoven into agriculture in general, as well as the marketing and industrial aspects thereof, to such an extent that research is getting progressively more complicated.

The different aspects that need to be addressed in systems research are (Hofmeyr, 1982):

- The interaction between the animal and its total environment, in other words, animal science ecology.
- All aspects regarding the control and manipulation of growth, reproduction and production of farm animals.
- Animal nutrition - the feeding of the animal during all its physiological stages.
- Advanced livestock management (health, housing, etc.).
- Marketing and handling of animal products.

The successful determination of a strategy must primarily be based on a thorough knowledge of all the elements that will impact on the achievement of this goal. The system eventually decided upon must be adapted with the given farming conditions (Louw, 1978). Agriculturists have a significant and urgent role to fulfil in classifying the arable land in different potential classes and also to develop adapted farming systems. Schulze (1997) stated that, due to topography and geology, vast regions that this area consists of veld, while been characterised by a temperate climate. The regional classifi-

cation of animal production systems implies that, because most factors interact favourably with a specific situation, certain production systems can be run more effectively in these areas (Luitingh, 1978). Resource experts of the former Highveld Region of the Department of Agriculture have made considerable progress with the classification of soils and division of the region into homogenous farming areas (Scheepers, Smit & Ludick, 1984). Consequently the development and implementation of biologically and economically efficient farming systems are the next logical steps.

Increased animal production causes an increased demand for stock feed and this necessitates a planning strategy for the efficient utilisation of this limited resource. In the implementation of a feeding strategy, further research is necessary regarding the following aspects. This will consequently lead to the development of an economic grazing- and fodder crop system that will eventually manifest higher production in ruminants (Luitingh, 1978): -

- Leguminous plants, -cultivars, production requirements and use.
- Supplementation.
- Management and/or utilisation strategy.
- Integration in the total farming system.
- Economic evaluation of the different systems.
- Mechanisation.
- Stored hay, silage and its economics.
- Animal response on the utilisation strategy, intake and digestibility, and other related matters.

It is a known fact that sufficient, balanced nutrition is the most important input in animal production (Van Marle, 1976) and thus an effective feeding strategy is of the utmost importance and should receive the highest priority. According to Van Marle (1982) the different aspects that should receive attention are:

- Availability of feed sources (fodder flow planning throughout the year).
- The chemical composition of the different feeds and its nutritional value for the animal.
- Ruminants, which compete to a lesser extent with man for the different feed sources, are involved.
- The different physiological requirements of the animals regarding maintenance, reproduction and production requiring different levels and composition of rations.
- The increased levels of production caused by the genetic improvement of the farm animals also causes a continual change in nutritional requirements regarding level of feeding and ration composition.
- The influence of topography, climate and soil on the quantity and quality of natural pastures.

- The possibility of radical veld improvement by means of fertilisation, sowing-in and planting of pastures (Theron & Harwin, 1976; Wasserman, 1979; Wasserman, 1981; Henning & Barnard, 1982; Cilliers, 1984).
- The cultivation, storage and utilisation of fodder and other crops (Laas *et al.*, 1981; Van Pletzen *et al.*, 1991).
- The utilisation of by- and waste products of related industries (Hofmeyr & Jansen, 1976).

Continuous work has been done on both the biological and economical aspects of animal nutrition, as well as the advantages associated with certain feeding regimes. Despite this, it can be stated that the implementation of sound economic feeding principles leaves much to be desired and much scope for improvement still exists. A classic example of this is a single nutritional aspect, namely the wintering of animals, accompanied by the production losses resulting in a loss of income for the farmer (Luitingh, 1978).

According to Verbeek (1982) long- and short term droughts will occur periodically and the uncertainty of the climate, with accompanying variation in the production of the vegetation, as well as that of the animal, necessitate stabilisation of production by means of supplementary feeding, alternative feeding strategies and other relevant aspects.

The Western Highveld is an important maize producing area where the cultivation of maize is practised on high potential soils. The introduction of animal production (as has already been mentioned) with the utilisation of maize and maize products and/or residues, in bridging the wintering problem, is of great importance. Van der Merwe *et al.*, (1985) concluded that, the development of the small stock industry as an integral part of the farming enterprise in the cropping areas, could be readily expected in the near future. Verbeek (1982) emphasised the utilisation of crop residues to bridge the winter feeding problem. Le Riche (1982) stated that the quality of the soil deteriorates if the crop residues or animal waste is not, directly or indirectly, made available to the soil. Louw (1978) also advocates the maximal use of crop residues for larger inclusion of the animal factor into crop production enterprises.

McClymont (1976), as quoted by Luitingh (1978), stated that the energy quotient (in other words the amount of additional energy necessary to produce a given amount of feed energy) must be as low as possible and gives the following production systems in a descending order of energy requirements:

- animal production from intensive ( grain) systems.
- artificial products, e.g. meat from soybean products.
- animal products produced from improved, fertilised veld.
- animal products from veld.

Silage in the feeding of sheep, in particular, was also investigated. Aspects such as wintering (Bosman *et al.*, 1967), maintenance (Swart *et al.*, 1971) and lactation (Coetzee & Dyason, 1967; Reyneke, 1967) received attention. Various authors also investigated silage in the finishing of sheep (Reyneke, 1971; Boshoff *et al.*, 1977; Boshoff *et al.*, 1979; Agbossamey *et al.*, 1998; Cilliers *et al.*, 1998). Unal *et al.* (1987) investigated the potential of silage for wool production. Boshoff *et al.*, (1980) suggested that maize farmers could finish lambs on maize silage for slaughter lamb production as an alternative farming enterprise in the Western Highveld. Esmail (1999), however, cautioned against the deficiencies of maize silage, especially for high producing animals, and suggested supplementation in correcting these problems.

Van Niekerk & Schoeman (1993) also accentuated the advantage of crop residues. Seen in the light of its potential value, the time of the year that it becomes available, as well as the fact that it has limited commercial value other than utilisation by animals, this is an invaluable feed source. Maize crop residues also received ample attention (Van Pletzen *et al.*; 1991, Schoonraad *et al.*, 1988a; Esterhuysen *et al.*, 1991a; Snyman *et al.*, 1993). Gertenbach *et al.* (1998) found that, although the highest proportion of maize crop residues was utilised by sheep alone, the introduction of cattle, realised higher mass gains/ha. Schoonraad *et al.* (1988b) concluded that maize crop residues can be successfully used as a roughage source for woolled sheep if both energy and protein are supplemented. It is desirable that crop residues be grazed as soon as possible after harvesting, before weathering decreases quality (Esterhuysen *et al.*, 1991b).

The role of cultivated pastures also received much attention in research (Rethman & Gouws, 1973; Dannhauser *et al.*, 1986; Dannhauser, 1988; Meissner & Paulsmeier, 1988; Brand & Van der Merwe, 1994; De Villiers *et al.*, 1994; Brand *et al.*, 1997; Van Vuuren *et al.*, 1997a,b; Kirkpatrick & Steen, 1999). The research mainly focused on bridging the dry periods of the year, with its feed shortages, and the building of a fodder bank. According to Meissner *et al.* (1989), the production potential of sheep grazing cultivated pastures is more a function of qualitative than of quantitative intake. McDonald (1971) concluded that at that stage, nutritional research under pasture conditions still has many gaps, because of the fact that it is more complex than research under controlled conditions due to the many variables that have an influence, either direct or indirect, e.g. rainfall and season. Cultivated pastures can also be used with great success in the finishing of animals (Van der Merwe *et al.*, 1985; Hyam *et al.*, 1981; Langholz, 1976).

Van Marle (1982) stressed the importance of adapted farming systems to local environmental conditions. After all, apart from the primary function of food production, the primary goal of agriculture is to create a balance between the different enterprises facilitating efficient farming enterprises (De Wet, 1980). Even in high potential areas, marginal soils must be withdrawn from cash crop production and rather be used for cultivated pastures or the cultivation of fodder crops. This may create the possibility of increasing stock numbers with the consequent stabilisation of the cattle enterprise by alleviating



the winter nutritional problem - one of the main problems regarding stock farming in the Western Highveld. This will also enhance stability in the total farming enterprise, accompanied by the reduction in the risk involved (Slabber, 1982; Van Wyk, 1980). Mohr (1975), as quoted by Luitingh (1978), stated that 25 - 30 % of the soils being used for maize production at that time, should be withdrawn and should rather be used for fodder crops or cultivated pastures. Regarding intensification, this must inevitably be accompanied by a rise in biological and economical efficiency (De Wet, 1980).

Reed (1977) stated that high quality forage has a high concentration of net energy and is consumed in large amounts per unit of time. Such forage is usually the cheapest source of energy for animals. Protein in home-grown legume forages is also less expensive than that provided by any other source. Carter & Day (1970) stressed the importance continuous evaluation of certain inputs, for example the fertilising of cultivated pastures, seen against increasing cost of production vs. relatively constant prices for animal products.

As early as 1945 Penzhorn investigated the possibility of winter cereal pastures in the Western Highveld (Penzhorn, 1945). Various other authors also investigated this feed source (Fair & Reyneke, 1972; Van Heerden & Reyneke, 1974; Radcliffe *et al.*, 1983). Jordan & Mayer (1989) showed the important role that milk yield exerts in determining growth rate of Merino lambs. Reyneke (1971), however, pointed out that, owing to uncertain rainfall and other climatological factors, green pastures cultivated under dryland conditions, would not be a viable option for these highveld areas and stressed the need for alternative feeding systems in case of pasture failure. Less than 1 % of the area of former Highveld Region (Agricultural Development Programme, 1981) were irrigated. Therefore, this feed source was not considered a viable option. Steenkamp (1979) recommended an investigation into the economic viability of intensive sheep production systems with limited introduction of cultivated pastures.

In the past nutritional research on veld was primarily directed at the chemical composition of the veld as well as conventional intake- and digestibility studies (Swart *et al.*, 1963; Van Schalkwyk *et al.*, 1968). Grazing material collected by hand, according to human judgement, show serious protein and phosphorus deficiencies (Du Toit *et al.*, 1940 a,b; Niemann *et al.*, 1963). The free grazing ruminant, however, has a range of plants to choose from and will give preference to certain plants. The chemical composition of material selected by the ruminant differs from the hand-collected samples as it has a higher digestibility and more favourable chemical composition (Van Dyne & Heady, 1965; Engels, 1972). In this regard Engels & Malan (1973) found that material selected by sheep contained, on average, 125.7 % more crude protein and 43.4 % more digestible nutrients. McDonald (1968) rightly suggested that pasture research should be performed under practical grazing conditions.

Approximately 85 % of the RSA's surface area consist of veld (Hugo, 1975; Van Marle, 1982; Engels, 1983, De Waal, 1990). In the Highveld Region this figure is approximately 55 % (Agricultural Devel-

opment Programme, 1981). This pasture is, with a minimum of subsidised energy, able to produce animal products. The ruminant is the only available means able to exploit the astronomic amount of energy that is deposited by the sun on the veld (Le Riche, 1982). According to McDonald (1971) a large majority of the world's ruminants are dependent on natural pasture for their existence.

Since the classical work of Du Toit *et al.*, (1940 a,b) on the nutritional value of the veld, extensive research has been conducted in determining nutritional value of the veld. In the Western Highveld, in particular, this has recently been extensively researched by various authors (Engels, 1983; Cilliers, 1984; Schutte, 1987; De Waal & Biel, 1989; Schutte, 1994; De Brouwer, 1998; De Brouwer *et al.*, 2000). De Waal & Combrinck (2000) stated that the quality of grass veld usually declines with the onset of winter, but sheep are still able to select herbage with a fairly high quality. However, these authors concluded that animal performance is often affected by an insufficient intake of digestible nutrients.

De Wet (1980), Joubert (1980) and Nel (1980) have shown that the marginal areas can successfully produce mutton and wool. According to Du Toit (1984) the continued rise in the price of animal feeds, will result in the fact that marketing from the veld will get more and more important.

With the important role that the veld has to play, it is essential that this vulnerable resource must, by means of sound and sensible veld management practices, be protected against over-exploitation and degradation. Hugo (1975) found that, should the number of sheep kept per unit area of veld be reduced, the following advantages would be achieved: better fleeces will be produced, higher lambing percentages, higher mass gains per hectare and veld deterioration would be delayed or checked. He also stated that the emphasis should be on the optimal utilisation of the available agricultural resources and regard the natural vegetation as the corner stone of the wool sheep industry.

According to Van Rooyen (1979) veld must be protected and utilised in the most economical way otherwise the veld, the farming industry and the farmer will perish. Incorrect utilisation of the veld in the past led to its deterioration, which is a further contributing factor responsible for reduced animal production (Meissner, 1982; Verbeek, 1982). Arnold (1964) found that when the grazing material preferred by sheep is getting limited, feed intake is reduced and the animal spend more time looking for food. Brand (2000) concluded that Merino sheep concentrate more on grass as part of their diet, compared to Dorper sheep. When the grazing became limited, Merinos spent more time (and energy) in selecting suitable material. This inevitably led to an increased trampling effect for Merinos. Booysen (1980) concluded that effective pasture management is essential for the improvement of the veld condition.

Wintering and especially specific deficiencies that exist, regarding extensive sheep farming, as well as other ruminants which are dependent on the veld, are some of the problems experienced in the

Western Highveld (Coetzee, 1967; Agricultural Development Programme, 1981; Verbeek, 1982; Engels 1983).

Van Rooyen (1979) alleged that, due to the fact that dry grassveld are insufficient to fulfil the needs of the grazing animal (especially during winter), it is possible to keep animals on veld in the summer rain cropping areas only if some or other supplementation is supplied.

Deficiencies during certain parts of the year can be successfully counteracted by the supply of rumen stimulating licks (Bischopp, 1964; Coetzee, 1964; Louw, 1978; Louw, 1979) or the provision of supplementation (Kemmer & Coetzee, 1967; Engels & Malan, 1973; De Waal *et al.*, 1981; Henning & Barnard, 1982; Henning & Barnard, 1991). Van der Merwe (1967) also stated that thousands of heads of cattle and sheep enjoy supplementary feeding through the harsh winter months.

Much research has been done on the nutrient requirements of animals during the various production stages. Supplementation, or an increased feed supply during the late pregnant and lactation periods, remains one of the cornerstones of successful sheep production (Schinckel & Short, 1961; Peart, 1967; Hodge *et al.*, 1983; Engels, 1969; Engels, 1972; Steenkamp 1979; NRC, 1985; De Waal & Biel, 1989; Van Wyk & Pretorius, 1990; Holst & Allan, 1992; McNeill *et al.*, 1997; McNeill *et al.*, 1998). De Villiers *et al.* (1993) stressed the importance of liveweight of the ewe in lamb survival, while Jainudeen & Hafes (1980) stated that more than one half of the increase in fetal weight occurs during the last trimester of pregnancy. Cloete & Brand (1990) cautioned that economic benefit of supplementation couldn't readily be assumed and alleged that there is merit in the assessment of the adequacy of supplementation on an objective basis.

The effect of compensatory growth regarding both wool- (Van Wyk & Pretorius, 1990; Holst & Allan, 1992; Robertson *et al.*, 2000) and meat (Greeff *et al.*, 1990; Van Wyk & Pretorius, 1990; Marais *et al.*, 1991a) production were also thoroughly investigated. Marais (1988) investigated the influence of compensatory growth on efficiency of feed utilisation and carcass composition.

The production of farm animals can also be enhanced by the strategic utilisation of available feed sources, such as flushing, creep feeding, etc. Regarding creep feeding, Santra & Karim (1999) concluded that lambs depend solely on the milk production of the dam from birth up to seven days of age and thereafter start nibbling and this gradually increases up to the fourth week. Creep feed is generally provided to lambs one week after birth to stimulate early rumen development and supplement their nutrient intake for faster growth (Hamada *et al.*, 1976). However, much controversy exists about the crude protein (CP) -content of the creep feed. Santra & Karim (1999) recommended a CP level of 18 %. Sawal *et al.* (1996), quoted by the same authors, found a CP level of 11 % to be adequate. Coetzee & Vermeulen (1966) with work done on the Western Highveld used a creep feed with 9.2 % CP, while CP-content that Susin *et al.* (1995) recommended, were 14.4 %.

Post wean lambs were subjected to various feeding regimes ranging from shrubs, maize crop residues, wheat straw, veld, dryland pastures (such as lucerne), maize silage up to irrigated winter cereal pastures and complete rations utilising various concentrate sources (Arnold, 1964; Fair & Reyneke, 1972; Van Heerden & Reyneke, 1974; Boshoff *et al.*, 1977; Boshoff *et al.*, 1979; Boshoff *et al.*, 1980; Hofmeyr *et al.*, 1982; Radcliffe *et al.*, 1983; Seed, 1983; Freer *et al.*, 1985; Schoonraad *et al.*, 1988b; Brand *et al.*, 1990; Cronjé & Weites, 1990; Brand *et al.*, 1991; Van der Merwe & Nel, 1991; Brand & Van der Merwe, 1994; De Villiers *et al.*, 1994; Agbossamey *et al.*, 1998; Kirkpatrick & Steen, 1999; Preziuso *et al.*, 1999). As far as the CP-content of the post wean and finishing rations are concerned, the majority of the authors prescribed a 14 % CP-content, while that of the finishing ration could be reduced to 11 % with the energy content being increased (Boshoff *et al.*, 1980; Van Vuuren & Nel, 1983 a,b; Cronje & Weites, 1990; Brand *et al.*, 1991; De Villiers *et al.*, 1993; Brand & Van der Merwe, 1993; Manso *et al.*, 1998). Andrews & Ørskov (1970) found that a lower protein content of the ration during the final stages of finishing enhances fat deposition and consequently a higher grading could be obtained.

In the case of pastures, natural or cultivated, this means that it should possess sufficient quality.

A low lambing percentage is one of the major problems facing the South African small stock industry (Van Rooyen, 1979; Le Riche, 1982). Le Riche (1982) found that, in order to bring about a significant improvement in the sheep industry, it is essential to identify and eliminate these weak links in the production sequence. The following aspects need to be addressed:

- fertility tests before the mating season,
- correct breeding season,
- lick supplementation,
- performance testing,
- selection and
- record keeping.

Engels & Malan (1979) stated that the main aim of any farming enterprise is a high reproduction rate. The reproduction rate of the ewe is mainly determined by the level of nutrition (in other words to what extent her requirements are being met). This is why the genetic potential of the ewe can only be manifested if the feed supplied contains the necessary, balanced nutritional substances. De Wet (1980) stated that a rise in the level of feeding is essential for any genetic progress to be utilised. Cloete & Scholtz (1998) reported that even a very intensive management system failed to reduce lamb mortality in South African Mutton Merinos and Dormers below 15 %.

The key problem of any animal production enterprise lies with sound feeding- and management practices (Van Rooyen, 1979). When a combination of lambing seasons are practised, effective fodder flow planning is an essential prerequisite (Marais, 1974; Nel, 1980). A high level of feeding reduced the age at the onset of puberty, while wool production had no influence on oestrus or the onset of puberty (Hugo *et al.*, 1982). Du Plessis & de Wet (1981) found in a comparison between Merinos, Dohne Merinos and South African Mutton Merinos (SAMM), that the Merino lambs were the most efficient utilisers of nitrogen for wool protein formation and the SAMM lambs for body protein formation.

As far as adapted farming systems are concerned, attention must also be given to adapted breeds within a specific area. Crew (1932), as quoted by Bonsma & Joubert (1957), stated that in the breeding of cattle, a problem exists as to the definition and creation of a biological type that harmonises with a given environment. Roux (1980), as quoted by Olivier (1982), stated that the relationship between wool- and non-wool breeds in the extensive sheep farming areas stabilised on a proportion of 50:50. In extensive sheep grazing areas, the Merino still remains an important sheep breed. Concerning lambing seasons, Barton (1984) stated that in South Africa lambing might occur in autumn, as well as in spring. Many wool production enterprises are based on Merino ewes. Besides wool, these ewes also produce their own replacements, castrated lambs, ewe lambs in excess to those required to maintain flock numbers and ewes which have been culled for reasons of age, defective teeth or other reasons. This author also postulates that the Merino is one of the few breeds that will mate at various times of the year.

Erasmus (1986) stressed that the Merino should be adapted to utilise its mutton production potential, without neglecting its wool production potential. Regarding the total productivity of the woolled sheep, Nawaz *et al.* (1992) stressed that when a species produces more than one commodity, such as meat and wool in the case of the Merino, overall productivity estimates must encompass all outputs. The fleece of the ewe is as important product as the weaned lamb. Meissner (1993) stated that regarding finishing, whilst the Merino is not the ideal feedlot type, income from wool can be a substantial additional benefit.

Various researchers investigated the possibility of mutton production from woolled sheep (Coetzee & Vermeulen, 1967; Cloete *et al.*, 1975; Boshoff, 1980; Cronje & Weites, 1990; Greeff *et al.*, 1990; Van Wyk & Pretorius, 1990). Van Niekerk & Schoeman (1993) concluded that mutton production holds advantages in the sense that response time to market influences is half that of beef production. These authors further stated that Merino and Merino types, by virtue of their numbers, supply the greatest proportion of mutton and lamb.

Griessel, (1979) proposes increased production of mutton through intensification by implementing the following strategies:

- A change in flock composition.
- An increase in the lambing and weaning percentage.
- Improvement of the general feeding- and management practices.

Breeding-, production- and marketing strategies have to accommodate the ever-changing requirements with regard to demand, consumer needs and consumer preferences. Arsenos *et al.* (2000) stated that despite the extended and continuous research on growth, development and meat production in sheep, there is little information concerning the overall quality of the final product. The grading regulations with regard to red meat, applicable since 1982 and which were superseded by the classification system of 1994, are examples of this. In the past research was done to determine the optimum marketing stage (Coetzee *et al.*, 1971), as well as the finishing and correct marketing stage of both young (Fair & Reyneke, 1972; Vosloo, 1975; Butler-Hogg *et al.*, 1984) and older cull animals (Van Niekerk *et al.*, 1965; Du Plessis, 1966; Du Plessis & Venter 1967; Troskie, 1968; Van Vuuren *et al.*, 1983c). These results had to be adjusted for the new regulations. Marais *et al.* (1991b) also investigated the effect of compensatory growth on carcass composition and fat percentage.

As far as wool production are concerned, nutritional research concentrated on the extent to which the level of feeding can be reduced, especially during certain times of the year, without causing a harmful effect to the wool production and wool quality (Schinckel & Short, 1961; Donnelly, 1984; Denney *et al.*, 1988; Schoonraad *et al.*, 1988a; Van Wyk & Pretorius, 1990; Robertson *et al.*, 2000). Masters *et al.* (1998) stated that both the initial liveweight at the start of their trial and liveweight change influenced the staple strength and wool growth. Langlands & Bennet (1973) concluded that fibre diameter was reduced by more harsh feeding conditions. White *et al.* (2000) concluded that the penalties associated with tender wool, caused by the thinning of the wool during times of the year when herbage supply is limited. These authors stressed the evaluation of supplementary feeds in terms of their ability to promote wool growth.

Up to this point research done locally was largely fragmented (component research) where different aspects were investigated. With the current study a more holistic approach, regarding woolled sheep farming, were followed where many of the problem areas, which are interwoven, were being addressed. The biological and economical efficiency of woolled sheep utilising various feed sources prevalent in the Western Highveld of South Africa were investigated. These sources include silage, foggage/maize crop residues and winter veld during the winter period, while cultivated pastures and veld were used during summer. A similar study was executed with beef cattle (De Brouwer, 1998) and as no similar work has been done with small stock, it was decided to conduct this study.

Part 1 of this study focused on the evaluation of *Digitaria eriantha* Steud. (Smuts Finger grass) as cultivated pasture for woolled sheep. Chapter 1 discussed the wintering aspect. In the second chapter it was evaluated as a summer pasture crop.

Part 2 dealt with the effect of three different wintering strategies on the biological performance of animal performance in an autumn lambing season. Chapter 1 focused on the adult animals, while Chapter 2 discussed the performance of their progeny.

Part 3 concerned the performance of the animals in a spring lambing season. Chapter 1, once again focused on the adult animals, while the second chapter dealt with their progeny (pre-wean, post wean, replacement ewes and finishing lambs).

In Part 4 the economical evaluation of the three wintering systems of both lambing seasons, based on their biological performance (discussed in the preceding chapters), has been dealt with. The economical evaluations were done up to a gross margin (GM) level. The various wintering treatments were evaluated in terms of GM/small stock unit (SSU), GM/ewe and GM/ha.

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# **PART 1**

**The utilisation of *Digitaria eriantha* Steud. for woolled sheep in the Western Highveld.**

# Chapter 1

## The wintering of young ewes on *Digitaria eriantha* Steud. pasture.

### INTRODUCTION

The poor quality of winter veld in the sour veld areas, as well as its detrimental effect on extensive sheep farming, is well-documented (Jacobsz *et al.*, 1971; Henning & Barnard, 1982; Verbeek 1982). Coetzee *et al.*, (1968) also stressed the adverse effects on wool production and reproduction.

As possible solutions to this problem the following have been suggested: rumen stimulating licks (Louw, 1979), protein supplementation during the winter months (Bekker & Stoltz, 1983), utilisation of crop residues (Schoonraad *et al.*, 1988), silage feeding (Coetzee & Vermeulen, 1967), veld fertilisation (Booyesen, 1980; Rethman, 1984), introduction of legumes (Graven *et al.*, 1968), a fodder bank (hay) (Jones, 1983; Dannhauser *et al.*, 1986) and foggage (I'Ons, 1968; Rethman & Gouws, 1973).

Le Riche (1982) alleged that the role of cultivated pastures to bridge the dry periods of the year, with its accompanying feed shortages, has not been well exploited. The cultivation of pastures, especially on low potential soils, for utilisation during these periods is important and this aspect deserves much more attention.

Research done regarding the utilisation of foggage by woolled sheep, especially in the lower rainfall areas, is limited. Dannhauser (1988) suggested that *Digitaria eriantha* (Smuts finger grass) as foggage can play an important roll in the wintering of livestock. Rethman (1984) stressed the fact that foggage must be seen as a low cost feed for the wintering of ruminants.

The object of this study was to determine the potential of *Digitaria eriantha* (Smuts finger grass) as foggage for woolled sheep at different stocking rates. Dannhauser (1988) dealt with the pasture aspects of this study (dry matter production, chemical analysis, etc.).

## PROCEDURE

The trial was carried out with young Dohne merino ewes under dryland conditions on a low potential Avalon 3100 soil type (Soil Classification Working Group, 1991) on the experimental farm Noyjons of the North West Agricultural Development Institute, Potchefstroom. The long-term average (Ita) rainfall for this region is approximately 640 mm/year (Institute for Soil, Climate and Water, 1989).

Although the trial was originally planned to start during 1982 and continue for three consecutive seasons, the low rainfall during some seasons resulted in an insufficient quantity of grazing material. Data was not collected during 1982 and 1984, but only during the seasons of 1983, 1985 and 1986. At the beginning of each season twenty year-old Dohne merino ewes were randomly allocated to four groups (5 animals/treatment).

In an attempt to determine the stocking rate of Smuts finger grass that can be applied at different stages of the winter period, the total duration of the trial (180 days) was divided into four grazing cycles of 45 days each:

Grazing cycle 1: 15th May - 30th June

Grazing cycle 2: 1st July - 15th August

Grazing cycle 3: 16th August - 30th September

Grazing cycle 4: 1st October - 15th November

During each of the different grazing cycles (45 days) four different stocking rates were applied. Camp sizes differed in order to obtain these stocking rates. The stocking rates that were applied were the following (camp sizes are given in parenthesis):

Stocking rate 1: 8,3 sheep/ha (0,6 ha)

Stocking rate 2: 16,6 sheep/ha (0,3 ha)

Stocking rate 3: 25,0 sheep/ha (0,2 ha)

Stocking rate 4: 33,3 sheep/ha (0,15 ha)

The trial was thus divided into 16 camps for utilisation during each season. If extrapolated to a grazable period of 180 days (winter) the respective stocking rates were 2, 4, 6 & 8 sheep/ha for a six-month period.

Approximately seven days after the commencement of each grazing cycle during the various seasons oesophageal fistula extrusion samples of the pasture were collected. Three samples for each stocking rate were collected. Samples were analysed for *in vitro* dry matter digestibility (IVDMD) according to the method of Tilley & Terry, (1963) as modified by Engels & van der Merwe, (1967) and nitrogen



(Clare & Stevenson, 1964) for the calculation of crude protein (CP). These results are presented by Dannhauser (1988).

Fertiliser was applied annually (during August) at a level of 120 kg N + 20 kg P/ha. The fertilisers used were limestone ammonium nitrate (LAN) (28 % N) and superphosphate (11,3 % P).

The results for each of the three different seasons ('83, '85 and '86) were analysed separately as a 4 x 4 factorial design with four stocking rates, as well as four grazing cycles (Steel & Torrie, 1960).

Fasting mass (16 hours without food or water) was determined at the start and end of each grazing cycle, while the animals were also weighed every fortnight.

Due to the fact that these animals were utilising winter grazing, a protein lick (42 % crude protein) with the following composition was supplied to the animals:

Groundnut oilcake meal	40 %
Salt	30 %
Dicalcium phosphate	15 %
Urea	10 %
Molasses	5 %

The average lick intake was determined fortnightly.

## RESULTS AND DISCUSSION

### Rainfall

The average monthly rainfall for the different seasons and the preceding summer months, as well as the long term average (Ita) for 74 years (1913 - 1986), are shown in Table 1.

Grobler (1956) recommends a minimum of 600 mm of rain per year for optimal animal production from Smuts finger grass. The distribution during the season also plays an important role. From Figure 1 it is evident that a lower rainfall occurred during all the seasons compared to the quantity needed for optimum animal production. This was in contrast with the Ita, which was even higher than the recommended minimum per year. During the season prior to the trial (1982) the pasture was hayed during January, as is recommended to produce high quality foggage. The season was, however, very dry which resulted in insufficient regrowth and, therefore, grazing material. Subsequently the pastures were not hayed during the remainder of trial.

TABLE 1 Average monthly rainfall (mm) during the various seasons.

Month	Year			
	1 (82/83)	2 (84/85)	3 (85/86)	Long term average
October	109,7	70,5	51,9	45,5
November	18,8	104,2	33,9	79,2
December	69,4	54,4	103,3	113,5
January	69,8	91,8	112,1	112,5
February	130,7	73,4	45,3	94,4
March	14,2	86,4	80,6	86,3
April	18,6	4,4	28,6	47,3
May	28,3	9,0	0,0	20,1
June	6,3	0,7	14,6	8,5
July	22,6	0,0	1,7	7,9
August	1,8	0,3	56,3	8,0
September	0,1	7,8	11,1	16,3
October	95,0	51,9	51,5	45,5
<b>TOTAL</b>	<b>585,3</b>	<b>554,8</b>	<b>590,9</b>	<b>685,0</b>

During the 1983-season (Year 1) the rainfall was approximately 100 mm lower than the Ita. Due to the limited amount of grazing available, the animals could only stay on the foggage for limited periods that varied between 26 and 37 days during the different grazing cycles of this season (as specified later).

Although the total rainfall during the 1985-season (Year 2) was much lower than the Ita, it was almost similar to the Ita during the active growing season of the grass. During this season 87 % (485 mm) of the total rainfall occurred from October to April compared to approximately 75 % ( $\pm$  440 mm) for the other two seasons. This was the only season in which there was enough grazing available for all the animals to stay in the camps for the duration of the trial. In this instance followers had to be used for all stocking rates to clean up excess grass.

The lower rainfall ( $\pm$  100 mm less than the Ita) of the 1986-season occurred during the growing season and this had the result that the sheep of the highest stocking rate (33,3 sheep/ha) could not graze the pasture for the duration of the different grazing cycles.

## Dry matter digestibility and crude protein content

The mean IVDMD and the CP-content of the pasture samples obtained by oesophageally fistulated animals for Grazing cycles 1 to 4 over the various seasons were: 52.2, 9.4; 46.9, 9.3; 51.0, 10.7 and 60.4 and 14.7 respectively (Dannhauser, 1988). Although it appears from these results as if the quality of the pasture during the different seasons was adequate for maintenance and that a salt-phosphate lick would have been sufficient, it must be kept in mind that these are mean values. During certain cycles of some seasons, especially those with relatively high rainfall, the digestibility of the pasture was low which necessitated supplementation with a rumen-stimulating lick. Despite this, animal performance was disappointing - mainly because of the limited quantity of grazing (as discussed later). The animals were removed from the trial when the available grazing was insufficient and a mass loss occurred. Rethman (1984) reported disappointing results with Smuts finger grass foggage that had been rested since January/February. The mass gain of the sheep was, however, satisfactory (50 - 60 g/day) when the grass was cut during March but the grazing capacity of the foggage was lower due to the fact that only 50 % of the potential production of the grass were available.

## Mass change

### *Period of grazing*

Due to the below average rainfall and the poor distribution, the planned grazing periods (45 days) could not always be realised (Table 2). Therefore, an analysis between grazing cycles within a specific year was not possible. However, with the exception of the first grazing cycle of Year 1, the grazing periods within a specific year were comparable and consequently the effect of grazing cycle on animal performance for the three different seasons could be compared statistically.

The average daily gains (ADG) of the animals during the different grazing cycles of the three trial seasons (with the number of grazing days in parenthesis) are shown in Table 2.

The differences ( $P < 0.05$ ) between Grazing cycle 1 (mass loss) and Grazing cycles 2 and 3 (mass gain) during the first year (83-season) (Table 2), possibly point to the fact that grazing material was limited for all stocking rates and animals remained on the grazing too long. Meissner & Paulsmeier (1988) found a negative ADG with sheep on Smuts finger grass for the months July to mid September, whereas the animals had a positive ADG after first spring rain. The poor growth rate during the fourth grazing cycle of Year 1 is possibly due to the fact that sheep grazed the young growth, of which the quantity was still insufficient, and did not graze enough foggage to satisfy their requirements.

**TABLE 2** Average daily gain per sheep (g) of the animals during the different grazing cycles (number of grazing days in parenthesis).

Year (Y)	Grazing cycle (G)				
	1 (15/5-30/6)	2 (1/7-15/8)	3 (16/8-30/9)	4 (1/10-15/11)	Ave. (Y)
1 (1983)	-25.3 <sup>a</sup> (37)	28.6 <sup>b</sup> (27)	34.1 <sup>b</sup> (28)	4.6 <sup>ab</sup> (26)	10.01 (30)
2 (1985)	49.7 <sup>a</sup> <sub>wx</sub> (45)	52.2 <sup>a</sup> <sub>w</sub> (45)	15.1 <sup>b</sup> <sub>xy</sub> (45)	-41.3 <sup>b</sup> <sub>y</sub> (45)	18.59 (45)
3 (1986)	2.0 <sup>a</sup> (43)	21.3 <sup>ab</sup> (41)	12.1 <sup>ab</sup> (42)	31.3 <sup>b</sup> (41)	16.54 (42)

<sup>a-d</sup> Values in the same row with different superscripts differ significantly ( $P < 0.05$ )

<sup>w-z</sup> Values in the same row with different subscripts differ highly significantly ( $P < 0.01$ )

During Year 2 (85-season) this tendency was repeated when the ADG during Grazing cycle 3 was lower than during Grazing cycles 1 ( $P < 0.05$ ) and 2 ( $P < 0.01$ ). The mass loss during Grazing cycle 4 differed ( $P < 0.01$ ) from the mass gains of Grazing cycles 1 and 2. Rethman (1984) found that animal performance during the spring months (September/October) was disappointing and recommended an alternative feed source for this period, whereas Meissner & Paulsmeier (1988) also recorded a mass loss during October/November.

During the third season (1986) the sheep maintained their mass during all the grazing cycles and even showed a slight mass gain. The limited number of grazing days must, however, be kept in mind since the animals with the highest stocking rate could not stay in the camps for the whole period. The high rainfall that was recorded during August 1986 (Year 3), resulted in early growth of the grass. There was already enough green material available during the fourth grazing cycle with the result that the animals' ADG during this period was significantly higher ( $P < 0.05$ ) than that of the first grazing cycle (Table 2).

### ***Mass gain per hectare***

As far as mass gain per hectare is concerned, three factor interactions ( $P < 0.01$ ) between the main effects, as well as interactions ( $P < 0.01$ ) between Year and Grazing cycle, and Grazing cycle and Stocking rate, occurred. This was probably due to the variation in and the below average rainfall (as discussed earlier), which resulted in the fact that the animals could not, for most of the grazing cycles, stay on the pastures for the planned period.

(as discussed earlier), which resulted in the fact that the animals could not, for most of the grazing cycles, stay on the pastures for the planned period.

Due to these interactions the total live mass gain/ha of the animals were only compared statistically within each grazing cycle of the different seasons and are presented in Table 3.

The initial loss of mass during the first grazing cycle of Year 1 (Table 2) resulted in a negative mass change per hectare for all stocking rates (Table 3). Although differences between stocking rates were detectable during Grazing cycles 1 and 2, these differences were not statistically significant ( $P > 0.05$ ), possibly because of larger variation. During the third grazing cycle (16/8 - 30/9) of Year 1 the total mass gain of the animals on the highest stocking rate (33.3 sheep/ha) were better ( $P < 0.01$ ) than that obtained with 16.6 sheep/ha. In contrast, exactly the opposite occurred during the fourth grazing cycle (1/10 - 15/11). This was possibly due to the relatively high rainfall during October ( $\pm 50$  mm above the lta) resulting in the sprouting of grass and the consequent lack of sufficient foggage utilisation.

During the first grazing cycle of the second season (1985) the total mass gains/ha of the animals on the heaviest stocking rate (33.3 sheep/ha) was higher ( $P < 0.05$ ) than that of the animals on Stocking rates 1 (8.3 sheep/ha) and 3 (25.0 sheep/ha). The gain/ha of the animals on the different stocking rates during the second grazing cycle of this season did not differ significantly. During the third grazing cycle the animals on the heaviest stocking rate gained significantly ( $P > 0.05$ ) more per hectare than the animals on Stocking rate 2. The mass gains of the animals during the fourth grazing cycle (which were negative for all the stocking rates), clearly show the effect of a rise in stocking rate. Where the available amount of grazing was limited, the higher stocking rates caused a greater ( $P > 0.05$ ) loss of mass.

During the third season (1986) there were no significant differences in the mass gain/ha among the different stocking rates during any of the grazing cycles.

### ***Stocking rate***

Despite shorter grazing periods during the first season (Table 2), the animals of the highest stocking rate lost mass (Table 3), whereas the best average gain/ha occurred at this stocking rate during the other two seasons. The poor distribution of the rainfall probably also contributed to this result. In this regard it is evident from Table 3 that the early rainfall during the third season (August, September and October), had the effect that the amount of young growth at this stage was already sufficient for the animals to maintain their mass and even show a slight gain/ha. Consequently these animals, in contrast with the other two seasons, showed the best gains/ha during the fourth grazing cycle.

TABLE 3 Total live mass gain (kg/ha) of the animals at the different stocking rates during the three different seasons.

YEAR 1 ('83-season)						
Grazing cycle (G)	Stocking rate (S) (sheep/ha)					CV (%) <sup>1</sup>
	1 (8.3)	2 (16.6)	3 (25.0)	4 (33.3)	Avg. (G)	
1 15 May - 30 Jun	-0.5 <sup>a</sup>	-5.7 <sup>a</sup>	-4.5 <sup>a</sup>	-4.7 <sup>a</sup>	-3.83	42.76
2 1 Jul - 15 Aug	-0.8 <sup>a</sup>	4.3 <sup>a</sup>	6.0 <sup>a</sup>	-0.7 <sup>a</sup>	2.21	33.15
3 16 Aug - 30 Sept	3.5 <sub>wx</sub>	0.0 <sub>w</sub>	5.0 <sub>wx</sub>	10.0 <sub>x</sub>	4.63	17.08
4 1 Oct - 15 Nov	2.8 <sub>w</sub> <sup>a</sup>	-0.7 <sub>wx</sub> <sup>a</sup>	1.5 <sub>wx</sub> <sup>ab</sup>	-6.7 <sub>x</sub> <sup>b</sup>	-0.75	23.58
Avg. (G)	1.25	-0.50	2.00	-0.50	0.56	
YEAR 2 ('85-season)						
Grazing cycle (G)	Stocking rate (S) (sheep/ha)					CV (%)
	1 (8.3)	2 (16.6)	3 (25.0)	4 (33.3)	Avg. (G)	
1 15 May - 30 Jun	4.4 <sup>b</sup>	7.1 <sup>ab</sup>	5.0 <sup>b</sup>	17.5 <sup>a</sup>	8.26	22.33
2 1 Jul - 15 Aug	4.8 <sup>a</sup>	8.0 <sup>a</sup>	12.0 <sup>a</sup>	11.3 <sup>a</sup>	9.04	20.57
3 16 Aug - 30 Sept	1.8 <sup>ab</sup>	-1.3 <sup>b</sup>	4.4 <sup>ab</sup>	8.7 <sup>a</sup>	3.33	23.42
4 1 Oct - 15 Nov	-3.3 <sub>w</sub> <sup>a</sup>	-5.7 <sub>w</sub> <sup>a</sup>	-6.5 <sub>wx</sub> <sup>a</sup>	-14.0 <sub>x</sub> <sup>b</sup>	-7.37	34.62
Avg. (G)	1.94	1.75	3.61	5.26	3.12	
YEAR 3 ('86-season)						
Grazing cycle (G)	Stocking rate (S) (sheep/ha)					CV (%)
	1 (8.3)	2 (16.6)	3 (25.0)	4 (33.3)	Avg. (G)	
1 15 May - 30 Jun	1.5 <sup>a</sup>	3.5 <sup>a</sup>	-2.2 <sup>a</sup>	-5.9 <sup>a</sup>	-0.77	33.94
2 1 Jul - 15 Aug	2.0 <sup>a</sup>	3.6 <sup>a</sup>	2.8 <sup>a</sup>	4.4 <sup>a</sup>	3.20	20.16
3 16 Aug - 30 Sept	2.5 <sup>a</sup>	-1.1 <sup>a</sup>	0.5 <sup>a</sup>	6.1 <sup>a</sup>	2.09	21.20
4 1 Oct - 15 Nov	2.1 <sup>a</sup>	4.0 <sup>a</sup>	6.8 <sup>a</sup>	8.3 <sup>a</sup>	5.21	16.94
Avg. (G)	2.03	2.50	1.78	3.23	2.40	

<sup>1</sup> Coefficient of variation

<sup>a-d</sup> Values in the same row with different superscripts differ significantly (P<0.05)

<sup>w-z</sup> Values in the same row with different subscripts differ highly significantly (P<0.01)

Due to the fact that the animals at the different stocking rates stayed on the pasture for different periods, as well as the interactions that existed, total mass gain/ha over the three seasons were not compared statistically. The mean mass gain/ha/season of the animals during the trial period for Stocking rates 1 to 4 was : 1.74; 1.77; 2.84 and 3.02 kg/ha.

Although these results indicate that the highest stocking rate (33.3 sheep/ha) had the highest gain/ha, this stocking rate cannot be recommended due to the uncertainty of the rainfall. During Years 1 and 3 the animals of this stocking rate could only stay on the pastures for 19 and 38 days respectively. The three lowest stocking rates (2, 4, & 6 sheep/ha for a six month period) seems more appropriate.

### **Lick intake**

Louw (1979) states that on roughage with low digestibility, like winter grass, the live mass gains of animals can, at best, be maintained only if effective rumen stimulating licks are fed. Meissner & Paulsmeier (1988) also reported that protein supplementation to sheep for the winter period significantly increased their ADG. As the animals in the current trial utilised winter grazing, a nitrogen-containing lick (42 % CP) was supplemented.

The average lick intake by the animals is presented in Table 4.

As can be seen in Table 4, the average daily lick intake was considerably lower than what is recommended for this particular lick (70 g/day). This was possibly due to the fact that the pasture, in most cases, supplied adequate protein for the animals' needs. The fact that the average lick intake was notably higher during the first two grazing cycles, in comparison to the third and fourth grazing cycles, can possibly be ascribed to the fact that the young growth was utilised during the last two grazing cycles. The higher lick intake of the animals on the two highest stocking rates probably points to the fact that the amount of grazing was insufficient at the higher stocking rates.

### **CONCLUSIONS**

The results of this investigation show that the utilisation of Smuts finger grass foggage, under these rainfall conditions, at the three lower stocking rates (2, 4, & 6 sheep/ha for a six month period) was sufficient for the maintenance requirements of the sheep. This implies that over a period of six months a stocking rate of approximately 6 sheep/ha can be applied. Where rainfall was not a limiting factor (85-season), the animals with the highest stocking rates (33,3 sheep/ha) also had sufficient grazing. During this season 87 % (485 mm) of the rainfall occurred from October to April compared to approximately 75 % ( $\pm$  440 mm) for the other two seasons. The best results during this year ('85- season)

**TABLE 4** Average lick intake (g/day) of the animals during the trial.

Grazing cycle (G)	Stocking rate (S) (sheep/ha)				Avg. (G)
	1 (8.3)	2 (16.6)	3 (25.0)	4 (33.3)	
1 15 May – 30 Jun	33.6	33.0	50.7	36.5	38.47
2 1 Jul - 15 Aug	31.7	32.2	44.0	46.6	38.63
3 16 Aug – 30 Sept	17.0	21.8	19.8	33.0	22.89
4 1 Oct - 15 Nov	25.6	16.2	29.3	31.2	25.54
<b>Avg. (G)</b>	26.97	25.78	35.95	36.82	

were obtained at the highest stocking rate. During a year with "normal" rainfall, the situation may improve to such an extent that it might be possible for all stocking rates to be supplied with sufficient grazing material to satisfy maintenance requirements.

The limited mass gains obtained during this trial show that Smuts finger grass foggage, supplemented with a protein lick, is not fit for high producing animals but must rather be used for the wintering of non-productive animals. Because of the disappointing mass gains towards the end of the season (October/November) it appears that the foggage must not be utilised during spring. Alternative feed sources must rather be utilised during this period. The commonly recommended practice that the grass must be cut during January/February and rested afterwards to provide foggage of a high quality, may be risky in the dry western cropping areas due to the unpredictability of the rainfall.

From these results it appears as if rainfall, in terms of both quantity and distribution, is the most critical factor and that the quantity, rather than the quality, of the grazing is the limiting factor for animal production.



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## Chapter 2

### The potential of *Digitaria eriantha* Steud. as summer pasture crop for growing sheep.

#### INTRODUCTION

The continuous decrease in area available for agricultural purposes, in conjunction with the ever-increasing need for higher production, necessitates definite efforts to realise more efficient production per unit area of available land. This especially applies for marginal soils withdrawn from maize production in favour of cultivated pastures and other forage crops (Booyesen, 1970; Luitingh, 1978). This practice will also lead to more stability in the total farming enterprise, as well as a decrease in risk (Grunow, 1974, Van Wyk, 1980).

Luitingh (1978) alleged that, in South Africa, approximately 12 million ha are both ecologically and economically suitable for veld improvement or substitution of veld by high producing pasture species. One of the most important goals of the latter option is to alleviate the pressure on the veld, specifically during certain critical periods. Laas *et al.* (1981) stated that an additional advantage in the utilisation of cultivated pastures is the expansion of the national sheep flock.

Regarding the utilisation of Smuts finger grass, Liebenberg (1956) claimed it to be good summer grazing with high palatability and an average nutritional value. Ludlow *et al.* (1982), as cited by Dannhauser (1985) pointed to the fact that the height of the grazing crops did not have any effect on beef production. Its effect on small stock production, however, was not discussed.

The object of this study was to determine the potential of *Digitaria eriantha* (Smuts finger grass) as a summer grazing crop for woolled sheep on two soil types at different stocking rates and fertilisation levels. Dannhauser (1985) dealt with the pasture aspects of this study.

#### PROCEDURE

The trial was carried out under dry land conditions on Valsrivier- (2112) and low potential Avalon (3100) soil types (Soil Classification Working Group, 1991) on the Noyjons experimental farm of the North West Agricultural Development Institute, Potchefstroom. The long term average (lta) rainfall

for this region is approximately 640 mm/year (Institute for Soil, Climate and Water, 1989). Eighty, year-old Döhne merino ewes (~40 kg), allocated according to initial mass, were divided into 16 groups (5 animals/treatment). The total trial area (10 ha) was divided into 16 camps. Camp sizes differed to obtain the required stocking rate.

- Two different fertilisation levels were applied on each of the soil types:

Fertilisation level 1 - 60 kg N + 10 kg P/ha

Fertilisation level 2 - 120 kg N + 10 kg P/ha

Fertiliser was applied annually (during September/October). The fertilisers used were limestone ammonium nitrate (LAN) (28 % N) and superphosphate (11,3 % P).

- Four stocking rates were also applied during the trial:

Stocking rate 1 : 4 sheep/ha/180 days

Stocking rate 2 : 8 sheep/ha/180 days

Stocking rate 3 : 12 sheep/ha/180 days

Stocking rate 4 : 16 sheep/ha/180 days

These particular stocking rates were chosen specifically to include a very low stocking rate (4 sheep/ha), as well as a relatively high stocking rate (16 sheep/ha). The trial was repeated for four consecutive summer seasons (81/82, 82/83, 83/84, 84/85) and was originally planned as continuous grazing for approximately 180 days (beginning of December till the end of May). At the end of each trial season (during the winter period) the camps were cleared of excess dry matter (DM). The DM-production for each season is presented by Dannhauser (1985). A salt-phosphate lick ( 50 % salt, 47 % dicalciumphosphate and 3% flour of sulphur) was supplied to the trial animals. The animals were weighed every fortnight. During the periods of low rainfall (accompanied by a lack of available grazing), with live mass gain as criteria (as will be discussed later), a rumen-stimulating lick, which consisted of 42 % crude protein (CP) was supplied to the animals. The lick composition is presented in Chapter 1. Lick intake was monitored throughout the trial.

During Year 1 the rumen-stimulating lick was supplied to the trial animals as from the end of April, while during Year 2, it had to be supplied from the first week of February. A rumen stimulating lick was made available to the animals for approximately three weeks during the third season (1984/03/08 - 1984/03/27) whereafter, due to rainfall and the regrowth of the pasture, a salt-phosphate lick was again made available to those animals still on the pasture (lowest stocking rate).

The trial was originally planned as a factorial design with stocking rate, soil type and fertilisation level as the main factors. The different levels of fertilisation, however, showed no significant effect on the gain/ha of the animals (37.6 and 39.6 kg/ha for Fertilisation levels 1 and 2 respectively) and therefore this treatment was not taken into consideration with the statistical analysis of the data. Consequently the SAS program (Statistical Analysis Systems, 1985) was used to analyse the data of the different seasons as a 4 x 2 factorial with four stocking rates and two soil types. The four seasons were also jointly analysed as a 4 x 4 x 2 factorial design with four seasons, four stocking rates and two soil types.

## RESULTS AND DISCUSSION

### Rainfall

The average monthly rainfall for the different seasons (December - April) and the preceding summer months (October & November), as well as the long term average per month (Ita) for 71 years, are shown in Table 1.

**TABLE 1: Average monthly rainfall (mm) for the four trial seasons, as well as the long-term average (1913 - 1984).**

Month	Year				Long term Average
	1 (81/82)	2 (82/83)	3 (83/84)	4 (84/85)	
October	29.4	109.7	95.0	70.5	47.9
November	119.3	18.8	106.5	104.2	80.0
December	111.9	69.4	70.0	54.4	100.7
January	102.9	69.8	71.5	91.8	111.3
February	39.1	130.7	7.9	73.4	93.5
March	48.6	14.2	93.2	86.4	82.9
April	77.7	18.6	14.6	4.4	47.3
<b>TOTAL</b>	528.9	431.2	458.7	458.1	563.6

The first part of the summer of Year 1 (November/December/January) had a relatively high rainfall, while the period February/March was exceptionally dry (Table 1).

The high rainfall during October '82 (Year 2), had the effect that the grass sprouted early and was ready to be grazed by mid-November. The rest of this season, with the exception of February, was extremely dry and very hot resulting in a high evaporation rate which further reduced the available soil moisture. A large part of February's rainfall was one downpour and the effectiveness of this was not as high as would normally be expected.

Although the rainfall figures for October and November of the third season ('83/84) were much higher than the long-term average (Table 1), the grass did, at no stage, show vigorous growth (possible reasons will be discussed later). However, due to the intensity and distribution of the rainfall, the monthly rainfall figure can often be misleading. The rainfall figures for the rest of the third season, with the exception of March, were much lower than the Ita.

Due to the fact that the dry matter (DM) production of the grazing was very poor during Year 4, the trial could only start during December. This was possibly due to the culmination of the effect of the possible factors which inhibited growth (as discussed under period of grazing). The rainfall figures for the first few months (December - February) of this season were appreciably lower than the Ita, while the rainfall during March was approximately the same as the Ita (Table 1).

## **Animal Performance**

### ***Period of grazing***

Due to the drought (below average rainfall, as well as the poor distribution) and consequent lack of available grazing during the various seasons, all the groups could not stay on the pasture for the total period (summer) and had to be removed at the stage that the grazing became insufficient, based on mass loss. The fourth season was the exception because the animals in some of the treatments started losing mass within the first two weeks of the season. The number of days that the animals of the different treatments stayed on the pasture for the summer period of the various seasons is shown in Table 2.

As can be seen in Table 2, the pasture could not, during any of the trial seasons, accommodate the animals of the two heaviest stocking rates (12 and 16 sheep/ha) for the whole of the summer period. This was only achieved during the first season on Stocking rates 1 and 2.

During Year 1 problems were experienced with the fact that the trial had to start at a set date. The pasture became too high and also got too mature for efficient utilisation by the sheep.

Consequently it was decided, for the remaining seasons, to start the trial at the stage that the grass was sufficient for grazing (which were determined by sample plots as described by

**TABLE 2** Number of days that the animals could stay on the grazing during the various seasons.

Year	Soil Type	Stocking density (S) (sheep/ha)			
		1 (4)	2 (8)	3 (12)	4 (16)
1 (1981/82)	Valsrivier	186	186	82	75
	Avalon	186	186	82	75
2 (1982/83)	Valsrivier	140	98	56	42
	Avalon	140	98	56	42
3 (1983/84)	Valsrivier	141	84	37	37
	Avalon	141	84	37	37
4 (1984/85)	Valsrivier	98	98	98	28
	Avalon	56	56	56	28

Dannhauser, 1985), rather than at a predetermined date. Although it was decided to use sweepers if the five trial animals could not utilise the pasture sufficiently this was, due to the low rainfall, not necessary during any of the following trial seasons.

Weed infestation, accompanied by a poor basal covering of Smuts finger grass resulted in a deficiency in available grazing material during the fourth season (Dannhauser, 1985). Therefore the animals of the three lowest stocking rates on the Avalon soil type had to be removed from the trial during January 1985 (56 days), while the animals of the Valsrivier soil type still grazed on the pasture till the last week of March (98 days).

Possible reasons for the poor growth of the pasture during certain seasons, could be one or more of the following:

- The consecutive dry seasons caused the grass to 'die' and thus the basal covering of the camps deteriorated. Continuous grazing could possibly also contribute to this. Dannhauser (1985) referred to the percentage foreign matter in the pasture that occurred at the different stocking rates.
- Weed encroachment occurred and the 'suffocation effect' of these weeds further contributed to the elimination of the Smuts finger grass.



- Late frost during Year 3, which occurred when the grass was already sprouting, had a retarding effect on the DM-production of the pasture.
- High temperatures during the trial period enhanced evaporation, and this had a negative effect on the already limited available soil moisture.

The short grazing periods on the different camps during the various seasons, caused large variations in mass gain between the different treatments during the various seasons. Due to the great variation in the number of grazing days between the different treatments (Table 2), the animals' gains during the different seasons were not compared statistically. The mass gain per unit area, however, (which took into consideration the number of grazing days) made comparison between the different treatments possible and were consequently compared statistically.

### ***Mass gain per hectare***

As mentioned previously the mass gains obtained on the two different fertilisation levels were not statistically different and were thus not considered as a main effect.

Despite this, interactions (in terms of mass gain/ha) still existed between the different seasons and stocking rates ( $P < 0.01$ ), as well as between the different soil types and stocking rates ( $P < 0.05$ ). These interactions were possibly due to the fact that the animals at the higher stocking rates, during the years that it seemed as if there was ample grazing available, had the best results, while these animals had the poorest results (in terms of gain/ha) during drought years (accompanied by a lack of available grazing).

The total live mass gain (kg/ha) of the animals on the different treatments were, therefore, only compared statistically on each soil type for the various seasons and is presented in Table 3.

Although the animals at the lowest stocking rate (4 sheep/ha) on the Valsrivier soil type during the first season (81/82) stayed in their camps for the whole of the summer period, the mass gain/ha of these animals was lower than the gain/ha of the animals at Stocking rate 3 ( $P < 0.05$ ) and Stocking rates 2 and 4 ( $P < 0.01$ ). The gain/ha at Stocking rate 4 (16 sheep/ha) was also higher ( $P < 0.01$ ) than that of Stocking rate 3 (12 sheep/ha) during this season. The only significant difference that occurred on the Avalon soil type was that Stocking rate 4 had a higher ( $P < 0.05$ ) mass gain/ha than Stocking rate 3. The relatively high coefficient of variation (CV) possibly contributed to this. The fact that the highest stocking rate on both soil types (Table 3) had the highest mass gain/ha during this season (Table 3), possibly points to the fact that the rainfall during this summer period (93 % of the Ita) was sufficient for this particular stocking rate.

TABLE 3 Total live mass gain (kg/ha) of the animals during the three different seasons.

YEAR 1 ('81/82-season)						
Soil Type (S)	Stocking rate (R) (sheep/ha)					CV (%) <sup>1</sup>
	1 (4)	2 (8)	3 (12)	4 (16)	Avg. (S)	
Valsrivier	35.9 <sup>a</sup> <sub>w</sub>	77.0 <sup>b</sup> <sub>xy</sub>	57.4 <sup>c</sup> <sub>wx</sub>	82.9 <sup>b</sup> <sub>y</sub>	61.26	10.24
Avalon	32.5 <sup>ab</sup>	49.2 <sup>ab</sup>	27.9 <sup>a</sup>	61.8 <sup>b</sup>	53.07	21.03
Avg. (R)	34.19	63.06	43.42	70.49	51.92	
YEAR 2 ('82/83-season)						
Soil Type (S)	Stocking rate (R) (sheep/ha)					CV (%)
	1 (4)	2 (8)	3 (12)	4 (16)	Avg. (S)	
Valsrivier	51.6 <sup>a</sup>	51.8 <sup>a</sup>	54.1 <sup>a</sup>	51.5 <sup>a</sup>	52.26	17.34
Avalon	36.6 <sup>a</sup> <sub>w</sub>	44.2 <sup>a</sup> <sub>wx</sub>	70.0 <sup>b</sup> <sub>x</sub>	54.3 <sup>a</sup> <sub>wx</sub>	50.96	15.43
Avg. (R)	44.08	48.20	61.65	52.92	51.63	
YEAR 3 ('83/84-season)						
Soil Type (S)	Stocking rate (R) (sheep/ha)					CV (%)
	1 (4)	2 (8)	3 (12)	4 (16)	Avg. (S)	
Valsrivier	44.8 <sup>a</sup>	48.3 <sup>a</sup>	56.4 <sup>a</sup>	33.8 <sup>a</sup>	45.82	15.57
Avalon	37.8 <sup>a</sup>	54.3 <sup>a</sup>	51.1 <sup>a</sup>	57.7 <sup>a</sup>	50.21	13.87
Avg. (R)	41.27	51.29	53.75	45.75	48.02	
YEAR 4 ('84/85-season)						
Soil Type (S)	Stocking rate (R) (sheep/ha)					CV (%)
	1 (4)	2 (8)	3 (12)	4 (16)	Avg. (S)	
Valsrivier	17.8 <sup>a</sup> <sub>w</sub>	18.8 <sup>a</sup> <sub>w</sub>	23.1 <sup>a</sup> <sub>w</sub>	-22.2 <sup>b</sup> <sub>x</sub>	10.18	25.44
Avalon	-2.3 <sup>a</sup>	-15.5 <sup>ab</sup>	-34.8 <sup>b</sup>	-13.8 <sup>ab</sup>	-13.88	26.87
Avg. (R)	7.79	3.52	3.83	-18.24	-0.47	

<sup>1</sup> Coefficient of variation

<sup>a-d</sup> Values in the same row with different superscripts differ significantly (P<0.05)

<sup>w-z</sup> Values in the same row with different subscripts differ highly significantly (P<0.01)

Despite conflicting results during the four trial seasons (Table 3) the animals grazing on the Valsrivier soil type performed better (P<0.01) than the animals grazing on the low potential Avalon.

The different number of days that the animals stayed on the pasture (Table 2), as well as the relatively high CV was possibly responsible for the fact that the mass gain/ha of the different treatments were quite similar during Years 2 (82/83) and 3 (83/84). The only significant difference that occurred during these two seasons was the higher ( $P < 0.01$ ) gain/ha of Stocking rate 3 in relation to Stocking rate 1 on the Avalon soil type during Year 2.

Although the rainfall during Year 4 was approximately the same as during the third season ( $\pm 81\%$  of the 1ta) and even higher than that of the second season (Table 1), the accumulating effect of the reasons mentioned earlier possibly contributed to the fact that the quality of the grazing deteriorated to such an extent that the animals' performance was much poorer both in terms of number of grazing days, as well as the gain/ha (Table 3). During this season the three lowest stocking rate on the Valsrivier soil type had better ( $P < 0.01$ ) gains/ha than those at the heaviest stocking rate. During Year 4, in contrast with Year 2, the lowest stocking rate on the Avalon soil type had a better gain/ha ( $P < 0.05$ ) than Stocking rate 3.

### ***Stocking rate***

The total gain/ha over the four trial seasons for Stocking rates 1 to 4 were 127.3; 165.1; 172.4 and 139.2 kg/ha respectively. From these results it is evident that Stocking rates 2 and 3 (8 sheep/ha and 12 sheep/ha) had comparable mass gains/ha during these seasons. However, when the number of grazing days (Table 2) are brought into consideration, the best results are obtained with 8 sheep/ha. From these results it can also be concluded that even during relatively dry seasons Stocking rate 1 (4 sheep/ha) was too low for optimum animal production. There was an overabundance of grazing material and consequently the grass became too mature for efficient use by the sheep. This, together with the fact that the sheep did not prefer to graze long grass, were possibly responsible for low intakes with accompanying disappointing animal performance. Stocking rate 4 (16 sheep/ha) was possibly too high and the available grazing were utilised in too short a period, which also resulted in disappointing animal performance.

The mass gains realised in this investigation, especially when the limited periods of grazing are taken into consideration, were very disappointing. Cilliers (1984), in a trial with beef cattle weaners on veld fertilised at 100 kg N + 10 kg P/ha, recorded summer mass gains that varied between 117 and 176 kg/ha. The relative dry years, in conjunction with continuous grazing, possibly contributed to the disappointing animal performance. Dannhauser (1985) alleges that the decision whether to apply continuous grazing or a multiple camp system, is a difficult one and quotes Brown (1977) who postulates that there is little difference between continuous and rotational grazing in terms of animal production. Contrary to this, Liebenberg (1956) states that Smuts finger grass can endure severe grazing if rotational grazing is applied. Dannhauser (1985) comes

to the conclusion that a small camps system, utilised by means of rotational grazing, would have been more efficient for sheep.

### **Lick Intake**

The sheep consumed very little lick ( $\pm 7.1$  g/sheep/day) of the salt-phosphate lick (expected intake  $\pm 28$  g/day). The intake of the rumen-stimulating lick ( $\pm 42.0$  g/sheep/day) was also much lower than expected ( $\pm 70$  g/day). It must be remembered, however, that this lick is normally given to animals utilising winter veld. The crude protein supplied to the animals varied between 10.8 and 23.9 crude protein/animal/day.

### **CONCLUSIONS**

A number of dry seasons prevailed during this trial (Table 1). The results of this study must thus be seen against this background. Due to the lack of available grazing, the average daily gain (ADG) of the trial animals was very disappointing. The animals at the highest stocking rate could not, during any of the years, stay on the pasture for the duration of the summer season. The sheep of the other treatments also had to be removed from the pastures occasionally due to lack of sufficient grazing material. From this investigation Stocking rate 2 (8 sheep/ha) showed the best results. This stocking rate recorded the best mass gain per hectare, accompanied by the longest grazing period.

Regarding soil type, the gain of the animals on the Valsrivier was better ( $P < 0.01$ ) than that of the animals on the low potential Avalon. It further appears that the higher fertilisation level held no additional advantage in terms of mass gain/ha. This situation could change drastically during years with higher rainfall when the reaction of the pasture to fertilisation could be vastly different.

The successive dry seasons resulted in a low soil moisture level, to such an extent that the basal covering of Smuts finger grass deteriorated and this enhanced weed infestation (Dannhauser 1985). From this it appears as if Smuts finger grass is not very drought resistant. Grobler (1956) recommends a minimum rainfall of 600 mm/year for optimal animal production on Smuts finger grass. Continuous grazing, however, could have a detrimental effect in this regard.

The results of this investigation show that Smuts finger grass, when continuous grazing is applied, has limited potential as summer grazing for sheep. This situation can possibly change during years with a "normal" rainfall and the application of a rotational grazing system.

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## **PART 2**

**Various feeding strategies for  
woolled sheep in an autumn  
lambing season in the Western  
Highveld.**

# Chapter 1

## Different feeding strategies for woolled sheep in an autumn lambing season: ewe performance

### INTRODUCTION

An increase in the population will lead to an increased demand for, amongst others, animal products (Le Riche, 1982; Verbeek, 1982). This requires a more intensive utilisation of the available land, as well as increased production from marginal areas. An ineffective feeding programme in general, and especially during the winter months, is the most important factor hampering woolled sheep farming in the Western Highveld. An economically efficient fodder flow programme, providing for the physiological needs of the animals at the different production stages, is of paramount importance for the success of any sheep farming enterprise. De Wet (1980) suggests that marginal soils be withdrawn from cash crop production and rather be used for cultivated pastures or fodder crops. This strategy may lead to the stabilisation of the livestock enterprise by alleviating wintering problems and the possibility of increasing livestock numbers. This will also enhance the stability of the total farming enterprise, accompanied by the reduction of the risk involved (Van Wyk, 1980).

Van Marle (1982) stressed the importance of the fact that farming systems must be adapted to the local environmental conditions. The constant supply of economically produced or obtained feed is of paramount importance in ensuring the success of any woolled sheep farming enterprise. Coetzee *et al.* (1968) alleged that poor nutrition during the wintering of farm animals poses the greatest problem in the summer rainfall areas and also stressed the adverse effects of this on wool production and reproduction.

According to Henning & Barnard (1982) decreased nutritional value limits the utilisation of winter veld for small stock production. Louw (1979) alleges that supplementary feeding provides the pastoralist with a technique for increasing the nutrient intake of grazing animals. When herbage is readily available, however, supplementary feeding depresses herbage intake (Hadjipieris & Holmes, 1966; Langlands, 1969; Cronje & Weites, 1990). Consequently, responses in production are less than would be expected from the nutrient content of the supplements given.

Cultivated pastures and maize crop residues may be another feed sources which can be utilised to bridge the dry winter periods (Rethman & Gouws, 1983; Dannhauser, 1985; Esterhuysen *et al.*, 1991; Van Pletzen *et al.*, 1991; Van Vuuren *et al.*, 1997a).

Feeding silage to sheep in different physiological stages such as maintenance (Swart *et al.*, 1971), lactation (Coetzee & Dyason, 1967; Reyneke, 1967) and finishing (Reyneke, 1971; Boshoff *et al.*, 1977; Boshoff *et al.*, 1979; Boshoff *et al.*, 1980) has also received attention. Silage as roughage for the wintering of sheep was also investigated (Bosman *et al.*, 1967). Peart (1967) and Hodge *et al.* (1983) stress the importance of adequate nutrition during pregnancy, while Langlands & Bennet (1973) accentuated the importance of ewe liveweight in relation to reproduction.

The outputs of production enterprises based on a Merino flock are wool, wethers, ewe lambs in excess of those required for replacement purposes and culled ewes. Barton (1984) stated that lambing might occur during either autumn or spring in South Africa and alleged that the Merino is one of the few breeds that will mate at various times of the year. Wintering of lactating ewes is, however, a major problem. The former Highveld Region of the Department of Agriculture had a significant number of Merino sheep making a substantial contribution to both mutton- and wool production (Agricultural Development Programme, 1981). As the Merino is sometimes considered to be a 'not-so-easy-care' sheep breed, it is probably the most suitable to identify the problems encountered with sheep farming in these areas, at different levels of intensification. This especially applies for ewes with lambs during the winter.

A trial was performed at Potchefstroom to investigate the effect of different feeding strategies on the biological and economical efficiency of small stock farming in the Western Highveld. The different nutritional strategies varied from an intensive approach, where animals were kept on cultivated pastures during the summer months and received pen feeding (silage) during winter, through decreasing levels of intensification to a fully extensive system where the animals were kept on veld throughout the year.

## **PROCEDURE**

### **Terrain**

This investigation was performed on the Noyjons experimental farm of the North West Department of Agriculture: Directorate: Technical Support Services which is situated approximately 15 km southwest of Potchefstroom (26°29' E & 26°45' S). The land type is a Bc 25 (Macvicar *et al.*, 1977) and the annual long term average (lta) rainfall for this area is approximately 580 mm (Institute for Soil, Climate and Water, 1989), which occurs mainly from November to April (Schulze, 1997). The



dominant veld type is the northern variation of *Cymbopogon-Themeda* (No 48) as described by Acocks (1988).

### **Trial animals**

Approximately 210 Merino ewes (medium wool) were stratified according to age, body mass and wool production and consequently allocated at random to one of six nutritional treatments. The ewes were mated for a period of six weeks from the middle of November and started lambing from the middle of April. As ewes from all three winter treatments were represented in each mating group (during summer) ram effects did not affect progeny results. Rams that were used for a period of three years before being replaced were alternated between different mating groups during the three trial years. This was done to exclude ram effects as far as possible. The lambs were weaned at an average body mass of 20 kg. Approximately 20 % of the adult ewes in each treatment were replaced annually, after their lambs had been weaned, by young ewes from the same treatment. The ewes were shorn during early January. The fleece of each ewe was weighed (quantitative wool production) and a midrib fleece sample was collected for the determination of the qualitative fleece characteristics (clean yield, clean fleece mass and fibre diameter). The ewe lambs (nine to ten months old) were also shorn and consequently had twelve months wool growth at the time of shearing during the subsequent season. The body mass of these animals was monitored every fortnight throughout the trial.

As far as health control is concerned, the health control programme, as is locally recommended for small stock in this area, was applied.

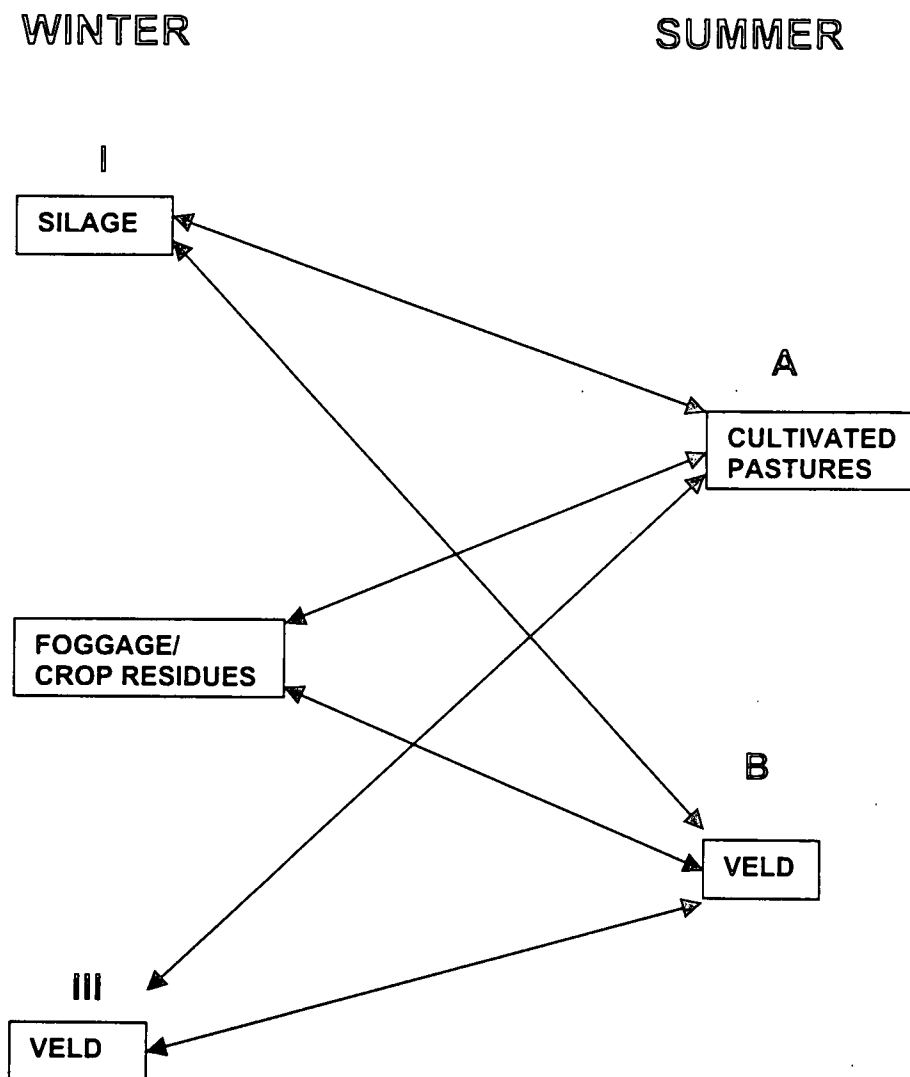
### **Treatments**

Although maize is the main cash crop produced in the Western Highveld, this area also comprises vast areas of natural veld, making it a mixed farming region. The mixed farming nature of the area made different fodder programmes (treatments) possible. The main objective of the different treatments was to simulate various farming situations, depending on the availability of the different feed sources on a specific farm.

The start of the winter period coincided with the onset of the lambing season (mid April) and lasted until the first week of November (prior to the next mating season). During this period the ewes were subjected to three different feeding strategies. At the end of each winter period the ewes were re-allocated to one of two summer treatments.

In order to be able to determine long-term effects of the different feeding regimes on the performance of the animals, they stayed in their various treatments for the duration of the trial or until being culled. The trial was carried out for three consecutive years (April 1986 – March 1989).

The different treatment combinations are illustrated in Figure 1.



**FIGURE 1** The Different Nutritional Treatment-combinations

**Different winter feeding strategies:**

**Silage in a pen during the winter period (Intensive treatment). (I)**

The quantity of silage provided to the ewes during the various production stages was based on the nutrient requirements of small stock and calculated according to NRC-standards (NRC, 1985). With

body mass changes as criteria (mainly determined by the quality of the silage during the various seasons), the quantity of silage provided to the animals was adjusted during the different years and for the various production stages. An average of 3 kg wet silage/animal/day was provided to the non-producing (dry) animals. During late pregnancy and lactation the quantity of silage provided was increased to provide for the higher requirements of these ewes. In addition to the silage, the ewes also received the same nitrogen-containing lick as in Part 1, which had a calculated crude protein (CP) content of 42 %. The lick composition is shown in Table 1.

**TABLE 1** Composition of the nitrogen-containing lick (winter lick)

INGREDIENT	(%)
Groundnut oilcake meal	40
Salt	30
Dicalcium phosphate	15
Urea	10
Molasses	5

Esmail (1999) stated that the low protein content of corn silage is a major nutritional drawback and suggested that a protein supplement must be fed when silage forms part of the basal diet. The quantity of silage discussed in this study is expressed on an 'as fed' basis and consisted of approximately 33 % dry matter (DM).

#### **Cultivated pastures (foggage)/maize crop residues grazing during winter (Semi-intensive treatment). (II)**

The cultivated pasture used in this investigation mainly consisted of Smuts finger grass - *Digitaria eriantha* (Steud). The pasture was fertilised at a level of 60 kg N/ha (limestone ammonium nitrate) at the start of each year's growing season (September), while the P-level of the soil (determined by soil analyses) was maintained at 12 - 15 ppm. Van Vuuren *et al.* (1997b) found no beneficial effects with higher fertilisation levels. The stocking rate applied on the Smuts finger grass foggage during the trial period was 2,5 ha/large stock unit (LSU) (Dannhauser, 1985). Meissner *et al.* (1983) defined LSU and used this to equate all classes of livestock to a biologically comparable unit.

These animals also utilised maize crop residues for a period of approximately two months after the maize was harvested (normally mid June to mid August – depending on the harvesting date and the quantity available). The stocking rate on the crop residues was 1 ha/LSU (Van Pletzen *et al.*, 1991) for a period of 60 days. After utilising crop residues, the ewes again grazed Smuts finger grass fog-

gage until the end of the winter period. During certain critical production stages (prior to mating, late pregnancy, lactation, etc.) these animals received energy supplementation in the form of chocolate maize [11.5 megajoules (MJ) metabolisable energy (ME)/kg and 14 % CP]. Daily supplementary feed allowance for these ewes grazing foggage was determined by production stage, body mass and -condition of the animals, as well as by the quantity of the available pasture. Various authors emphasised the use of supplementation for grazing animals during certain critical production stages (Coetzee, 1969; Louw, 1979; Jacobs & De Wet, 1982; De Waal & Biel, 1989). In this investigation it was particularly essential for the lactating Merinos during the winter period. The winter lick (Table 1) was also given to the animals of the semi-intensive treatment.

### **Veld grazing during winter. (Extensive treatment). (III).**

The animals of the extensive treatment grazed veld for the entire winter period. The ewes (as was the case with the animals of Treatment II) received energy supplementation during certain critical production stages, when necessitated by the condition of the ewes. A winter lick (Table 1) was also made available to the animals on winter veld. The stocking rate applied on the veld was 4.9 ha/LSU/year (Drewes, 1991).

### **Summer Treatments**

At the end of the winter period the animals of each winter treatment were divided into two summer treatments. The ewes in Treatment A utilised cultivated pastures, while those in Treatment B utilised summer veld. A salt-phosphate lick (50 % salt, 47 % dicalciumphosphate and 3 % flour of sulphur) was supplied to animals in both treatments.

### **Statistical analysis**

The General Linear Models Procedure of the Statistical Analysis Systems program (SAS, 1985) was used to analyse the body mass of the ewes at the start of the different production stages [summer period, winter period, lactation period and the non-lactating (dry) period], as well as the mass changes during each cycle of the various trial years (86/87, 87/88, 88/89). The body mass at the start of each production stage was used as co-variant in the statistical analysis of the mass changes. This data, as well as the wool production data and ewe productivity during the three trial years were analysed separately (similar to the way it has been done in the second chapter of Part 1) for each year. A 3 x 2 factorial design was used with the three winter treatments and the two summer treatments as the main factors. Reproduction data (lambing and weaning percentages), which are categorical data (0; 1), were tested by means of the Chi-square test. Regarding the Chi-square test, there is no coefficient of variation (CV) applicable (Table 5). Although repeated measurements on the same animal were made during the period of the three trial years, the observations were treated as inde-

pendent, mainly because of the 20 % flock replacement each year. Within the various years there were no significant ( $P>0.05$ ) interactions between the summer and winter treatments. In the statistical analysis of the mass change of the ewes, the following factors (independent of the treatment applied), which possibly had an influence on the live mass changes of the ewes, were also tested for significance. These were included only if they exerted a significant influence on the body mass changes of the ewes during a specific period. Where this was the case, the necessary correction was made to the relevant mass changes:

- **Age of ewe (A):**

Age of the ewe (years) during the specific season. Ewes of seven years and older were grouped together.

- **Pregnancy status (P):**

Non pregnant

Pregnant

- **Stage of lambing season (cycle) lambled (C):**

First cycle (17 days)

Second cycle

- **Sex of lamb (Sx):**

Unknown

Ram

Ewe

Both sexes (twins)

- **Lambing status (L):**

Lamb stillborn

Twins - one stillborn

Twins - both stillborn

Single lamb

Twins

- **Weaning status (W):**

Single lamb – died pre-wean

Twins – both died pre-wean

Twins – only one lamb weaned

Single lamb – weaned

Twins – both lambs weaned

◦ **Production status – previous year (season) (Y):**

Non Pregnant

Single lamb – died pre-wean

Twins – both died pre-wean

Twins – only one lamb weaned

Single lamb – weaned

Twins – both lambs weaned

## **RESULTS AND DISCUSSION**

### **RAINFALL**

The average monthly rainfall figure for the various years, as well as the long term average (Ita) for 46 years, is presented in Table 2. It is evident that the rainfall during the trial years, especially during the summer months, was considerably higher than the Ita. This caused the grass, to grow out early in the season with subsequent early maturation which could aggravate the already poor utilisation of grass during the winter months.

### **ANIMAL PERFORMANCE**

#### **Feed provision and lick intake.**

##### ***Winter Treatment***

##### **Silage (Treatment I)**

During the lactation period of the various trial years the daily silage intake of the ewes averaged 5.1 kg/ewe (5.2; 5.2 and 4.9 kg respectively for Years 1 to 3). During the third season, in an attempt to prevent pregnancy toxaemia (which occurred during the previous year) a daily amount of 125 g chocolate maize/head was supplied to these ewes from the start of the lambing season (mid April) till two weeks after all the ewes had lambed. Donnelly (1984) stresses the need for supplementary feeding during late pregnancy to avoid losses from pregnancy toxaemia. After the lambs were weaned, the amount of silage provided to the non-lactating ewes, was once again limited to 3 kg (1 kg DM)/ewe/day. Regarding the winter lick (Treatment I), the average daily intake for the whole of the winter period varied between 77 and 119 g/ewe during the various winter periods. The lick intake increased considerably after the lambs were weaned and the amount of silage supplied to the ewes was restricted.

**TABLE 2: Average monthly rainfall (mm) for the three trial years, as well as the long-term average (1943 – 1989).**

Month	Year			Long term average
	1 (86/87)	2 (87/88)	3 (88/89)	
April	35.6	14.0	37.1	50.8
May	0.0	0.0	5.5	20.8
June	17.0	0.0	5.6	7.8
July	0.0	0.0	1.0	6.0
August	41.0	22.0	0.0	8.9
September	18.5	119.5	27.3	20.8
October	45.3	95.7	193.1	48.0
November	84.8	94.9	74.0	71.0
December	187.8	90.5	138.4	94.9
January	143.2	134.0	149.0	101.1
February	68.0	73.5	247.8	83.4
March	33.4	140.6	31.0	78.0

### **Foggage/crop residues (Treatment II)**

The average winter lick intake for the animals of the foggage/crop residue treatment varied between 46.8 and 57.2 g/ewe/day for the whole of the winter period (including the period that they utilised crop residues). This was lower than the lick intake of ewes receiving silage (Treatment I). No chocolate maize supplementation was provided to ewes when grazing crop residues. It was also during this period (mid June to mid August – depending on the season) that their lambs were weaned. Ewes were given supplementation in the form of chocolate maize from the start of the lactation period until they started utilising crop residues (average duration 9 weeks over the three trial years). The quantity supplied during the different years, varied between no supplementation at all and a maximum of 500 g/ewe/day, depending on the availability of the foggage, as well as the condition of the ewes. Jacobs & De Wet (1982) obtained optimum lamb growth at a supplementation level of 400 g maize/ewe/day on cultivated pastures. Dixon *et al.* (1996) determined that the effect on milk secretion and lamb growth was much less during late pregnancy than providing a similar amount of additional nutrients post partum. Due to a loss in body mass towards the end of the winter periods of Years 1 and 3, these ewes received a chocolate maize supplementation of 250 g/ewe/day (flushing prior to mating). The average duration of the flushing period during these two years was 5 weeks.

### **Veld (Treatment III)**

The ewes grazing veld during the winter period also received supplementation (which varied between 250 and 500 g chocolate maize/animal/day during the various years) from the start of the winter period (lactation) until their lambs were weaned. The length of this period during which the supplementation was provided, averaged 13 weeks. After weaning, these ewes only received a winter lick on the veld. The lick intake of the ewes grazing winter veld varied between 51 and 94 g/ewe/day. During Years 1 and 3, however, (as was the case with the animals of the semi-intensive treatment) it was necessary to provide a daily supplementation of 250 g chocolate maize/ewe towards the end of the winter period. Similar to Treatment II the duration of the flushing period averaged 5 weeks.

### ***Summer Treatment***

The daily salt-phosphate lick (summer lick) intake of the animals grazing cultivated pastures and veld averaged 7.6 and 6.9 g/animal, respectively, during the total summer period of the various years.

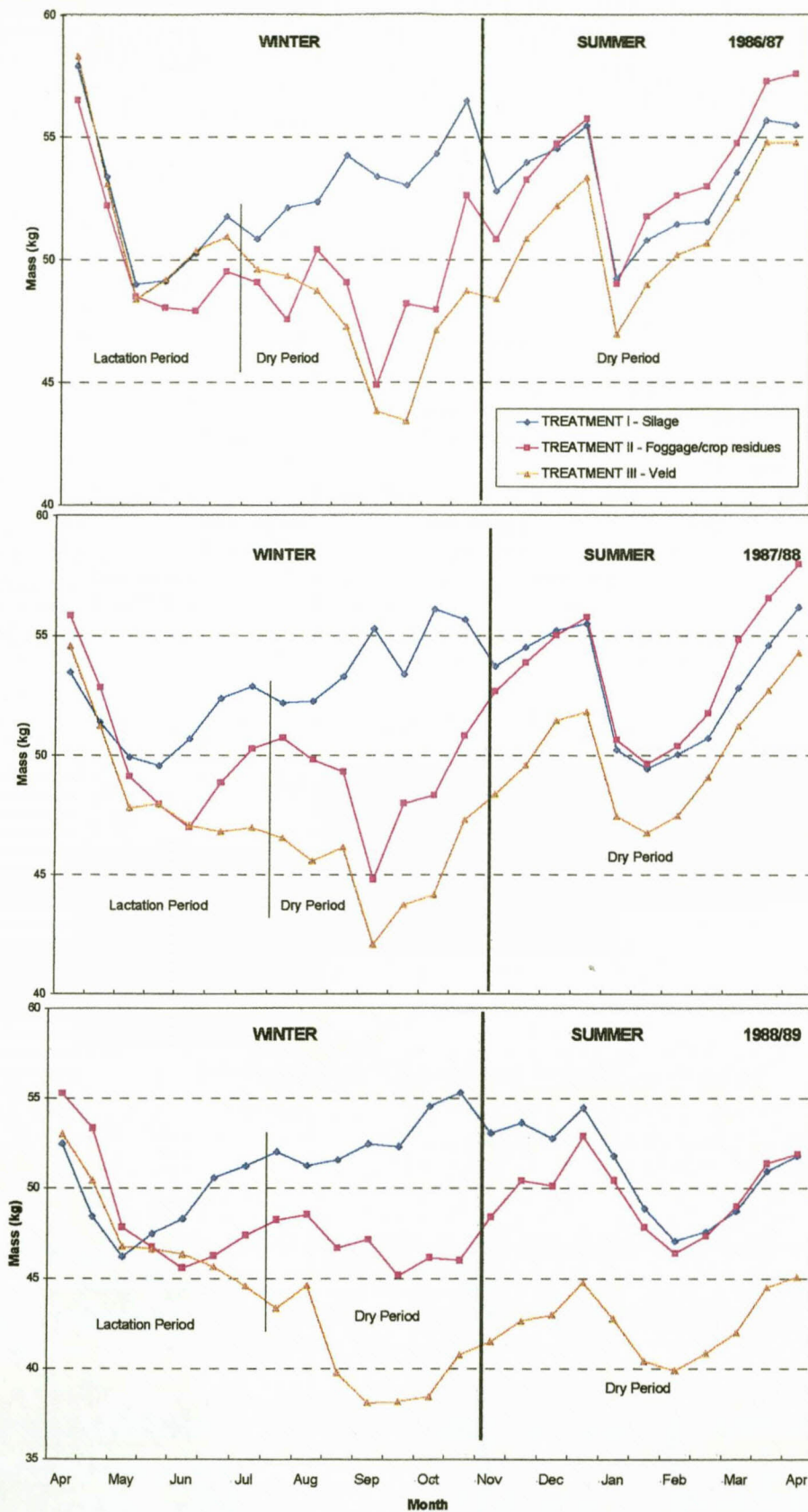
### **Mass changes**

The mass changes of the animals of the various treatments during the three years of the trial (for both the winter and summer seasons) are indicated in Figure 2 and Table 3. Figure 2 and Table 3 are complementary to one another. Figure 2 highlights animal mass trends throughout the year and also indicates the statistical differences between treatments during the various phases of the production cycle. Although the animals received different feed sources during summer, the mass changes indicated in Figure 2 (for the whole year) are those of ewes according to the three winter treatment allocations. This was done to determine the performance/mass changes (presence and degree of compensatory growth) of the animals from the various winter treatments during the summer. In Table 3 the exact average daily gain (ADG) for the winter and summer periods are presented separately. The independent factors (mentioned previously) were only included in the analysis when they caused significant differences and the necessary corrections were made to the mass changes involved.

### ***Winter Treatment***

Regarding the body mass of the animals during the various trial years, basically the same tendency was evident during all three years (Figure 2). The winter period started just prior to the lambing season when the body mass of the ewes was at a maximum. The ewes which





**SIGNIFICANCE OF POSITIVE MASS CHANGES**

**1986/87**

Total Summer period:  
3,2 > 1\*\*

Total winter period:  
1 > 2 > 3\*\*

i) Lactation period:  
1 > 2\*\*

ii) Dry period:  
3,2 > 1\*\*

**1987/88**

Total Summer period:  
2,3 > 1\*\*

Total winter period:  
1 > 2,3\*\*

i) Lactation period:  
1 > 2,3\*\*

ii) Dry period:  
3,2 > 1\*\*

**1988/89**

Total Summer period:  
3,2 > 1\*\*

Total winter period:  
3 > 2\*  
1 > 3,2\*\*

i) Lactation period:  
1 > 2,3\*\*

ii) Dry period:  
3,2 > 1\*\*

\*\*P < 0.01

\*P < 0.05

**FIGURE 2. INFLUENCE OF WINTER FEEDING SYSTEMS ON THE LIVE MASSES OF EWES DURING THE VARIOUS SEASONS**

**TABLE 3** Average mass changes (g/day) during the respective summer and winter periods of the various seasons

	TREATMENTS					Avg.	CV (%) <sup>1</sup>
	WINTER			SUMMER			
	I	II	III	A	B		
<b>SUMMER PERIOD</b>							
<b>YEAR 1</b> (1986/87)	-8.83 <sub>w</sub>	31.95 <sub>x</sub>	36.83 <sub>x</sub>	31.98	7.98	<b>19.98</b>	17.54
<b>YEAR 2</b> (1987/88)	4.65 <sub>w</sub>	39.13 <sub>x</sub>	39.34 <sub>x</sub>	34.23	21.18	<b>27.71</b>	16.34
<b>YEAR 3</b> (1988/89)	-32.75 <sub>w</sub>	25.68 <sub>x</sub>	32.13 <sub>x</sub>	6.76	9.95	<b>8.36</b>	18.14
<b>WINTER PERIOD</b>							
<b>YEAR 1</b> (1986/87)	-7.77 <sub>w</sub>	-25.19 <sub>x</sub>	-40.85 <sub>y</sub>	-24.80	-24.39	<b>-24.60</b>	22.66
<b>YEAR 2</b> (1987/88)	9.42 <sub>w</sub>	-15.47 <sub>x</sub> <sup>a</sup>	-26.49 <sub>x</sub> <sup>a</sup>	-21.94 <sub>w</sub>	0.25 <sub>x</sub>	<b>-10.85</b>	17.27
<b>YEAR 3</b> (1988/89)	18.96 <sub>w</sub>	-30.05 <sub>x</sub>	-25.59 <sub>x</sub>	-15.06 <sub>w</sub>	-9.39 <sub>x</sub>	<b>-12.23</b>	8.95

<sup>1</sup> Coefficient of variation

<sup>a-d</sup> Values in the same row with different superscripts, for the respective summer and winter periods, differ significantly (P<0.05)

<sup>w-z</sup> Values in the same row with different subscripts, for the respective summer and winter periods, differ highly significantly (P<0.01)

There were no interactions between the winter and summer treatments within each year.

#### Winter Treatments

I - Silage  
II - Foggage/crop residues  
III - Veld

#### Summer Treatments

A - Cultivated pastures  
B - Veld

grazed foggage/crop residues or veld, showed a net loss in body mass (P<0.01) for the whole of the winter period (Figure 2). The mass advantage of the animals (P<0.01) receiving silage during winter (Table 3) must probably be attributed to the high nutritional value of the silage (Bosman *et al.* 1967).

The mass gain (Figure 1) of the animals grazing maize crop residues (beginning of June till mid August) was especially evident during Years 2 and 3. This gain is in agreement with results obtained by Swart *et al.* (1983) and Gertenbach *et al.* (1998). The latter authors reported, at a mean stocking rate of 2.3 LSU/ha, a mass gain for at least the first six to eight weeks of the grazing period. Weber *et al.* (1970) found mass gains of 10.5 kg and 23.6 kg per animal for cows and heifers respectively, over a 100-day crop residue grazing period. According to these authors, a realistic stocking rate on maize crop residues for the winter period should be 0.8

cows/ha which, in South African terms, would correspond to roughly one LSU/ha, as was applied in the current investigation.

De Waal & Biel (1989) also recorded mass losses with ewes kept on winter veld. These authors reported that these losses could, to a certain extent, be alleviated by supplementation (energy and protein). In this trial chocolate maize was given to the lactating ewes during winter.

During September the pasture (Smuts finger grass or veld) normally started sprouting, which was apparently sufficient to initiate a recovery in body mass. An important prerequisite here is that the quantity of the grazing material should be sufficient. The supplementary feeding supplied to the groups towards the end of the winter period (as discussed earlier) must also be kept in mind. Generally speaking, this recovery in body mass of the ewes in the foggage/crop residue treatment was sufficient to show a higher body mass at the end of the winter period compared to their mass at wean (Figure 2). The apparent loss in body mass of the ewes during the summer period (January) might be misleading and could be attributed to the fact that these ewes were shorn during this period (Figure 2).

During summer (while the animals utilised either cultivated pastures or veld) the animals of the semi-intensive and extensive treatments showed a higher mass gain ( $P < 0.01$ ) than the animals of the intensive treatment (Table 3). This is probably because of compensatory growth. During the lactation period, while the animals were in their winter treatments, the animals of Treatment I had a lower mass loss ( $P < 0.01$ ) than those of the two other treatments (Figure 2). Exactly the opposite was the case during the non-lactating or dry period (most which occurred during summer). The animals of Treatments II and III performed better ( $P < 0.01$ ) during their non-lactating phase. Sahlu *et al.* (1999) found that the body weight change, especially in the latter half of the realimentation period, increased linearly as the level of feed intake during the restriction phase decreased.

No reason could be found for the fact that, in contrast to the previous years, the body mass of the animals of all three treatments at the end of the summer of Year 3 were considerably lower than their body mass at the start of that year's winter period (Figure 2). It is also worth noting that despite the lack of significant differences between the animals of Treatments II and III during most of the years, the average mass of Treatment III, at the end of the trial, was approximately 16 % lower than that of the other treatments. This probably implies that, in the long term, the animals of the extensive treatment will be inferior as far as their animal performance is concerned.

### ***Summer Treatment***

During the winter period, the mass gain of the animals from the summer veld treatment, compared to cultivated pastures, was significantly better ( $P < 0.01$ ) during the second and third years (Table 3). This was probably also due to compensatory growth as the animals that grazed cultivated pastures, in most cases, performed better during winter (Table 3). Referring to compensatory growth, Marais *et al.* (1991) came to the conclusion that the results obtained were not always consequent. These authors found contradictory results with ram and ewe lambs during the realimentation period after restricted feeding.

### **Wool production**

The quantitative wool production (kg) of the ewes in the various treatments and the qualitative fleece characteristics (clean yield, and fibre diameter) were determined. The clean wool yield was consequently calculated and the wool production data are presented in Table 4.

### ***Winter Treatment***

The fibre diameter of the wool of ewes which utilised maize crop residues during two months of the winter period, was higher ( $P < 0.05$ ) than that of the animals receiving silage and veld for all three years (Table 4). This is probably because of the fact that they had a high energy feed at their disposal during a difficult stage in the fodder flow of the other treatments. Van Pletzen *et al.* (1991) also reported an increase in fibre diameter similar to that of the current trial with Merino sheep grazing maize crop residues. When the stocking rate increased (more harsh nutritional environment), they observed a decline in the fibre diameter. Accordingly, Langlands & Bennet (1973) found that fibre diameter and fleece length were reduced by more harsh feeding conditions.

From Table 4 it was evident that the mass advantage of the ewes of the intensive treatment (Figure 2) was not reflected in their clean wool production. A possible reason for this is the high non-protein nitrogen (NPN) -content of the silage (De Brouwer *et al.*, 1991) which can hamper wool production, both in terms of quality and quantity. This could be due to a lack of essential amino acids, especially the sulphur containing amino acid, cysteine (McDonald *et al.*, 1984). Lee & Williams (1994) found that clean wool growth rate was related to nitrogen (N) intake but not diet *per se*. Coetzee & Pieterse (1966), on the other hand, found that a fish meal-supplemented winter forage realised a significantly better clean wool growth rate than a N-equivalent and isocaloric amount of urea and maize meal. Bosman *et al.* (1967), however, ascribed the disappointing results regarding wool production of sheep fed maize silage to the underprovision of nutrients.

**TABLE 4** Wool production characteristics of the ewes from the different treatments during the various seasons

	TREATMENTS						CV (%) <sup>1</sup>
	WINTER			SUMMER		Avg.	
	I	II	III	A	B		
<b>FIBRE DIAMETER (<math>\mu</math>)</b>							
<b>YEAR 1 (1986/87)</b>	20.13 <sup>a</sup>	21.03 <sup>b</sup>	20.09 <sup>a</sup>	20.26	20.58	<b>20.42</b>	9.84
<b>YEAR 2 (1987/88)</b>	20.67 <sup>a</sup> <sub>w</sub>	21.51 <sup>b</sup> <sub>x</sub>	21.24 <sup>c</sup> <sub>x</sub>	20.89 <sup>a</sup>	21.39 <sup>b</sup>	<b>21.14</b>	8.34
<b>YEAR 3 (1988/89)</b>	20.24 <sub>w</sub>	21.30 <sub>x</sub>	20.16 <sub>x</sub>	20.62	21.01	<b>20.82</b>	8.34
<b>CLEAN YIELD (%)</b>							
<b>YEAR 1 (1986/87)</b>	70.11 <sub>w</sub>	66.41 <sub>x</sub>	66.78 <sub>x</sub>	68.43	67.11	<b>67.77</b>	7.85
<b>YEAR 2 (1987/88)</b>	70.32 <sup>a</sup>	68.29 <sup>b</sup>	69.61 <sup>a</sup>	70.24 <sup>a</sup>	68.57 <sup>b</sup>	<b>69.41</b>	6.31
<b>YEAR 3 (1988/89)</b>	67.85 <sub>w</sub>	69.61 <sub>w</sub>	73.90 <sub>x</sub>	70.87	70.03	<b>70.45</b>	7.26
<b>CLEAN WOOL MASS (KG)</b>							
<b>YEAR 1 (1986/87)</b>	2.76	3.01	2.74	2.87	2.60	<b>2.84</b>	21.00
<b>YEAR 2 (1987/88)</b>	3.16 <sup>ab</sup>	3.26 <sup>a</sup>	3.06 <sup>b</sup>	3.17	3.14	<b>3.16</b>	16.11
<b>YEAR 3 (1988/89)</b>	3.22 <sup>ab</sup>	3.41 <sup>a</sup>	3.11 <sup>b</sup>	3.27	3.22	<b>3.24</b>	21.02

<sup>1</sup> Coefficient of variation

<sup>a-d</sup> Values in the same row with different superscripts, for the respective summer and winter periods, differ significantly ( $P < 0.05$ )

<sup>w-z</sup> Values in the same row with different subscripts, for the respective summer and winter periods, differ highly significantly ( $P < 0.01$ )

There were no interactions between the winter and summer treatments within each year.

#### Winter Treatments

I - Silage  
 II - Foggage/crop residues  
 III - Veld

#### Summer Treatments

A - Cultivated pastures  
 B - Veld

These authors stated that, due to its bulkiness, a higher intake of silage did not seem possible and came to the conclusion that, in the wintering of woolled sheep, silage cannot be highly rated.

Clean wool yield of the ewes showed no definite trend. During Years 2 and 3 the clean wool mass of the foggage/crop residue treatment were significantly ( $P < 0,05$ ) better than that of the animals that grazed veld during winter (Table 4). Esterhuyse *et al.*, (1991) and Van Pletzen *et al.*, (1991) found low clean yield figures with sheep grazing maize crop residues. In the present

study it was only the case during Year 2. Langlands *et al.*, (1984) also found negative results in terms of wool production when the feed source was restricted.

### ***Summer Treatment***

The ewes grazing cultivated pastures during the summer had a significantly higher ( $P < 0.05$ ) clean wool yield during Year 2 than those grazing summer veld (Table 4). The higher fibre diameter ( $P < 0.05$ ) of the veld treatment during this year must probably be linked to their lower lambing percentage during this season (as will be discussed).

### **Reproduction**

The lambing- and weaning percentages of the ewes, which started lambing at the start of the winter period (mid April), are presented in Table 5.

As was discussed under statistical analysis, a CV is not applicable in the Chi-square test analysis (Table 5).

### ***Winter Treatment***

During the first year of the trial ewes grazing crop residues showed a non significant ( $P > 0.05$ ) lower lambing percentage. This was in contrast to Years 2 and 3 when the ewes grazing winter veld had the lowest lambing percentage ( $P > 0.05$ ). The poor lambing percentage in all treatments during the third year was mainly due to a ram effect as one of the rams that was used during this year was apparently temporarily sterile during part of the breeding season. Unfortunately no provision was made beforehand to exclude such ram effects. This had a suppressive influence on the results of all the treatments (Table 5) which could not be attributed to treatment effects as such. There was a non-significant ( $P > 0.05$ ) tendency for the lambing percentage of the veld treatment to decline as the trial progressed. This could possibly be attributed to the lower liveweight of the ewes of the extensive treatment, especially during the third year (Figure 2) which may be considered a treatment effect, Donnelly *et al.* (1982) found in a three year trial that an increase in reproductive performance with higher weight at joining time were consistent from year to year.

Weaning percentages showed the same tendencies among treatments as lambing percentages. The relative low weaning percentage, in general, must partly be attributed to the high rainfall during the trial seasons (Table 2). During these high rainfall seasons the pasture matured relatively early and this caused problems with the utilisation of the pasture and performance of

**TABLE 5** Reproduction parameters and productivity of the ewes during the various trial years.

	TREATMENTS					
	WINTER			SUMMER		Avg.
	I	II	III	A	B	
<b>LAMBING PERCENTAGE<sup>2</sup></b>						
YEAR 1 (1986/87)	116.1	102.0	112.7	109.5	110.9	<b>110.2</b>
YEAR 2 (1987/88)	107.2	107.2	95.5	109.7	96.8	<b>103.3</b>
YEAR 3 (1988/89)	100.0	99.6	77.0	92.2	92.2	<b>92.2</b>
<b>WEANING PERCENTAGE<sup>3</sup></b>						
YEAR 1 (1986/87)	95.2	91.4	102.4	95.4	97.3	<b>96.4</b>
YEAR 2 (1987/88)	92.5	97.2	82.6	98.7	83.1	<b>90.9</b>
YEAR 3 (1988/89)	68.8	69.1	62.6	63.0	70.7	<b>66.8</b>

<sup>1</sup> Coefficient of variation

<sup>2</sup> Lambing Percentage =

$\frac{\text{Number of lambs born}}{\text{Number of ewes mated}}$

<sup>3</sup> Weaning Percentage =

$\frac{\text{Number of lambs weaned}}{\text{Number of ewes mated}}$

<sup>a-d</sup> Values in the same row with different superscripts, for the respective summer and winter periods, differ significantly ( $P < 0.05$ )

<sup>w-z</sup> Values in the same row with different subscripts, for the respective summer and winter periods, differ highly significantly ( $P < 0.01$ )

There were no interactions between the winter and summer treatments within each year.

#### Winter Treatments

I - Silage  
II - Foggage/crop residues  
III - Veld

#### Summer Treatments

A - Cultivated pastures  
B - Veld

the ewes and lambs. This was especially the case during the early winter months (as was discussed under rainfall).

Predation by jackals was also experienced during the trial, especially during the second and third years. As far as weaning percentages are concerned, Sormunen-Cristian & Suvela (1999) also reported lamb mortality figures before the age of 150 days of between 15.2 and 17.7 % for summer and autumn lambing ewes respectively. Cloete & Scholtz (1998) reported that even a very intensive management system failed to reduce lamb mortality in South African Mutton Merinos and Dormers below 15 %.

### *Summer Treatment*

From the fact that there were no definite trends in the reproduction data as far as the summer treatments are concerned, it must be deduced that the difference in summer treatments were not so severe that it caused a marked difference in reproduction.

## **CONCLUSIONS**

According to the biological results obtained in this trial the silage and foggage/crop residue wintering strategies can be applied in the crop production areas of the Highveld. Although the animals of the intensive treatment had the best performance in body mass during winter, the animals of the semi-intensive treatment showed compensatory growth during the summer period to such an extent that there were no significant differences between the two treatments at the end of each year. However, the body mass of the animals of the extensive treatment were the exception, in so far that they had a 16 % lower body mass than the animals of the other two treatments. Accordingly, reproductive performance tended to decline as the trial progressed. The veld treatment showed the lowest ( $P < 0.05$ ) lambing percentage during Years 2 and 3. From this it seems that in the long term these animals would be disadvantaged and it would be advisable to consider alternative feed sources if available.

Maize crop residues, if available, are an invaluable feed source in the fodder flow program of the sheep farmer during winter to improve wool production and reproductive performance.

During the trial seasons of this investigation, the relative high rainfall figure during the early and mid summer months caused problems with the utilisation of the grass for the ewes in general, and especially for the ewes and lambs during the lactation period (early winter).

The nutritional value of maize silage, as a feed source for adult ewes, was sufficient to supply in their nutritional needs during their various production stages – to such an extent that the silage provision for the non-lactating ewes had to be restricted to a daily allowance of 3 kg wet silage (1 kg DM)/ewe to prevent the ewes from becoming too fat. However, the relatively good performance, in terms of the growth, of the ewes was not reflected in their wool production so that it seems that some or other natural protein supplement is essential to provide these ewes with the essential amino acids to improve wool production further.

Regarding the summer treatments, the mass gains of the animals utilising cultivated pastures tended ( $P > 0.05$ ) to be higher during summer. During the winter period the cultivated pasture treatment showed a highly significantly ( $P < 0.01$ ) greater body mass loss compared to the animals grazing on veld during summer. However, no significant differences ( $P > 0.05$ ) occurred in the clean wool production, as well as the reproductive parameters of these treatments.



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## Chapter 2

### Different feeding strategies for woolled sheep in an autumn lambing season: lamb performance

#### INTRODUCTION

Efficiency of lamb production depends primarily upon dam milk production, reproduction and growth of the lambs (Engels & Malan, 1979). A profitable growth rate is thus an important tool in improving the productivity of the flock and the financial viability of the sheep enterprise (Dickerson, 1970). Van Niekerk & Schoeman (1993) also stated that where sheep and lambs graze pasture throughout the year, it is usually necessary to provide them with supplementary feed in seasons of pasture shortage or where the quality of the available pasture is lacking (especially on winter veld).

Lambs depend solely on the milk production of the dam from birth up to seven days of age and thereafter start nibbling and this gradually increases up to the fourth week (Santra & Karim, 1999). Creep feed is generally provided to lambs one week after birth to stimulate early rumen development and supplement their nutrient intake for faster growth (Hamada *et al.*, 1976).

As far as the finishing of lambs is concerned, Shelton & Carpenter (1972) concluded that with low levels of reproductive efficiency, lamb meat could be produced more efficiently if these lambs are slaughtered at heavier weights. One legitimate objection to heavier carcasses, however, is the well-known relationship between carcass weight and the amount of fat in the carcass (Oliver *et al.*, 1968). A higher reproduction rate (i.e. increased meat production through increased lamb and culled ewe numbers), in combination with economic forage production, can be a much more viable option to be used successfully in the raising and finishing of lambs or maintaining them throughout the winter period.

In the post wean feeding and finishing of lambs, various roughage sources have been investigated. Roughage such as wheat straw (Brand *et al.*, 1990; Cronjé & Weites, 1990; Brand *et al.*, 1991), pastures (Arnold, 1964; Freer *et al.*, 1985), irrigated pastures (Fair & Reyneke, 1972; Van Heerden & Reyneke, 1974; Radcliffe *et al.*, 1983; Brand & Van der Merwe, 1994; De Villiers *et al.*, 1994), forages (Kirkpatrick & Steen, 1999) and lucerne (Brand *et al.*, 1992; Cronjé *et al.*, 1992; Preziuso *et al.*, 1999), shrubs (Van der Merwe & Nel, 1991), chemically treated roughage (Hofmeyr *et al.*, 1982; Seed, 1983;

Brand *et al.*, 1990), maize crop residues (Schoonraad *et al.*, 1988) and maize silage (Boshoff *et al.*, 1977; Boshoff *et al.*, 1979; Boshoff *et al.*, 1980; Agbossamey *et al.*, 1998) were investigated. Research has also been done on the rearing of lambs on veld (Atkins, 1980). However, due to the arid conditions in South Africa, implementing this practice usually has to be accompanied by the use of ample supplementary feed. Van Niekerk & Barnard (1969) also stressed the limiting effect of the climate in supporting intensive lamb production systems. Regarding the use of winter cereal pastures, these authors stated that their inclusion is limited because of the fact that their success is largely dependent on rainfall and is, therefore, unreliable. Penzhorn (1945) also concluded that, owing to uncertain rainfall and other climatological factors, variable results were obtained with green fodder over years and that this makes it too risky an enterprise to promote. From the above it is evident that certain limitations (especially during winter) exists with the use of veld and other pastures, as such, for sheep farming. Alternative strategies will have to be found to alleviate this shortcoming.

With the large-scale cultivation of maize as a cash crop in the Western Highveld, which often takes place on marginal soils, animal production can also play an important role in the stabilisation of the farming enterprise. The pressure on pasture and veld can be alleviated by the use of maize in livestock production, especially during certain critical times of the year.

In Part 2, Chapter 1 the effect of different wintering strategies (with feed sources applicable to this region) on the biological performance of ewes from the autumn lambing season, were investigated. This chapter discusses the pre- and post wean biological performance of the lambs of these ewes. The mass gain and wool production data of the replacement ewes and the mass gain and slaughter data of the fattened rams of the various treatments are also presented.

## **PROCEDURE**

The various treatments that the ewes (dams of these lambs) were subjected to during the trial period are described in Part 2, Chapter 1 and can be summarised as follows:

Winter treatments:

- Treatment I : Silage in a pen for the duration of the winter period (Intensive treatment).
- Treatment II : Ewes utilising fertilised cultivated pastures/maize crop residues (Semi-intensive treatment).
- Treatment III : Ewes grazing veld, which had been rested for the summer. (Extensive treatment).

The two summer treatments consisted of the following:

Treatment A - Cultivated pastures.

## Treatment B - Summer veld.

The lambing season started at the beginning of the winter period, as soon as the dams were allocated to their winter treatments. The lambs of each treatment were weaned as a group when an average fasted mass of 20 kg was attained. The lambs of the various treatments received the same ration and were fed in one group during the different post weaning stages. This was done to investigate the possible effects of the nutritional treatments of the ewes on the post wean performance (growth rate and wool production) on their progeny. The feed intake of the lambs from the various treatments were thus not monitored.

Different rations were supplied to the lambs during the various stages (creep feed, post wean ration, replacement ewe ration, as well as a finishing ration) in order to provide in the nutritional requirements of the lambs during the different growth stages (NRC, 1985). In these rations maize meal was used as energy source and an urea-free high protein concentrate (HPC) was used as a protein source. In the composition of the rations the nutritive value of the feeds, according to Bredon *et al.* (1987), were used. As these were all completely balanced rations, only a salt-phosphate- (summer-) lick was supplied additionally throughout the year.

The pre-wean lambs of the intensive and semi-intensive treatments (Treatments I and II, respectively) received a creep feed from approximately ten days of age up to weaning in an attempt to enhance their pre-wean growth (Johnston, 1992). The lambs of Treatment III, representing a more extensive approach, did not receive creep feed. The body mass of the lambs was monitored every fortnight throughout the trial and their fasted body mass was determined at the start of each period.

The composition of the various rations is presented in Table 1.

The rations were supplied *ad libitum* (*ad lib.*) to the lambs during the different stages and their growth rate determined the duration of each stage (time to reach the target mass).

### **Pre- wean**

Regarding the recommended protein content of the creep feed, discrepant results exist in literature. Santra & Karim (1999) stated that increased levels of protein in the creep mixture were wasted. These authors found an 18 % crude protein- (CP-) content in the creep feed to be adequate. Sawal *et al.* (1996), cited by the same authors, reported that pre-weaner lambs in a sub-temperate climate, had satisfactory growth response on a creep mixture with 11 % CP. Coetzee & Vermeulen (1966) used a creep feed with 9.2 % CP, while Susin *et al.* (1995) utilised a creep feed with a CP-content of 14.4 %. NRC (1985) proposed various creep feeds with the CP-content varying from 14 % to 20 %. Apparently the circumstances under which these feeds are utilised, are the deciding factor. The crude protein content of the creep feed used in this investigation was 15.1 %.



TABLE 1 Composition of the various rations provided to the lambs

INGREDIENT	RATION			
	Creep feed	Post wean	Replacement	Finishing
Maize meal	55	60	25	60
HPC	10	20	5	-
Lucerne meal	35	-	25	40
<i>Eragrostis curvula</i> hay	-	20	45	-
ME-content (MJ/kg) <sup>*1</sup>	11.36	11.90	9.72	11.48
CP-content <sup>#1</sup>	15.10	14.30	10.83	11.50

\* - ME-content (MJ/kg) = Metabolisable energy content (mega-joules/kg)

<sup>#</sup> - Crude protein content

<sup>1</sup> - Calculated nutritional requirements (NRC, 1985) and nutritive value of feeds (Bredon et al., 1987).

### Post wean (wean to 30 kg)

After weaning, the lambs of all three treatments were fed a post wean ration (Table 1) up to a body mass of 30 kg. Boshoff *et al.* (1980) recommended a protein content of 14 % in the post wean ration of lambs. A similar CP-content in the post wean ration were also used by various other authors (Van Vuuren & Nel, 1983a; Cronje & Weites, 1990; Brand *et al.*, 1991; Brand & Van der Merwe, 1994; Manso *et al.*, 1998). Although no adaptation problems were experienced with this post wean ration during a preliminary trial, severe problems were encountered during the first year, after the lambs were weaned. Consequently, in an attempt to prevent this, feed lime (3 %) was added to the post wean ration during the remainder of the investigation.

### Replacement ewes

After reaching an average body mass of 30 kg the rams and replacement ewes were separated. The replacement ewes (20 % of the adult ewe flock) were fed the replacement ewe ration (Table 1). In order to prevent excessive fattening of the future breeding ewes, this ration had a lower energy content than the finishing ration (NRC, 1985). They received this ration up to the age of six months when these young ewes were allocated to the same summer treatment (cultivated pastures and veld) as their dams (Part 2; Chapter 1). This was done to investigate the long-term effects of the various treatments. By the time the adult ewes were shorn (mid January) these ewe lambs (approximately nine months of age) were also shorn and consequently had twelve months wool growth at the time of shearing during the subsequent season. During mid May these ewes were allocated to their various winter treatments (Part 2, Chapter 1). At the end of the winter period these ewes

(on average eighteen months old) were grouped together with the adult ewes of the respective treatments and were mated at this stage.

### Finishing rams

The high-energy finishing ration (Table 1) were supplied to the ram lambs after they reached 30 kg body mass. This was done to enhance their growth rate and to obtain the desired carcass grading by the time they reached slaughter mass. The protein content of the finishing ration was also reduced to 11 % (Cilliers *et al.*, 1998). Andrews & Ørskov (1970) found that a lower protein content of the ration during the final stages of finishing, enhanced fat deposition. During the first season the rams were slaughtered at a body mass of approximately 42 kg. Although the carcass grading system are no longer relevant, the carcasses were graded according to the system used at that stage and the following point scale, as was used by Van der Merwe (1973), was allocated to the different carcass grades (Table 2):

**TABLE 2** Scores for different grades of mutton (lamb) carcasses.

Carcass grade	Point
Super <sup>+</sup>	10
Super	9
Super <sup>-</sup>	8
1 <sup>+</sup>	7
1	6
1 <sup>-</sup>	5
2 <sup>+</sup>	4
2	3
2 <sup>-</sup>	2
3	1

### Statistical analysis

The SAS program (Statistical Analysis Systems, 1985) was used for the statistical analysis of the data. The mass gain of the animals, the wool production data of the replacement ewes and the slaughter data of the fattened rams were analysed separately for each year (86/87, 87/88, 88/89). A 3 x 2 factorial design was used with the three winter treatments and the two summer treatments as the main effects.

Due to the fact that the lambs of Treatment III, which represented the more extensive approach, did not receive creep feed, they were not quite comparable to lambs of the other two treatments. This treatment must, however, be considered as an extensive treatment with lower input costs.

## RESULTS AND DISCUSSION

### Feed intake

The average daily feed intake of the lambs for the different stages within the three different trial years are indicated in Table 3.

**TABLE 3** Average daily intake of the various groups of animals on air dry basis.

YEAR	RATION				
	Creep feed (g/head)		Post wean (kg/head)	Replacement (kg/head)	Finishing (kg/head)
	I <sup>a</sup>	II <sup>a</sup>			
YEAR 1	145.8	115.0	0.8	1.0	1.4
YEAR 2	218.0	159.6	0.8	0.8	1.6
YEAR 3	292.9	85.6	0.9	1.3	1.2
AVERAGE	218.90	120.07	0.83	1.03	1.44

<sup>a</sup> - Treatments :

- I - Silage (Intensive)
- II - Foggage/Crop residues (Semi-intensive)

The mass gain (ADG) of the lambs (time to attain the desired mass), both pre-wean (creep feed) and post wean determined the duration of the periods for which the animals received the various rations (post wean, finishing and replacement ewe).

### Pre-wean

The daily creep feed intake of the lambs averaged 218.9 and 120.1 for Treatments I (Silage) and II (Foggage/Crop residues) respectively over the three trial years (Table 3). During the second and third seasons the creep feed intake of the lambs of the silage treatment, was considerably higher than those on the foggage/crop residue treatment. The reason for the higher creep feed intake of these lambs was probably due to the fact that they stayed in the kraal (with their moth-

ers) for the whole of the pre-wean period. Another reason might be the probable lower milk production of their dams.

### **Post wean (wean to 30 kg)**

The average daily feed intake of the lambs (post wean) for the three different trial years, are also presented in Table 3.

During the first season (1986/87) the lambs of all the treatments were weaned during the first week of July. They received the post wean ration for approximately three months before the rams and ewes were separated. From this point the rams received a finishing ration (Table 3) while the ewes received the post wean ration for a further six weeks, before attaining the desired weight of 30 kg. After having reached 30 kg, their ration was changed to the replacement ewe ration (Table 3).

During the second season (1987/88) the lambs of Treatments I and III were weaned one and three weeks later than those of Treatment II respectively. From these various weaning stages the lambs started to utilise the post wean ration together with the other lambs. The ram lambs of Treatments I and II received the finishing ration from the beginning of September, while those of the extensive treatment (Treatment III), due to a lower body mass, utilised the post wean ration until mid September. All the ewe lambs received this post wean ration until the end of September.

During the third season the lambs which received creep feed were weaned at the beginning of August and those of the extensive treatment three weeks later. The ram lambs received this post wean ration for approximately two and a half months during this year, while the ewe lambs utilised it for four months before attaining an average mass of 30 kg.

### **Replacement ewes**

As was mentioned earlier, these ewes were allocated to their various winter treatments during mid May (6 months old) till the end of the winter period (on average eighteen months old). At this stage these young ewes were grouped together with the adult ewes of the respective treatments and were mated.

The feeding of the young ewes of the various treatments were:

### **Intensive treatment (Treatment I)**

These ewes were restricted to 3 kg silage/ewe/day (on 'as is' basis). With mass gain as criteria, attempting to prevent excessive fattening of the replacement ewes, the amount of silage provided to these ewes [1 kg dry matter (DM) ~ 9,0 MJ ME and 90 g CP] were basically similar to that supplied to the non-lactating ewes, (Chapter 1). During the third season, however, due to insufficient growth by these young ewes, the amount of silage provided to them was increased from the beginning of September and this resulted in the daily silage intake averaging 3,5 kg/animal/day for the whole of the winter period. In addition to the silage, a nitrogen-containing lick (as was presented in Chapter 1) was also made available to these ewes. The daily lick intake of these animals averaged 85.7 g/ewe over the three winter seasons.

### **Semi-intensive treatment (Treatment II)**

Due to a lack in cultivated pastures (foggage) at the start of the trial, the replacement ewes of the semi-intensive treatment had to graze on veld with the replacement ewes of the extensive treatment until they started utilising maize crop residues. After they were removed from the crop residues, these young ewes were able to utilise foggage until the end of the winter period. During the period that these ewes grazed on winter veld and foggage they received a daily supplementation of 250 g chocolate maize/ewe, due to insufficient mass gain. During the second and third seasons these ewes utilised maize crop residues for approximately two months during mid winter (depending on the harvesting date). While they utilised foggage, during the remainder of the winter period, these young ewes again received a chocolate maize supplementation, which varied between 125 and 250 g/head/day. A nitrogen-containing lick was also supplied to the animals during this period. The lick intake during the three trial years averaged 51.6 g/ewe/day for the replacement ewes of the semi-intensive treatment. This figure includes the lick intake during the period that they grazed on the crop residues.

### **Extensive treatment (Treatment III)**

The replacement ewes of the extensive treatment that grazed winter veld for the duration of the winter period also received a daily chocolate maize supplementation (that varied between 125 and 250 g/ewe) during the three different trial years. Their winter lick intake during these years averaged 63.8 g/ewe/day.

### **Finishing period**

During Year 1 the finishing rams were slaughtered in two groups. The period that these two groups received the finishing ration was 5 and 9 weeks respectively. During the second season the rams were also slaughtered in two groups (third week of August and the first week of November).

The large difference in the length of the finishing period (for the rams of all three treatments) is mainly because of the fact that minimal selection was done on these rams after weaning. During Year 3 the first rams were slaughtered at the beginning of January and after that fortnightly (after they had been weighed).

### **Mass changes**

The birth mass, the pre- and post wean ADG of the lambs, as well as the mass gain of the ewe lambs, while receiving the replacement ewe ration, during the various years are presented in Table 4.

### **Birth mass**

#### ***Winter Treatment***

From Table 4 it is evident that the lambs of the silage treatment showed the lowest ( $P>0.05$ ) birth mass. The only significant differences as far as the birth masses of the lambs are concerned, however, occurred during the first year when the average birth mass of the lambs of Treatment III was significantly ( $P<0.05$ ) higher than that of Treatment I. El-Hag *et al.* (1998) stressed the importance of 'steaming' up during late pregnancy to increase lamb birth weights, while Clarke *et al.* (1997) stated that maternal bodyweight critically influences placental weight, lamb size and survival after birth. McNeill *et al.* (1998) suggested that when ewes, varying in body condition, are fed *ad lib.* during pregnancy the placenta places an upper limit to the amount of nutrients that can reach the foetus, so that even when a lean ewe eats more than a fat ewe, the extra nutrients are partitioned toward maternal reserves rather than to the foetus. This probably accounted for the higher body mass of the ewes from the more intensive winter treatments not being reflected in the birth masses of their progeny.

#### ***Summer Treatment***

There were no significant differences present during the duration of the trial, regarding birth masses, between the two summer treatments.

### **Pre wean gain**

#### ***Winter Treatment***

The lambs that received creep feed (silage or foggage/crop residues) had disappointing mass gains during the first season, when compared to the veld treatment (Table 4). It thus appears as if the creep feed intake during this particular season (Table 3) was too low to influence the mass

**TABLE 4** Birth mass of the lambs and their average daily gain (g/day) during the pre- and post wean periods.

	TREATMENTS						CV (%) <sup>1</sup>
	WINTER			SUMMER		Avg.	
	I	II	III	A	B		
<b>BIRTH MASS (kg)</b>							
YEAR 1 (1986/87)	4.17 <sup>a</sup>	4.59 <sup>ab</sup>	4.6 <sup>b</sup>	4.46	4.48	<b>4.47</b>	20.96
YEAR 2 (1987/88)	4.16	4.55	4.24	4.24	4.40	<b>4.31</b>	21.42
YEAR 3 (1988/89)	4.14	4.43	4.40	4.38	4.27	<b>4.33</b>	19.51
<b>PRE-WEAN GAIN</b>							
YEAR 1 (1986/87)	173.16	192.60	194.03	195.86	178.06	<b>186.60</b>	17.15
YEAR 2 (1987/88)	194.02 <sup>a</sup>	222.70 <sup>b</sup>	158.43 <sup>ab</sup>	193.63	190.82	<b>192.11</b>	18.25
YEAR 3 (1988/89)	169.64 <sup>a</sup>	185.92 <sup>a</sup>	121.93 <sup>b</sup>	166.63	155.99	<b>161.71</b>	15.93
<b>POST WEAN GAIN</b>							
YEAR 1 (1986/87)	212.24 <sup>a</sup>	255.71 <sup>b</sup>	239.77 <sup>ab</sup>	230.26	241.55	<b>236.24</b>	19.11
YEAR 2 (1987/88)	241.85	258.82	252.38	256.05	245.64	<b>251.27</b>	19.03
YEAR 3 (1988/89)	132.42	135.77	144.40	139.20	134.45	<b>137.24</b>	18.48
<b>REPLACEMENT EWE RATION</b>							
YEAR 1 (1986/87)	73.40	69.40	70.20	73.41	68.58	<b>71.00</b>	11.35
YEAR 2 (1987/88)	26.66	27.40	21.38	34.53	15.76	<b>25.15</b>	15.40
YEAR 3 (1988/89)	17.42 <sup>a</sup>	19.29 <sup>a</sup>	42.41 <sup>b</sup>	29.94	22.80	<b>26.37</b>	18.53

<sup>1</sup> Coefficient of variation

<sup>a-d</sup> Values in the same row with different superscripts, for the respective summer and winter periods, differ significantly (P<0.05)

<sup>w-z</sup> Values in the same row with different subscripts, for the respective summer and winter periods, differ highly significantly (P<0.01)

**Winter Treatments**

I - Silage  
 II - Foggage/crop residues  
 III - Veld

**Summer Treatments**

A - Cultivated pastures  
 B - Veld

gains of the lambs. When such low intakes are realised, the provision of creep feed would probably be uneconomical. It was only during the third season that the provision of creep feed caused significant (P<0.05) differences (Table 4).

From Table 4 it is evident that the lambs of the ewes grazing foggage/crop residues had a higher ADG than the lambs of the silage treatment. However, these differences were only significant during the second year ( $P < 0,05$ ). This was despite the higher creep feed intake of the lambs of the intensive treatment (Table 3). In terms of body mass changes, the ewes receiving silage had the better performance (Chapter 1). This probably supports the conclusion that, although the feeding of silage to ewes seems beneficial in term of their body mass and body mass gain, this advantage is neither transferred to their wool growth nor to the mass gain of their progeny. There seems to be two possible reasons for this. Firstly, especially in the case of wool growth, this could probably be attributed to the high non-protein nitrogen- (NPN-) content of the silage. Secondly, this high NPN-content of the silage also seemed to have an adverse effect on the milk production of the ewes. Esmail (1999) stressed the fact that silage as a sole feed source was inadequate to support sufficient milk production. Hence the poor growth of the lambs of the silage treatment. Coetzee & Dyason (1967) also emphasised the importance of supplementation (especially protein supplementation) when lactating woolled sheep were fed maize silage. However, milk production was not measured in the current investigation.

During the second and third years the pre-wean gains of the lambs of the extensive treatment was appreciably lower than that of the animals of both the other two treatments (Table 4). This was probably due to the fact that they did not receive any creep feed, The lower body mass (Chapter 1) and probably poorer body condition of the ewes that were kept on winter veld could also play a role.

### ***Summer Treatment***

No significant differences occurred between both the pre- and post wean performance of the lambs of the two summer treatments. There was, however, a tendency for the lambs of the cultivated pasture treatment to perform better than the progeny of the ewes grazing summer veld (Table 4).

### **Post wean gain (wean to 30 kg)**

#### ***Winter Treatment***

The only significant difference ( $P < 0.05$ ) occurred during the first season when lambs originating from the silage treatment showed a slower growth rate than lambs from Treatment II. During the next two years the silage treatment tends to show a lower growth rates (Table 4). From these results it seems that the winter treatments of the ewes had a negligible influence on the post wean gains of their progeny.



The ADG of the lambs (both pre- and post wean) from all the treatments were considerably lower during the third year. The poorer pre-wean ADG's must probably be attributed to a similar poorer performance and lower body mass of their dams during this year (Chapter 1). This carry-over effects was still present during the post wean period.

Regarding growth rates (post wean) these results were superior to results obtained by Van Vuuren & Nel (1983b) who obtained an average ADG of 174 g/day with Merino lambs on a ration containing 12.5 MJ digestible energy (DE)/kg and 13.6 % CP. Schoonraad *et al.* (1988), on the other hand, obtained an ADG of 186 g/day with Dohne Merino lambs receiving a complete ration (12.5 MJ DE/kg; 14 % CP) with maize residues as a roughage source. It must, however, be pointed out that the roughage in the current study was ground *Eragrostis curvula* hay.

### ***Summer Treatment***

No significant differences occurred between both the pre- and post weaning performance of the lambs which can be attributed to the dams' summer treatment. This was probably because the lambs were born at the end of the summer period.

## **Replacement ration**

### ***Winter treatment***

During the period that these ewes received the replacement ration no significant differences occurred between the ewes of silage and foggage/crop residue treatments. The gain of the ewe lambs of the extensive treatment recorded during the third year (1988/89), was significantly ( $P < 0.05$ ) higher than that of the other two treatments (Table 4). The only logical explanation for this is the possibility that compensatory growth still occurred in these ewe lambs which did not receive creep feed during the pre-wean period (carry-over effects). The fact that the mass gain of the lambs during the first year (1986/87) was noticeably higher than that of the other two seasons, is due to the fact that these lambs were not shorn during this period, as was the case during the other two years.

### ***Summer treatment***

The summer treatment of the adult ewes had no significant influence on the performance of the ewe lambs (Table 4).

## Replacement ewes

The mass gains of these ewes, for the period that they were allocated to their winter treatments (same treatments as the adult ewes) are presented in Table 5.

**TABLE 5** Average daily gain (g/day) of the replacement ewes during the winter period

	TREATMENTS						CV (%) <sup>1</sup>
	WINTER			SUMMER		Avg.	
	I	II	III	A	B		
<b>WINTER PERIOD</b>							
<b>YEAR 1</b> (1986/87)	56.58 <sub>w</sub>	47.19 <sub>w</sub>	27.71 <sub>x</sub>	44.17	43.48	<b>43.83</b>	20.43
<b>YEAR 2</b> (1987/88)	59.94 <sub>w</sub>	42.54 <sub>x</sub>	47.80 <sub>x</sub>	52.47	47.72	<b>50.09</b>	16.97
<b>YEAR 3</b> (1988/89)	91.06 <sub>w</sub>	68.87 <sub>x</sub>	46.38 <sub>y</sub>	77.25 <sub>w</sub>	60.29 <sub>x</sub>	<b>68.77</b>	20.68

<sup>1</sup> Coefficient of variation

<sup>a-d</sup> Values in the same row with different superscripts, for the respective summer and winter periods, differ significantly (P<0.05)

<sup>w-z</sup> Values in the same row with different subscripts, for the respective summer and winter periods, differ highly significantly (P<0.01)

### Winter Treatments

- I - Silage
- II - Foggage/crop residues
- III - Veld

### Summer Treatments

- A - Cultivated pastures
- B - Veld

### *Winter treatment*

It appears that the quantity of silage (1 Kg DM) provided to the replacement ewes of the intensive treatment (Treatment I) was sufficient to assure an acceptable mass gain (Table 5). During the second and third winter seasons the mass gains of these ewes were significantly (P<0.01) higher than that of the animals from the other two winter treatments. During the third year the animals grazing winter veld also had a significantly lower (P<0.01) mass gain than the animals of the foggage crop residue treatment (Table 5). This superiority of the silage treatment regarding body mass gains was similar to that of the adult ewes (Chapter 1).

The significantly (P<0.01) lower body mass gains of the replacement ewes utilising winter veld, compared to the other two winter treatments, during Years 1 and 3 probably points to the fact that wintering replacement ewes on veld from approximately 12 months of age was not a viable option. If available, an alternative wintering strategy should be recommended. Rhind *et al.* (1998) concluded that undernutrition of female lambs during the first months of life, results in a

reduction in lifetime reproductive performance. This occurred irrespective of nutrition during adult life and these authors recommended that food resources should be diverted, where possible to this phase of the production cycle to ensure that subsequent reproduction is not compromised.

### ***Summer Treatment***

Regarding the summer period, the only significant difference were the significantly ( $P < 0.01$ ) better growth of the ewes from the cultivated pasture treatment during the third season (Table 5).

### **Wool production**

The influence of the different feeding systems on the quantitative and qualitative wool production of these replacement ewes is presented in Table 6.

### ***Winter Treatment***

Wintering treatment did not influence fibre diameter ( $P > 0.05$ ) of the wool (Table 6), indicating that for the replacement ewes, nutritional differences were not sufficient to influence fibre diameter. Denney *et al.* (1988), however, found that post natal undernutrition of Merinos decreased fleece weight at one year of age. It must be kept in mind, however, that the replacement ewes in the current trial received their different nutritional treatments only from the middle of the year.

Despite the fact that ewes utilised maize crop residues during all three years, clean wool yield was only significantly influenced during the second season, with varying degrees of significance, as indicated in Table 6.

Treatment I consistently returned the highest clean wool yields, which can be ascribed to the fact that they were wintered in pens and fed maize silage. No consistent pattern of clean wool mass emerged from the results. All the treatments returned the highest average fleece mass during different years. This probably indicated that no treatment experienced nutritional stress, despite differences in mass gains. A possible reason for these contradictory results is the fact that these replacement ewes received the same treatment for a large part of the year. Once again the different degrees of significance are indicated in Table 6.

**TABLE 6** Wool production characteristics of the replacement ewes from the different treatments during the various years

	TREATMENTS						CV (%) <sup>1</sup>
	WINTER			SUMMER		Avg.	
	I	II	III	A	B		
<b>FIBRE DIAMETER (<math>\mu</math>)</b>							
<b>YEAR 1 (1986/87)</b>	18.93	19.81	19.43	19.16	19.49	<b>19.34</b>	7.57
<b>YEAR 2 (1987/88)</b>	18.72	18.64	19.24	18.39 <sup>a</sup>	19.51 <sup>b</sup>	<b>18.87</b>	6.79
<b>YEAR 3 (1988/89)</b>	19.68	20.49	19.80	19.84	20.19	<b>19.98</b>	7.62
<b>CLEAN YIELD (%)</b>							
<b>YEAR 1 (1986/87)</b>	68.28	64.14	62.07	64.57	66.43	<b>65.59</b>	5.05
<b>YEAR 2 (1987/88)</b>	72.88 <sup>a</sup> <sub>x</sub>	67.63 <sub>y</sub>	69.42 <sup>b</sup>	70.68	68.51	<b>69.75</b>	6.27
<b>YEAR 3 (1988/89)</b>	71.58	69.23	70.83	71.59 <sup>a</sup>	69.03 <sup>b</sup>	<b>70.59</b>	5.61
<b>CLEAN WOOL MASS (KG)</b>							
<b>YEAR 1 (1986/87)</b>	3.20	3.20	2.85	3.14	3.12	<b>3.13</b>	11.78
<b>YEAR 2 (1987/88)</b>	2.39 <sub>x</sub>	2.74 <sup>a</sup>	2.92 <sup>b</sup> <sub>y</sub>	2.73	2.51	<b>2.63</b>	11.77
<b>YEAR 3 (1988/89)</b>	3.08 <sup>ab</sup>	3.35 <sup>a</sup>	2.99 <sup>b</sup>	3.17	3.18	<b>3.17</b>	13.83

<sup>1</sup> Coefficient of variation

<sup>a-d</sup> Values in the same row with different superscripts, for the respective summer and winter periods, differ significantly (P<0.05)

<sup>w-z</sup> Values in the same row with different subscripts, for the respective summer and winter periods, differ highly significantly (P<0.01)

**Winter Treatments**

I - Silage  
 II - Fodder/crop residues  
 III - Veld

**Summer Treatments**

A - Cultivated pastures  
 B - Veld

**Summer Treatment**

The ewes of the summer veld treatment had the highest fibre diameter. This was in contrast to what one would normally expect, but was similar to results obtained by the adult ewes (Chapter 1). However, this was only significant (P<0.05) during the second season (Table 6). Langlands & Bennet (1973) found that fibre diameter was reduced by more harsh feeding conditions. A possible explanation to results obtained in the present study could be the veld condition being superior to the cultivated pasture, especially during the second season. Masters *et al.* (1998) concluded that both the initial liveweight and liveweight change exerted an influence on the staple strength and wool growth.

### Finishing period

The mass gains of the ram lambs, which received a high-energy ration during the finishing period, as well as the slaughter data of these rams (average carcass mass, dressing percentage and carcass grading) are presented in Table 7.

**TABLE 7** Average daily gain, carcass mass (kg) and dressing percentage of the finished rams during the various years

	TREATMENTS					Avg.	CV (%) <sup>1</sup>
	WINTER			SUMMER			
	I	II	III	A	B		
<b>AVERAGE DAILY GAIN</b>							
YEAR 1 (1986/87)	184.86	181.80	212.14	194.41	195.13	<b>194.82</b>	17.06
YEAR 2 (1987/88)	229.32	250.29	228.28	239.29	235.20	<b>237.00</b>	19.03
YEAR 3 (1988/89)	142.69	155.91	165.80	160.02	146.46	<b>153.02</b>	19.59
<b>CARCASS MASS (kg)</b>							
YEAR 1 (1986/87)							
YEAR 2 (1987/88)	16.54	17.10	16.54	17.40	16.37	<b>16.77</b>	12.11
YEAR 3 (1988/89)	16.33	16.62	16.28	16.26	16.69	<b>16.46</b>	9.05
<b>DRESSING PERCENTAGE</b>							
YEAR 1 (1986/87)							
YEAR 2 (1987/88)	43.32	42.38	42.46	43.76	42.38	<b>42.91</b>	6.33
YEAR 3 (1988/89)	39.96	40.48	40.34	40.06	40.66	<b>40.34</b>	5.73
<b>CARCASS GRADING – POINT SYSTEM</b>							
YEAR 1 (1986/87)							
YEAR 2 (1987/88)	7.18	6.76	6.14	6.91	6.58	<b>6.73</b>	17.51
YEAR 3 (1988/89)	6.00 <sup>b</sup>	6.86 <sup>a</sup>	6.06 <sup>ab</sup>	6.60	6.30	<b>6.46</b>	19.70

<sup>1</sup> Coefficient of variation

<sup>a-d</sup> Values in the same row with different superscripts, for the respective summer and winter periods, differ significantly (P<0.05)

<sup>w-z</sup> Values in the same row with different subscripts, for the respective summer and winter periods, differ highly significantly (P<0.01)

#### Winter Treatments

- I - Silage
- II - Fodder/crop residues
- III - Veld

#### Summer Treatments

- A - Cultivated pastures
- B - Veld

During the first season (86/87) some of the rams were used for other purposes and could not be slaughtered. There were thus not enough data collected during the data for this season and they were consequently not included in the statistical analysis.

The rams were slaughtered as they reached the desired mass (42 kg). This resulted in different finishing periods, even within a treatment. Despite this, there were no significant differences in the daily mass gains between any of the treatments during the trial, both for the winter and summer periods (Table 7). The marked poorer mass gain of the rams of all the treatments during the third year is probably linked to the fact that poor growth rates was manifested in all phases during the third year. This is also in agreement with the poor performance of the ewes (Chapter 1). An explanation for these results is difficult to find.

As can be seen in Table 7, there were no significant differences ( $P > 0.05$ ) in the carcass mass and dressing percentage of the rams at slaughtering. Regarding carcass grading the only difference between the intensive and semi-intensive winter treatments ( $P < 0.05$ ) occurred during the 1988/89-season when the lambs of the semi-intensive treatment attained a higher grading.

Despite the fact that the animals were slaughtered at a set body mass, the carcass grading of Treatment III (extensive treatment) seems to be lower than that of the other two treatments. During the second season (1987/88) the carcass grading of the animals of Treatment I was higher than that of Treatment III. During the third season, however, the carcass grading of the animals of the semi-intensive treatment were also markedly better than that of Treatment III. This implies that, although the animals basically had the same carcass mass and dressing percentage, the progeny from the extensive treatment, did not have enough subcutaneous fat and the necessary fat distribution to obtain the desired grading despite the fact that they received the same treatment post wean.

These results agree with those obtained by Marais *et al.* (1991) who found that the deposition of fat declined with increasing feed restriction. Clarke *et al.* ((1997) stated that maternal bodyweight influences lamb size and condition after birth. Denney *et al.* (1988) , on the other hand, concluded that prenatal undernutrition had no permanent effect on progeny liveweight over the first three years of their life. Alden (1970) stated that although restricted nutrition of penned animals during prenatally postnatal life may permanently affect mature liveweight and carcass composition the evidence from field experiments is not conclusive. Murphy *et al.* (1994) also came to a similar conclusion and made the allegation that information is lacking on the overall effect of different finishing systems on growth performance and carcass composition of lambs. The results obtained with the extensive system (veld treatment) supports the statement that was made earlier that an alternative feed source, where available, should be utilised for woolled sheep during the winter period.

## CONCLUSIONS

From the results of this study it seems that the body mass advantage of the ewes in the intensive treatment during winter (receiving silage in kraal for the whole of the winter period) was not reflected in the performance of their progeny. However, the poorest pre-wean gains were recorded from the lambs of the veld treatment.

Post wean the lambs of the silage treatment showed the lowest growth rates. The fattened rams from all the treatments were slaughtered at the same body mass and basically had the same growth rate during the finishing period, dressing percentage and carcass mass. Despite this, the rams from the extensive treatment still showed the lowest grade.

Furthermore, it can be concluded that (based on body mass gains), where available, an alternative feed source should be provided to the replacement ewes of the extensive treatment (Treatment III) during winter to ensure sustained productivity throughout their lifetime. However, this was not fully supported by the results of the wool growth, which did not indicate severe nutritional stress.

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# **PART 3**

**Various feeding strategies for  
woolled sheep in a spring  
lambing season in the Western  
Highveld.**

## Chapter 1

### Different feeding strategies for woolled sheep in a spring lambing season: ewe performance

#### INTRODUCTION

Improved animal production, brought about by enhanced efficiency, should be the aim of any animal production system. Van Marle (1982) stated that an increase in the effectiveness of production could be brought about by better utilisation of available sources, adapted farming systems and the elimination of problem areas. This author also stated that this enhanced production is applicable to both intensive and extensive systems. Luitingh (1978) promoted production systems research and stated that a great need exists for the formulation or the establishment of efficient and economical livestock production systems. An effective research program remains the source of new information and specific problem areas can be addressed, enabling the relevant farming enterprise to be run successfully and profitably (Van Rooyen, 1979).

To be effective essentially means that the specific enterprise also has to be adapted and in harmony with the environment. Van Wyk (1980) also stressed this aspect and gave extensive crop production as an example. De Wet (1980) alleged that, apart from the primary function of food production, the primary goal of agriculture is to create a balance between the different enterprises, facilitating efficient farming systems. McClymont (1976) stressed that adapted systems should be economically viable, ecologically sound and socially acceptable, while Le Riche (1982) promoted production systems which are in harmony with the environment. Carter & Day (1970) also stressed the importance of the continuous evaluation of certain inputs, for example fertilising cultivated pastures, seen against increasing cost of production vs. relatively constant prices for animal products.

In order for a production system to be in harmony with the environment the food sources that can be produced economically in the specific environment, have to be utilised to an optimum level, while the limitations of the specific area have to be taken into account.

Ample documented evidence exists regarding the low nutritive value of veld in the highveld areas during winter months (Du Toit *et al.*, 1940; Du Plessis & Venter, 1967; Coetzee *et al.*, 1968a; Coetzee *et al.*, 1968b; Louw *et al.*, 1972; Louw, 1979; Henning & Barnard, 1982; Engels, 1983). Wintering thus remains an area of major concern in these areas (Van Pletzen *et al.*, 1991; Henning & Barnard, 1991). Niemann (1964) stated that this nutritional limitation is much more a case of a qualitative than

a quantitative deficiency. A spring lambing season probably has the advantage that the ewes are not lactating during winter. Engels (1983) stressed the fact that, although winter veld may be abundant, it is of low nutritional value and fails to meet the requirements of producing animals. A number of authors proposed various nitrogen sources in alleviating the problems of poor veld quality (Swart & Van der Linde, 1966; Kemm & Coetzee, 1967; Van der Merwe, 1967; Henning & Barnard, 1982; Bekker & Stoltz, 1983; Aitchison *et al.*, 1988). Various alternative roughage sources, applicable to this region, have also been investigated in an attempt to alleviate the nutritional problems experienced during the winter months.

Silage has been extensively investigated as a feed source for sheep (Coetzee & Dyason, 1967; Coetzee & Vermeulen, 1967; Reyneke, 1971; Boshoff *et al.*, 1977; Boshoff *et al.*, 1979; Boshoff *et al.*, 1980; Unal *et al.*, 1987; Cilliers *et al.*, 1998). Reyneke (1967) also investigated the potential of silage as a feed source for lactating ewes. This feed source can successfully be used as a feed source for spring lambing ewes.

Maize crop residues also received attention (Van Pletzen *et al.*; 1991, Schoonraad *et al.*, 1988a; Esterhuyse *et al.*, 1991a; Snyman *et al.*, 1993). Schoonraad *et al.* (1988b) concluded that maize crop residues can be used successfully as a roughage source for woolled sheep if both energy and protein are supplemented. It is desirable that crop residues be grazed as soon as possible after harvesting, before weathering decreases quality (Esterhuyse *et al.*, 1991b). Ewes lambing during spring has the advantage that maize crop residues are available during late pregnancy when fetal growth are at a maximum (Jainudeen & Hafes, 1980).

Cultivated pastures could also be used with a high measure of success in alleviating the pressure on veld during the winter months (Rethman & Gouws, 1973; Dannhauser *et al.*, 1986; Dannhauser, 1988; Meissner & Paulsmeier, 1988; Van Vuuren *et al.*, 1997). According to Meissner *et al.* (1989), the production potential of sheep grazing cultivated pastures is more a function of qualitative than of quantitative intake.

Above-mentioned results were, however, obtained by means of component research where the value and potential of a single feed source was investigated in isolation. Due to the fact that animal production is such a complex matter, much more of an holistic approach was needed.

Parallel to the autumn lambing season (Part 2, Chapter 1) a trial with ewes in a spring lambing season was also implemented at the same locality. The trial was performed over three consecutive seasons (April 1986 – March 1989). Certain aspects, in common with this trial, were reported in that chapter and will be referred to as Part 2.

## PROCEDURE

The various feeding strategies, as described in detail in Part 2, Chapter 1, varied from an intensive system, where the animals received silage in a pen during winter and grazed on cultivated pastures during the summer months, through decreasing levels of intensification to a fully extensive system, where the animals only received veld grazing for the whole year.

The different treatments to which the ewes were exposed, can be summarised as follows:

### Winter treatments:

- Treatment I : Maize silage in a pen for the duration of the winter period (Intensive treatment).
- Treatment II : Fertilised dormant cultivated pastures and maize crop residues (Semi-intensive treatment).
- Treatment III : Dormant winter veld, which had been rested (ungrazed) for the entire summer period. (Extensive treatment).

A winter lick (Table 1), as well as strategic supplementation [chocolate maize - 11.5 megajoules (MJ) metabolisable energy (ME)/kg and 14 % crude protein (CP)] was provided to all the ewes during the winter period.

**TABLE 1** Composition of the nitrogen-containing lick (winter lick)

INGREDIENT	(%)
Groundnut oilcake meal	40
Salt	30
Dicalcium phosphate	15
Urea	10
Molasses	5

### Summer treatments:

- Treatment A - Cultivated pastures.
- Treatment B - Summer veld.



A salt-phosphate lick (50 % salt, 47 % dicalciumphosphate and 3 % flour of sulphur) was supplied to animals during summer.

Two hundred and ten (210) Merino ewes (medium wool), stratified according to wool characteristics, body mass and age were randomly allocated to one of six possible nutritional treatments. Managerial aspects that differed from the autumn lambing season are the following:-

- The ewes were mated from the beginning of April and started lambing during the first week of September.
- The lambs were weaned at the end of November.
- Towards the end of November (after their lambs had been weaned) ewes were re-allocated to their various summer treatments until mid May at which stage the winter treatments of the following season commenced.
- The ewe lambs (three to four months of age) were shorn during mid January and consequently had twelve months wool growth at the time of shearing during the next season.

Statistical analysis of data was similar to that of Part 2. As was the case in Part 2, the independent factors were only included when they exerted a significant influence on the results and the necessary adjustments were made to the mass changes involved. Analysis of reproductive performance (lambing- and weaning percentages) was based on flock performance.

## **RESULTS AND DISCUSSION**

### **RAINFALL**

The average monthly rainfall figures recorded during the trial are presented and discussed in Part 2.

### **ANIMAL PERFORMANCE**

#### **Feed Provision and lick intake**

##### ***Winter Treatment***

##### **Silage (Treatment I)**

From the start of the winter period of all three winter seasons the non-lactating ewes of Treatment I received 3 kg of wet silage/head (approximately 1 kg DM) until the lambing period started (NRC, 1985). Due to pregnancy toxæmia, which did occur during Year 1, certain nutri-

tional adjustments were made for the rest of the trial. The quantity of silage was increased, during the last two weeks of late pregnancy and the first month of the lactation period, to a daily allowance of 4 kg/head. An additional allowance of 125 g chocolate maize/ewe/day (energy supplementation) were also supplied to these ewes. The winter lick intake of these ewes were basically similar to that recorded with the autumn lambing season and varied between 82 and 118 g/ewe/day during whole winter period the various trial years.

At the start of lactation the quantity of silage provided to the ewes was normally increased to provide in their increased nutritional requirements. However, the body mass and performance of the ewes were used as parameters to determine the quantity of silage provided during lactation for the different years. The daily silage intake of the ewes during lactation averaged 4.2; 5.5 and 3.0 kg/head for Years 1 to 3 respectively. These intakes were basically similar to that of the autumn lambing season (Part 2). The variation in the quantity supplied and animal performance was probably largely due to silage quality. As the body condition of the ewes was good during the third season, the quantity of silage was not increased. However, in an attempt to curb the occurrence of pregnancy toxemia, the ewes received an energy supplementation during Years 2 and 3 (125g/ewe/day) from late pregnancy and for the first month of lactation. Holst & Allan (1992) also stressed an increased nutrition level during the last month of pregnancy to reduce the incidence of pregnancy toxemia.

Various authors stressed the advantage of a succulent feed for lactating ewes (Van Niekerk & Barnard 1969; Reyneke, 1967; Reyneke, 1971; Fair & Reyneke, 1972; Van Heerden & Reyneke, 1974). De Villiers *et al.* (1993) accentuates the valuable contribution that a sufficient milk supply has on lamb growth. Jordan & Mayer (1989) also showed the important role that milk yield exerts in determining growth rate of Merino lambs. In their investigation variation in milk yield accounted for 56 % of the variation in lamb growth rate. Although ewe mass and lamb birth mass also had a significant effect on lamb growth rate, these effects disappeared by the inclusion of milk yield in their regression model.

Penzhorn (1945), however, pointed out that, owing to uncertain rainfall and other climatological factors, green pastures cultivated under dryland conditions, would not be a viable option for these highveld areas. Preller and Coetzee (1964) supported this viewpoint. Reyneke (1971) stressed the need for alternative feeding systems in case of pasture failure.

### **Foggage/crop residues (Treatment II)**

It was necessary to provide energy supplementation (250 g chocolate maize/ewe/day) from the start of the winter season (early pregnancy) in Treatment II (foggage/crop residues) during the first year (1986/87), due to the body condition of the ewes. After the ewes had utilised the

maize crop residues for the periods described in Part 2, they were returned to foggage and received a daily energy supplement during late pregnancy. Supplementation, the quantity again determined by the body condition of the ewes, varied between 250 and 500 g/day for the different years. The average winter lick intake (Table 1) of the ewes that received foggage/crop residues varied between 65 and 160 g/ewe/day.

Cloete & Brand (1990) pointed out the advantages of supplementing lactating ewes. They concluded that supplementation resulted in some biological gain. These authors cautioned, however, that economic benefit of supplementation couldn't readily be assumed and alleged that there is merit in the assessment of the adequacy of supplementation on an objective basis.

The lick intake of these ewes that nursed lambs during spring and early summer was higher than that of the ewes in the autumn lambing season. The lick intake varied between 58 and 72 g/day during the various years. The higher lick intake can probably be ascribed to the fact that ewes suckling lambs during spring received less supplementation. Van Pletzen *et al.* (1991) stressed the need for nitrogen and energy supplementation on winter grazing, especially for lactating ewes. They also accentuated the strategic value of maize crop residues in the wintering of livestock in terms of the time of the year that they become available (June to August). Van Niekerk & Schoeman (1993) pointed out the benefits of wintering small stock on crop residues and claimed it mainly to be an economic advantage.

### **Veld (Treatment III)**

Body condition necessitated that ewes which grazed veld during winter (Extensive treatment - Treatment III) received an energy supplementation (250 g chocolate maize/ewe/day) from approximately a month after the start of the winter period in Year 1. De Waal & Biel (1989) stressed the fact that supplementation of energy and protein to Merino ewes on veld must be in combination in order to have any significant effect on animal performance. During the next two years these ewes only received a winter lick until a month before lambing. During the last month of pregnancy the ewes received a daily supplementation in the form of 250 g chocolate maize/ewe. During lactation this amount was increased to 500 g/day. The daily winter lick intake of these ewes averaged 112 g/day during the three winter seasons.

Schinckel & Short (1961) found the pre-natal feeding of ewes to be crucial. These authors observed with Merino sheep that if the level of pre-natal feeding was low enough that there was a marked depression in fetal growth. In extreme cases this retarded weight growth was a permanent one and was carried through to maturity. According to McNeill *et al.* (1997) the fetus of a leaner ewe has to compete with a demand for the replenishment of previously lost maternal tissues. This potentially results in less nutrients for the fetus relative to the case had the

ewe been in better condition. This was especially important for the ewes grazing on winter veld in an to attempt to provide sufficient nutrients for lamb growth.

### ***Summer Treatment***

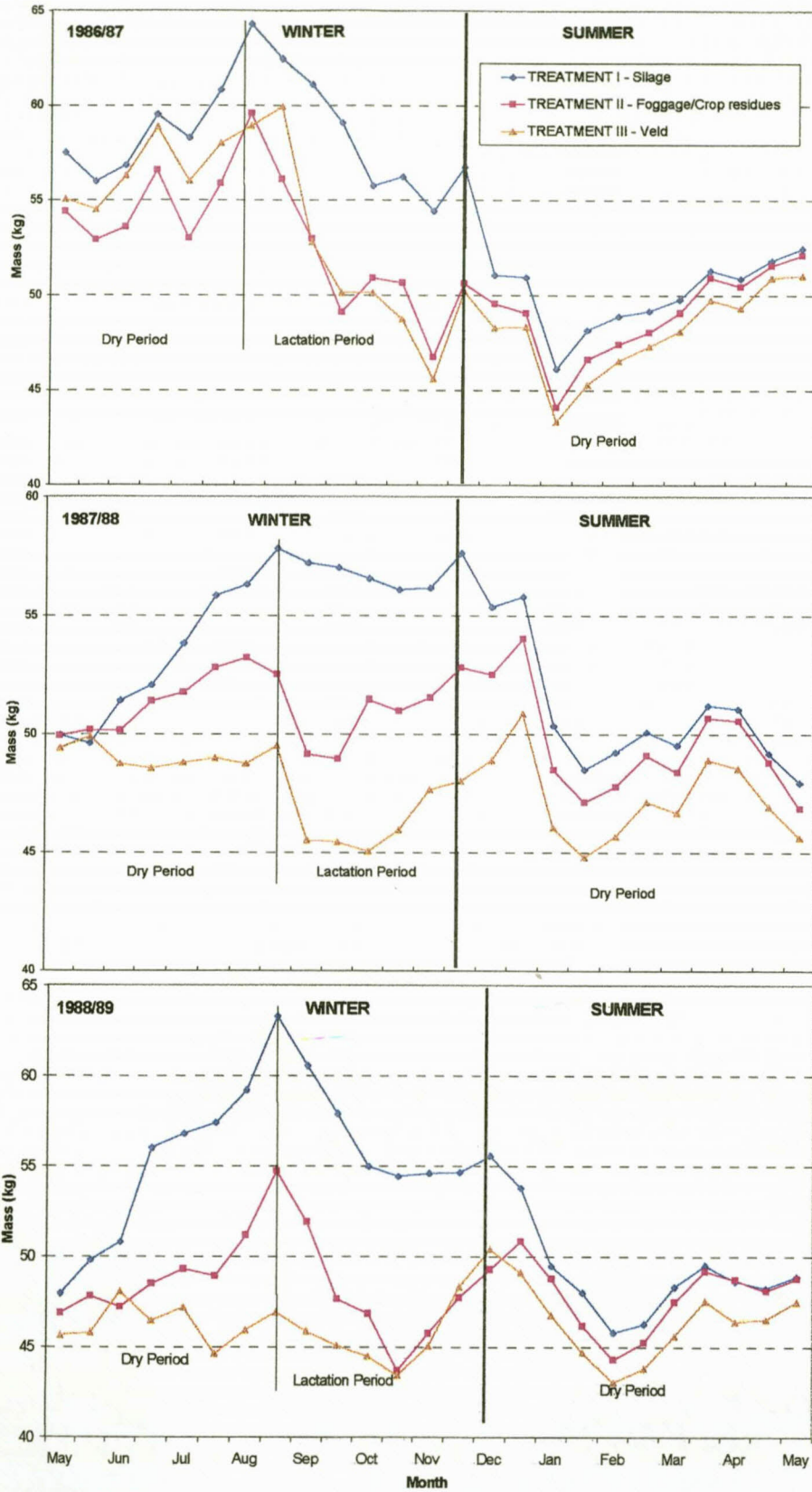
Ewes that utilised cultivated pastures averaged a summer lick (Part 2, Chapter 1) intake of 6.6 (5.4 – 8.3) g/ewe/day over the three summer seasons. Ewes grazing summer veld had a lower average summer lick intake of 6.0 (4.9 – 7.0) g/ewe/day. Towards the end of the summer period of Years 1 and 3 (during the mating period) the body condition once again necessitated the supply of flush feeding (between 125 and 250 g chocolate maize/head/day) to the ewes of both summer treatments prior to mating. Venter & Greyling (1994) also found that the flushing of Merinos had a beneficial effect on the reproduction. However, this will ultimately be determined by the body condition of the ewes.

### **Mass changes**

The average body masses of animals in the different treatments, during the various trial seasons, are presented in Figure 1. Mass changes (ADG) are indicated separately for the summer and winter seasons in Table 2. As was discussed in Part 2, this figure and table provide complementary information. The figure shows the tendency of the animals' mass (winter treatments) throughout the year and also provides the statistical differences between treatments during the various phases of the production cycle. The exact ADG's for the summer and winter periods are presented in Table 2.

### ***Winter Treatment***

During all three trial years, the lactation period of ewes grazing winter veld (extensive treatment) was two weeks longer than that of the other two treatments. The body mass of the ewes that received silage in the pen was consistently higher ( $P < 0.01$ ) than the body mass of the other two treatments during the winter period of all three the trial years (Figure 1). During the first year the average body mass of the animals receiving silage was basically the same at the beginning and end of the winter period, while they showed a net gain in body mass over the winter period of the other two years (Figure 1). Regarding the body mass of the ewes that utilised foggage/crop residues and winter veld, they differed between the various years. In the first year a net loss in body mass of these ewes occurred during the winter period. In contrast, body mass was maintained during the next two winter seasons (Figure 1). These differences were mainly determined by the climatic conditions. The rainfall figure during early spring (September/October) of the first year (1986/87) was much lower than the figure for the following two winter seasons (Table 1 – Part 2, Chapter 1). Consequently the grass sprouted earlier during the



**SIGNIFICANCE OF POSITIVE MASS CHANGES**

**1986/87**

Total summer period  
2,3 > 1\*\*

Total winter period  
1 > 3,2\*\*

i) Lactation period  
3 > 2\*\*

ii) Dry period  
2,1 > 3\*\*

**1987/88**

Total summer period  
3 > 2 > 1\*\*

Total winter period  
1 > 2 > 3\*\*

i) Lactation period  
2 > 3\*\*

ii) Dry period  
1 > 2,3\*\*

**1988/89**

Total summer period  
2 > 3 > 1\*\*

Total winter period  
1 > 2 > 3\*\*

i) Lactation period  
2 > 3\*\*

ii) Dry period  
3 > 2 > 1\*\*

\*\*P < 0.01

\*P < 0.05

**FIGURE 1 INFLUENCE OF WINTER FEEDING SYSTEMS ON THE LIVE MASSES OF EWES DURING THE VARIOUS SEASONS**

**TABLE 2** Average mass changes (g/day) during the respective summer and winter periods of the various seasons

	TREATMENTS						CV (%) <sup>1</sup>
	WINTER			SUMMER		Avg.	
	I	II	III	A	B		
<b>SUMMER PERIOD</b>							
<b>YEAR 1</b> (1986/87)	-13.62 <sub>w</sub>	12.20 <sub>x</sub>	6.84 <sub>x</sub>	-3.22 <sub>w</sub>	6.83 <sub>x</sub>	<b>1.81</b>	15.36
<b>YEAR 2</b> (1987/88)	-46.52 <sub>w</sub>	-18.98 <sub>x</sub>	-4.38 <sub>x</sub>	-22.72	-23.86	<b>-23.22</b>	18.42
<b>YEAR 3</b> (1988/89)	-34.14 <sub>w</sub>	-4.16 <sub>x</sub>	-16.01 <sub>y</sub>	-21.22	-14.98	<b>-18.10</b>	19.02
<b>WINTER PERIOD</b>							
<b>YEAR 1</b> (1986/87)	-6.20 <sub>w</sub>	-12.11 <sub>x</sub>	-10.53 <sub>x</sub>	-8.84 <sub>w</sub>	-22.37 <sub>x</sub>	<b>-15.61</b>	20.73
<b>YEAR 2</b> (1987/88)	39.53 <sub>w</sub>	15.37 <sub>x</sub>	-3.06 <sub>y</sub>	20.28 <sup>a</sup>	14.28 <sup>b</sup>	<b>17.28</b>	15.40
<b>YEAR 3</b> (1988/89)	34.70 <sub>w</sub>	9.03 <sub>x</sub> <sup>a</sup>	17.82 <sub>x</sub> <sup>b</sup>	19.27	6.42	<b>12.85</b>	18.42

<sup>1</sup> Coefficient of variation

<sup>a-d</sup> Values in the same row with different superscripts, for the respective summer and winter periods, differ significantly (P<0.05)

<sup>w-z</sup> Values in the same row with different subscripts, for the respective summer and winter periods, differ highly significantly (P<0.01)

There were no interactions between the winter and summer treatments within each year.

#### Winter Treatments

I - Silage  
II - Foggage/crop residues  
III - Veld

#### Summer Treatments

A - Cultivated pastures  
B - Veld

last two seasons. This was responsible for the recovery in body mass of the two grazing treatments (Figure 1). From the latter it appears that under certain climatic conditions, as experienced during Years 2 and 3, it is quite possible for non-producing (dry) animals to maintain their body mass over the whole of the winter period. However, sufficient rainfall during the spring months, with accompanied early sprouting of the grass, is crucial in this regard.

In terms of mass gain, ewes receiving silage had higher gains (P<0.01) during the winters of Years 2 and 3 than those in the other two treatments (Table 2). Their mass loss during the first year were also lower (P<0.01). This was probably due to a lack of recovery in body mass by the two grazing treatments (as was discussed previously). According to West *et al.* (1989), ewes with a poor body condition (low body condition score) have also been associated with high pre-natal- and neonatal lamb mortality, as well as lower lamb survival from birth to wean.

During lactation (the last part of the winter period) no definite pattern/trend could be identified over the various years between the three different winter treatments (Figure 1). The ewes grazing winter veld performed better than those grazing foggage/crop residues during Years 1 and 3 ( $P < 0.01$ ), while the opposite was true during the second season ( $P < 0.05$ ). During all these seasons animals from the silage treatment realised the highest body mass.

De Villiers *et al.* (1995) found that the body mass of lactating ewes were negatively influenced by higher stocking rates (feeding conditions adversely affected and less herbage availability). In the current trial the more harsh feeding conditions were manifested in the quality of the veld, and to a lesser extent the foggage, when compared to the animals receiving pen feeding.

Mass changes of the ewes during summer (mainly because of compensatory growth) showed the opposite reaction when compared to the winter period. During the summer season the ewes of the extensive treatment (winter veld) and those that utilised foggage/crop residues performed better ( $P < 0.01$ ), in terms of body mass gain, than the ewes that received silage during winter (Table 2). The ewes of the silage treatment lost mass during the summer period of all three years. The fact that the ewes were shorn during summer, is probably the reason why these non-lactating animals (with the exception of the animals that grazed foggage/crop residues and veld during the summer period of Year 1) showed a net loss in body mass during the total summer period of all three the trial years (Table 2). The mass of the ewes in all three treatments followed the same trend during the summer period (Figure 1). Although the mass of the ewes grazing winter veld (Treatment III) was constantly lower than that of ewes in the other two treatments, it was not as great as for ewes of the autumn lambing season (Part 2). Ryan *et al.* (1993) stated that sheep could compensate completely, in terms of body mass, after nutritional restriction. Similar to the current study, Greeff *et al.* (1986) concluded that sheep exhibit compensatory growth to varying degrees depending on the previously imposed restriction.

During the non-lactating period, which spanned the whole summer and the first part of the following winter, the ewes that received silage and foggage/crop residues performed better ( $P < 0.01$ ) during all three the years than the ewes of the extensive treatment (winter veld) (Figure 1). It is evident from Figure 1 (especially during Years 2 and 3) that this was mainly due to the poor performance of the ewes grazing veld during the start of the winter period (last part of the non-lactating period). The effect this had on their lambing performance will be discussed at a later stage. It can be concluded that the performance of ewes during late pregnancy and lactation was disappointing when relying on winter veld as main fodder source (despite the supplementation that was provided). As was discussed previously, if another better feed source is economically available, this should rather be utilised during this stage. However, it can also be argued that this should be considered as an extensive treatment with reduced input costs, and the

biological results of this approach should not be considered to be comparable with that of more intensive treatments. An economic evaluation should provide the final answer. According to Al-Sabbagh *et al.* (1995) the body condition of ewes lambing in moderate condition should rather be maintained than supplementing these ewes to increase their body condition score to a higher level.

### ***Summer Treatment***

In contrast to the summer period, the ewes utilising cultivated pasture during summer, throughout the trial, performed better during the winter period than the animals grazing veld (Table 2).

### **Wool production**

Quantitative and qualitative wool production parameters (as discussed in Part 2) were determined and are presented in Table 3.

### ***Winter Treatment***

In agreement with Part 2, Chapter 1 the highest fibre diameter ( $P < 0.05$ ) was observed in the foggage/crop residue treatment. This probably due to a high energy feed available to them during mid winter (Van Pletzen *et al.*, 1991).

Regarding clean wool mass, the only significant differences occurred during Year 3 in favour of the foggage crop residue treatment. In accordance with the autumn lambing season, the mass advantage of the ewes receiving silage (Figure 1) was not reflected in their wool production.

The ewes receiving silage had, with the exception of Year 3, the highest clean wool yield (Table 3) – the level of significance during the various years are indicated in Table 3. As was expected, the animals in the semi-intensive treatment (which grazed harvested maize lands for part of the winter) had the lowest clean yield during all the trial years. Esterhuysen *et al.* (1991a) also reported clean wool yield appreciably lower for animals grazing crop residues than that normally recorded for sheep grazing veld (approximately 70 %). They suggested that dust infiltration while grazing crop residues was responsible for reduced clean wool yields.

Unfortunately the tensile strength of the wool was not determined. Swart *et al.* (1967) postulated that, in terms of wool production, maize silage proved to be a deficient feed source. Coetzee & Dyason (1967) and Coetzee & Vermeulen (1967) emphasised the use of protein supplementation for woolled sheep utilising maize silage. Bosman *et al.* (1967) accentuated the fact that more clean wool will be produced when supplementation was provided. Cloete & Brand (1990) also found an increase in wool production with additional supplementation. Various at-



**TABLE 3** Wool production characteristics of the ewes from the different treatments during the various seasons

	TREATMENTS						CV (%) <sup>1</sup>
	WINTER			SUMMER		Avg.	
	I	II	III	A	B		
<b>FIBRE DIAMETER (<math>\mu</math>)</b>							
YEAR 1 (1986/87)	20.40 <sub>w</sub>	21.48 <sub>x</sub>	20.97 <sub>wx</sub>	21.27 <sub>w</sub>	20.63 <sub>x</sub>	<b>20.95</b>	8.35
YEAR 2 (1987/88)	20.26 <sup>a</sup>	21.05 <sup>b</sup>	20.76 <sup>ab</sup>	21.01 <sub>w</sub>	20.36 <sub>x</sub>	<b>20.69</b>	8.15
YEAR 3 (1988/89)	19.80 <sub>w</sub>	21.26 <sub>x</sub>	20.28 <sub>w</sub>	20.87 <sub>w</sub>	20.01 <sub>x</sub>	<b>20.45</b>	8.31
<b>CLEAN YIELD (%)</b>							
YEAR 1 (1986/87)	69.38 <sub>w</sub>	65.10 <sub>x</sub>	68.86 <sub>x</sub>	68.82 <sub>w</sub>	66.74 <sub>x</sub>	<b>67.78</b>	7.61
YEAR 2 (1987/88)	70.35 <sup>a</sup>	68.22 <sup>b</sup>	68.94 <sup>ab</sup>	69.52	68.82	<b>69.17</b>	6.43
YEAR 3 (1988/89)	70.59 <sub>w</sub>	71.39 <sub>w</sub>	74.29 <sub>x</sub>	72.00	72.18	<b>72.09</b>	6.84
<b>CLEAN WOOL MASS (KG)</b>							
YEAR 1 (1986/87)	3.04	2.97	2.80	2.96	2.92	<b>2.94</b>	18.71
YEAR 2 (1987/88)	2.97	2.87	2.82	2.95	2.82	<b>2.89</b>	16.38
YEAR 3 (1988/89)	3.14 <sup>a</sup>	3.35 <sup>b</sup> <sub>w</sub>	3.03 <sub>x</sub>	3.23	3.12	<b>3.17</b>	17.61

<sup>1</sup> Coefficient of variation

<sup>a-d</sup> Values in the same row with different superscripts, for the respective summer and winter periods, differ significantly (P<0.05)

<sup>w-z</sup> Values in the same row with different subscripts, for the respective summer and winter periods, differ highly significantly (P<0.01)

There were no interactions between the winter and summer treatments within each year.

#### Winter Treatments

I - Silage  
II - Foggage/crop residues  
III - Veld

#### Summer Treatments

A - Cultivated pastures  
B - Veld

tempts have also been made to determine the optimum combination of protein and energy supplementation for woolled sheep (Coetzee, 1964; Jacobsz *et al.*, 1971). The winter lick provided to these animals had a crude protein (CP) value of 42 %. Thirty eight percent (38 %) of the protein fraction in the lick originated from natural protein sources. From the wool production results obtained, this quantity of natural protein still seemed to be deficient and a natural protein supplementation should be supplied additionally when providing maize silage to woolled sheep. Kemm & Coetzee (1967) also highlighted the importance of protein supplementation to woolled sheep grazing winter veld. Cronje & Weites (1990) postulated that the often varying results reported regarding wool production can be ascribed to the fact that these studies were conducted

before the advent of the concept of rumen degradable and bypass protein and energy and that the experimental design often precluded the separation of these effects. Brand *et al.*, (1997) also ascribed the absence of any significant differences in fibre diameter in their study to the high degradability of lupin seed.

According to Masters *et al.* (1999) evidence exists that the response in wool growth resulting from feeding protected protein supplements continues after the feeding has stopped. Feeding such proteins, alternated with traditional supplements, may increase wool growth as much as continuous feeding, but at a lower cost.

The ewes which grazed winter veld tended to show the lowest clean wool mass during all three the trial years (Table 3). This must be seen in conjunction with Figure 1, where the ewes in the extensive treatment generally had the lowest body mass. Masters *et al.* (1998) found that higher liveweight and a positive liveweight change both increased staple strength and wool growth in general.

### ***Summer Treatment***

The fibre diameter of the ewes that grazed cultivated pastures during summer was higher ( $P < 0.01$ ) than that of the ewes that grazed veld. The clean wool yield also differed highly significantly ( $P < 0.01$ ) in favour of cultivated pastures during the first season (Table 3). This must probably be attributed to the veld condition at the start of the trial.

## **REPRODUCTION**

The ewes in the spring lambing season, which were mated during autumn, started lambing at the beginning of September. Their lambing- and weaning percentages are presented in Table 4.

### ***Winter Treatment***

According to Table 4 the ewes that grazed foggage/crop residues tend to return the highest lambing percentages during Years 1 and 2 ( $P > 0.05$ ). From the lambing percentage figures of Years 2 and 3 it appears as if the poor nutritional environment of the extensive treatment, manifested in the body mass and condition of these ewes, affected reproductive rates. However, as was mentioned in Part 2 the high rainfall figures, especially during early- and mid summer, resulted in the grass growing out early in the season and maturing relatively early. Consequently, the quality of the grass was inferior and probably not utilised effectively by the sheep.

Problems were also experienced due to predators, stray dogs, as well as theft during the trial, and consequently, these ewes had to be penned at night. These ewes, and the ewes which

TABLE 4 Reproduction parameters of the ewes during the various trial years.

	TREATMENTS					
	WINTER			SUMMER		Avg.
	I	II	III	A	B	
<b>LAMBING PERCENTAGE<sup>1</sup></b>						
<b>YEAR 1 (1986/87)</b>	115.5	134.0	131.7	134.4	119.7	<b>127.06</b>
<b>YEAR 2 (1987/88)</b>	98.99	101.1	91.38	103.76	90.5	<b>97.16</b>
<b>YEAR 3 (1988/89)</b>	113.89	92.00	86.95	97.08	98.13	<b>97.59</b>
<b>WEANING PERCENTAGE<sup>2</sup></b>						
<b>YEAR 1 (1986/87)</b>	70.31	115.65	115.84	102.27	98.93	<b>100.60</b>
<b>YEAR 2 (1987/88)</b>	76.80	84.76	75.09	79.03	78.73	<b>79.43</b>
<b>YEAR 3 (1988/89)</b>	97.22	65.05	68.20	74.17	79.47	<b>76.82</b>

<sup>1</sup> Lambing Percentage =  $\frac{\text{Number of lambs born}}{\text{Number of ewes mated}}$

<sup>2</sup> Weaning Percentage =  $\frac{\text{Number of lambs weaned}}{\text{Number of ewes mated}}$

<sup>a-d</sup> Values in the same row with different superscripts, for the respective summer and winter periods, differ significantly ( $P < 0.05$ )

<sup>w-z</sup> Values in the same row with different subscripts, for the respective summer and winter periods, differ highly significantly ( $P < 0.01$ )

There were no interactions between the winter and summer treatments within each year.

#### Winter Treatments

- I - Silage
- II - Foggage/crop residues
- III - Veld

#### Summer Treatments

- A - Cultivated pastures
- B - Veld

received silage, mainly lambed in the kraal. The pasture conditions and lamb losses had a major influence and only the former (pasture conditions) was partially due to treatment effects. It seems thus that an alternative grazing strategy should be practised during the lambing season and that a solution will have to be found where ewes had to lamb in confined conditions. Nutritional effects and lambing in kraals were primarily responsible for the poor weaning percentages. Nevertheless, lambing and weaning percentages showed the same tendencies.

#### *Summer Treatment*

The ewes were mated at the end of the summer period and there were no statistically significant differences in the lambing percentages of the two summer treatments (Table 4). It must once again be concluded that the difference in the two summer treatments were not so severe that it led to significantly ( $P < 0.05$ ) differences in reproduction.

Weaning percentage of the two summer treatments (pre-wean period just prior to the following summer period) also failed to exhibit any significant differences (Table 4).

Regarding the total productivity of the woolled sheep, Shetaewi & Ross (1987) stated that the fleece of the ewe is as important a product as the weaned lamb. Meissner (1993) concluded that, regarding finishing, whilst the Merino are not an ideal feedlot type, income from wool can be a substantial additional benefit. Nawaz *et al.* (1992) stressed that when a species produces more than one commodity, such as meat and wool in the case of sheep, overall productivity estimates must encompass all outputs.

## CONCLUSIONS

All the treatments, to a greater or lesser extent, could be applied in the Western Highveld areas. The mass advantage obtained by the more intensive treatments during winter was, to a great extent nullified during summer. The reason for this was compensatory growth (ewes of Treatments 2 and 3) that occurred during the subsequent summer period. The feed source available (as well as its' cost) to a specific farming enterprise should be the deciding factor in the final decision on which strategy to follow. Although the average body mass of the ewes of the veld treatment was somewhat lower than that of the animals of the foggage/crop residue throughout the trial, there was not such a marked difference at the end of Year 3 as the autumn lambing season.

The ewes grazing foggage and crop residues during winter consistently showed the highest fibre thickness. The animals grazing winter veld, however, tended to show a lower body mass and lower clean wool production during all three the trial years.

The relatively high rainfall recorded during the trial period also caused problems with the utilisation of the grass in general, especially during the pre-wean period. Sheep could not utilise rapidly maturing grass effectively and this might require flexibility in the system, probably allowing for the introduction of cattle in years of high rainfall increasing the overall efficiency of feed utilisation.

Crop residues are a low cost feed source that have an important role to play in the fodder flow of sheep, especially in a spring lambing season, as ewes were in late pregnancy during the mid-winter months when crop residues are traditionally utilised. In determining the best utilisation strategy for crop residues, the introduction of cattle may also have beneficial effects. Gertenbach *et al.* (1998) found that, although the highest proportion of maize crop residues was utilised by sheep alone, the introduction of cattle with sheep or cattle alone, realised larger live mass gains/ha than when only sheep grazed the crop residues.

Maize silage is an excellent feed source for sheep, as is reflected in the body mass of the ewes and the fact that it had to be restricted for non-lactating animals. However, it became evident that the utilisation of this feed source possibly has some limitations which will have to be rectified, especially regarding wool production. Natural protein supplementation could make a valuable contribution in this regard. If the smaller wool fibre diameter from the silage treatment is due to a nutritional fineness, as is suggested, it is expected that this will lead to the occurrence of tender wool. Thus, silage as the only feed source can not be recommended for woolled sheep as the wool fibre diameter is reduced by the quality of feed protein.

Regarding the two summer treatments, the ewes utilising cultivated pasture, in general tended to show better results when compared to the veld treatment (body mass gains, wool production and reproduction).

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## Chapter 2

### Different feeding strategies for woolled sheep in a spring lambing season: lamb performance

#### INTRODUCTION

The aim of any farming enterprise should be to obtain maximum profitability from a farming unit and this will also determine the success and viability of the enterprise (Van Marle, 1982). This inevitably demands enhancement of the effectiveness of production. Van Zyl & Sartorius von Bach (1993) stated that South African agriculture could no longer afford inefficiency in any form. Le Riche (1982) alleged that a rise in living standards in a large part of the population, resulted in the fact that preference is given to food sources of animal origin.

One of the main cost factors in efficient livestock production is feed provision. The availability of high quality feed sources is of paramount importance in any intensive production system. In Part 2, Chapter 2 the utilisation of various roughage sources included in the post wean and finishing rations of lambs was dealt with extensively. Winter cereal pastures, however, are too much of a risk due to the problem of pasture establishment under adverse climatic conditions (Penzhorn, 1945). Fair & Reyneke (1972) also accentuated the climatological requirements of these pastures. Reyneke (1971) stressed a need for alternative feeding systems in event of pasture failure. Due to the erratic and unreliable rainfall of the Western Highveld this appears not be a viable option.

The Western Highveld is traditionally known as the grain silo of South Africa. However, not all farms are equally suited to crop production. Due to topography and geology vast areas of this region consist of veld, while being characterised by a temperate climate (Schulze, 1997). This area has mixed farming potential and crops are produced on many of the farms in the highveld. It has a great potential due to the availability of various feed sources, for a variety of small stock enterprises ranging from quite intensive to extensive. The nutritional limits of this region are quite well known and documented (Cilliers, 1984; Schutte, 1987; Schutte, 1994), especially during the winter months (Coetzee *et al.*, 1968; Louw *et al.*, 1972; Louw, 1979; Engels, 1983; De Brouwer, 1998). De Waal (1990) stated that an important constraint on animal production from pastures remains an insufficient intake of digestible nutrients. The need for supplementation for lactating ewes (both in terms of and lamb wool production) grazing winter veld were stressed by various authors (Kemmer & Coetzee, 1967; Engels & Malan, 1979; De Waal *et al.*, 1981; Henning & Barnard, 1982; Henning & Barnard, 1991). Van

der Merwe (1967) also stated that thousands of head of cattle and sheep enjoy supplementary feeding through the harsh winter months.

Various maize products have also been used in the post weaning and finishing of lambs. The potential of maize crop residues for lactating ewes, as well as for lambs post wean, were investigated (Schoonraad *et al.*, 1988a; Schoonraad *et al.*, 1988b). Silage as a roughage source in the finishing of lambs also received attention (Boshoff *et al.*, 1977; Boshoff *et al.*, 1979; Boshoff *et al.*, 1980; Agbosamey *et al.*, 1998; Cilliers *et al.*, 1998).

Grain farmers are in an unusually favourable position as far as the use of surplus and inferior grade maize is concerned. These can be used to good advantage in growth and finishing rations of lambs (Brand *et al.*, 1990; Brand & Van der Merwe, 1993). This can especially be a consideration when a favourable meat: grain price-ratio exists. Thus, animal production systems should be planned according to the potential of the region. Available feed sources to fulfil the specific nutrient requirements for reproduction, lactation and assuring a large and viable lamb crop are the primary considerations.

According to Long *et al.* (1989) total weight of lamb weaned per year from a flock of sheep is the best single measure of that flock's productivity and is mainly determined by its component traits: fertility, prolificacy, lamb survival and lamb weaning weight. Van Niekerk & Schoeman (1993) is of the opinion that mutton production holds advantages in the sense that response time to market influences is half that of beef production. Meissner (1993) concluded that, whilst Merinos are not an ideal feedlot type, income from wool can be a substantial additional benefit.

Regarding the total productivity of the woolled sheep, Shetaewi & Ross (1987) stated that the fleece of the ewe is as important a product as the weaned lamb. Nawaz *et al.* (1992) stressed that when a species produces more than one commodity, such as meat and wool in the case of sheep, overall productivity estimates must encompass all outputs. Erasmus (1986) stated that the Merino, traditionally recognised as a woolled sheep, should be adapted to utilise its mutton production potential. This author also stressed that aspects such as reproduction rate, mothering ability and growth rate should receive urgent attention, while their wool production potential should under no circumstances be forfeited. No research regarding systems for woolled sheep in the Western Highveld of South Africa has been carried out.

In Part 2 the effect of different winter and summer strategies (with feed sources applicable to this region) on the biological performance of ewes (Chapter 1) and lambs (Chapter 2) in an autumn lambing season were investigated. The first chapter of Part 3 dealt with the effect of these various strategies on the performance of ewes which were mated in autumn (spring lambing season). This chapter deals with the pre- and post wean biological performance of the progeny of the ewes mated

in autumn (spring lambing season). The mass gain and wool production data of the replacement ewes and the mass gain and slaughter data of the fattened rams of the various treatments are also discussed.

## PROCEDURE

The ewes, as described in Part 3, Chapter 1 started lambing at the beginning of September and the lambs were weaned at the end of the winter period (approximately the end of November). The procedure followed with these lambs was similar to that of the lambs of the autumn lambing season. They also received the various rations for the different growth stages (pre-wean, post wean, replacement ewes and finishing) as specified in Part 2, Chapter 2 (lambs of the autumn lambing season). This will subsequently only be referred to as Part 2.

The importance of natural protein sources in the post wean- and finishing rations of lambs, as well as the energy and crude protein content of the post wean- and finishing ration are also highlighted by several researchers (Andrews & Ørskov 1970; Brand & Van der Merwe 1993; Boshoff *et al.*, 1980; Cilliers *et al.*, 1998). This and the composition of the various rations are discussed and motivated in Part 2, Chapter 2.

As was the case with the progeny of the autumn lambing season the lambs of all the treatments were fed in one group during the various post weaning stages and they received these rations *ad lib*. This was done for the same reason as mentioned in Part 2 Chapter 2. The feed intake of the lambs from the various treatments was thus not monitored separately. The lambs were also weighed fortnightly. The same prerequisites applied for each of the various phases and the growth rates of the lambs of each of the treatments determined the duration of each phase (time to reach the specified target mass). As discussed in Part 2, only the lambs of the ewes that received silage and foggage/crop residues during winter received creep feed. The lambs of the extensive treatment (low cost approach) once again did not receive any creep feed. The procedures regarding the replacement ewes and finishing rams are described in detail in Part 2.

The nutritional treatments of the adult ewes were:

### Winter treatments:

- Treatment I : Silage in a pen (Intensive treatment).
- Treatment II : Cultivated pastures/maize crop residues (Semi-intensive treatment).
- Treatment III : Rested veld. (Extensive treatment).

A nitrogen-containing lick, plus strategic supplementation (chocolate maize), was supplied to the animals during the winter period.

### **Summer treatments:**

- Treatment A - Cultivated pastures.
- Treatment B - Summer veld.

During summer ewes were provided a salt-phosphate lick.

These treatments are described in greater detail in Part 2, Chapter 1, as well as Part 3, Chapter 1.

The replacement ewes of the spring lambing season, as described in Part 2, Chapter 2, received the replacement ewe ration until six months of age, after which they were allocated to the same treatment combination as their dams and were turned out on their separate summer treatments.

The data were statistically analysed similar to that of the autumn lambing season in order to compare the effects of the intensive, semi-intensive and extensive treatments. As the extensive treatment received no creep feed, the effect of the feeding regime of their mothers could not be investigated. This treatment must, therefore, be compared as a total feeding system with the other treatments

## **RESULTS AND DISCUSSION**

### **Feed intake**

The average daily feed intake of the lambs during the various stages for each of the three different trial years is indicated in Table 1. Natural protein sources were used in the rations supplied to these lambs during their various growth stages (Part 2 Chapter 2).

### **Pre-wean**

During Years 1 (86/87) and 2 (87/88) the lambs that received creep feed (because of a higher growth rate) were weaned two weeks earlier than the lambs from the veld (extensive treatment). Santra & Karim (1999) also concluded that the use of creep feed had definite biological advantages. Similar to the results obtained for the autumn lambing season, the lambs in the silage treatment (Treatment I) had a higher creep feed intake than those from the foggage/crop residue



**TABLE 1** Average daily intake of the various groups of animals on air dry basis.

YEAR	RATION				
	Creep feed (g/head)		Post wean (kg/head)	Replacement (kg/head)	Finishing (kg/head)
	I <sup>a</sup>	II <sup>a</sup>			
YEAR 1	131.3	115.0	1.04	1.11	1.39
YEAR 2	144.7	128.8	1.24	1.34	1.46
YEAR 3	183.0	91.8	1.16	1.36	1.27
AVERAGE	153.0	111.9	1.15	1.27	1.37

<sup>a</sup> - Treatments :

- I - Silage (Intensive)
- II - Foggage/Crop residues (Semi-intensive)

treatment (Treatment II). A possible reason for this might be the fact that the lambs of the ewes that grazed foggage/crop residues grazed cultivated pastures for part of the winter period and these lambs (born in the spring) ingested lush, green pasture, additional to the creep feed. Van Niekerk & Barnard (1969) found that lambs given access to creep feed consumed considerably less green grazing than non-supplemented groups. These authors, unfortunately, did not discuss the effect of the pasture on creep feed intake.

The possibility also did exist that the lambs ingested some of the silage provided to the ewes. However, due to their digestive tract not fully developed at such an early stage, they would probably not be able to utilise this roughage source efficiently. According to Van der Merwe (1970) the rumen of the lamb is non-functional and it can be considered a monogastric animal during the first few weeks of its life.

The fact that the lambs of the silage treatment spent the whole pre-wean period with their mothers in a pen may also have contributed to their higher creep feed intake (Table 1).

**Post wean (wean to 30 kg)**

The average feed intakes (kg/day) of the post wean ration (which the lambs received until an average body mass of 30 kg was obtained) are presented in Table 1.

In an attempt to prevent adaptation problems of the lambs (of which some did not receive any creep feed pre-wean), feed lime (3%) was added to the ration. Additionally, the post wean ration was initially (during the first two weeks) limited at 350 g/lamb/day. Due to their faster growth rate,

the ram lambs reached the target mass of 30 kg approximately six weeks earlier than the ewe lambs. Van Wyk & Pretorius (1990) found similar results in a study with Merino lambs where the ram lambs showed an approximately 19 % higher growth rate than ewe lambs. Brand & Van der Merwe (1993), providing a complete ration to lambs, and De Villiers *et al.* (1994), with lambs grazing kikuyu, came to the same conclusion with South African Mutton Merino lambs. Jordan & Mayer (1989) also concluded that ram lambs were superior to ewe lambs in terms of growth.

### **Replacement ewes**

The replacement ewes received the replacement ewe ration for an average period of 6 weeks over the three different trial years. At the end of this period they were allocated to their respective summer treatments (cultivated pastures and summer veld).

The poor performance of the young replacement ewes (in terms of body mass gain) on the pasture towards the end of the summer period necessitated supplementation in the form of chocolate maize during Year 2. Approximately 200 g/ewe/day were provided to the cultivated pastures and veld treatments from the beginning of March until the end of the summer period (May). During the third season (88/89) it was also necessary to provide supplementation to these young ewes, but only for the last three weeks of the summer period. The grazing (as was discussed in Part 2) grew out high and reached maturity at an early stage and was quite mature towards the end of the summer period during all the trial years (especially during Years 2 and 3). This probably contributed to the poor performance of these ewes and the subsequent need for supplementary feeding. The grazing strategy (utilisation of the pastures at such a young age) was probably not suitable for these replacement ewes. In contrast, Holst *et al.* (1997) supplied oats (250 g/day) to young Merino-cross weaned lambs grazing lucerne and achieved an average growth rate of 115 g/day. However, these authors described the pasture they were utilising as having a 'reasonable quality'.

During the winter period the replacement ewes were allocated to their various winter treatments. They were grouped together with the replacement ewes of the autumn lambing season (six months older). Their combined feed intake was discussed in Part 2.

### **Finishing period**

The average finishing period for the rams during the three trial years averaged approximately eight weeks before they were slaughtered. As was discussed in the second chapter of Part 2, minimal selection of these ram lambs was done after they were weaned.

## Mass changes

### Birth mass

Table 2 indicates the influence of the different nutritional treatments on the birth mass, as well as the pre- and post wean gains (ADG's) of the spring lambs.

**TABLE 2 Birth mass of the lambs and their average daily gain (g/day) during the pre- and post wean period.**

	TREATMENTS					Avg.	CV (%) <sup>1</sup>
	WINTER			SUMMER			
	I	II	III	A	B		
<b>BIRTH MASS (kg)</b>							
YEAR 1 (1986/87)	4.78	4.48	4.47	4.55	4.55	<b>4.55</b>	18.50
YEAR 2 (1987/88)	4.47	4.08	4.20	4.36	4.09	<b>4.24</b>	21.99
YEAR 3 (1988/89)	4.72 <sub>w</sub>	4.13 <sub>x</sub>	4.35	4.44	4.38	<b>4.42</b>	19.19
<b>PRE-WEAN GAIN</b>							
YEAR 1 (1986/87)	204.93	217.23	186.31	194.29	211.88	<b>202.48</b>	15.73
YEAR 2 (1987/88)	202.25 <sub>wx</sub>	219.19 <sub>w</sub>	181.71 <sub>x</sub>	199.72	206.29	<b>202.72</b>	16.49
YEAR 3 (1988/89)	163.91 <sup>a</sup>	184.47 <sup>b</sup>	183.57 <sup>b</sup>	179.28	172.05	<b>175.97</b>	16.97
<b>POST WEAN GAIN</b>							
YEAR 1 (1986/87)	180.57 <sub>w</sub>	169.55 <sub>w</sub>	142.90 <sub>x</sub>	170.76 <sub>w</sub>	152.08 <sub>x</sub>	<b>162.17</b>	19.49
YEAR 2 (1987/88)	249.39	243.86	253.83	253.94	242.49	<b>248.51</b>	16.20
YEAR 3 (1988/89)	151.58	155.95	145.58	152.87	149.40	<b>151.35</b>	19.22

<sup>1</sup> Coefficient of variation

<sup>a-d</sup> Values in the same row with different superscripts, for the respective summer and winter periods, differ significantly (P<0.05)

<sup>w-z</sup> Values in the same row with different subscripts, for the respective summer and winter periods, differ highly significantly (P<0.01)

#### Winter Treatments

- I - Silage
- II - Foggage/crop residues
- III - Veld

#### Summer Treatments

- A - Cultivated pastures
- B - Veld

### ***Winter Treatment***

The higher body mass of the ewes that received silage during winter (Part 3, Chapter 1) probably resulted in their lambs also having the highest birth mass during all three the trial years (Table 2). Various authors highlighted the importance of body condition and body mass of the ewe in relation to birth weight and survival of the lamb (Holst & Allan, 1992; McNeill *et al.*, 1997; McNeill *et al.*, 1998). Brand *et al.* (1997) also indicated the positive effect that supplementation of the ewe, during late pregnancy, had on lamb birth weight and post natal growth. Furthermore, these ewes consumed silage during most of their pregnancy (May – August). However, it was only during the last trial year that there were statistical significant differences. The lambs of the silage treatment had a significantly higher birth mass ( $P < 0.01$ ) than those of the foggage/crop residue treatment. This was directly in contrast to the results obtained with the autumn lambing season (Part 2, Chapter 2). This was probably due to the fact that the ewes of the silage treatment that lambed during spring received silage during late pregnancy. Jordan & Mayer (1989), in research done with Merino ewes, stressed the importance of milk yield and indicated the positive correlation that exists between milk yield, ewe weight, lamb birth weight and lamb growth rate.

### ***Summer Treatment***

The ewes were in their winter treatments during the last four months of pregnancy. This was possibly the reason why their summer treatments did not have any significant influence on the birth mass of the lambs during any of the trial years (Table 2). According to Jainudeen & Hafes (1980) more than one half of the increase in fetal weight occurs during the last trimester of pregnancy. Holst & Allan (1992) also emphasised the importance of nutrition in the last trimester when fetal growth is most rapid.

## **Pre-wean gain**

### ***Winter Treatment***

Despite a consistently higher creep feed intake of the lambs from the silage treatment (Table 1), their growth rate, during all three years, was inferior to that of the lambs from the foggage/crop residue treatment (Table 2). In fact, during the third year (1988/89) a significantly lower ( $P < 0.05$ ) growth rate occurred for these lambs compared to both the other two treatments. This confirms the deduction made in Part 2, Chapter 1 that ewes receiving silage did not transfer their advantage (in terms of body mass and possibly milk production) to their lambs. The results of this trial once again question the adequacy of maize silage as a succulent feed for lactating ewes. Esmail (1999) pointed out that silage as the sole feed source was inadequate for sufficient milk

production. From Table 2 it is evident that the pre-wean growth rates of the lambs of the foggage/crop residue treatment were also consistently higher than that of the lambs of the veld treatment (extensive treatment). During the second season the lambs of the veld treatment had a highly significantly ( $P < 0.01$ ) lower gain than the animals of the foggage/crop residue treatment. Lloyd-Davies & Devaud (1988), with Merino lambs, found comparable pre-wean mass gains to that of the current trial. Jordan & Mayer (1989) also accentuated sufficient nutrition of the lactating ewe. These authors obtained pre-wean growth rates which averaged between 138 and 178 g/day for Merino lambs of which their dams were fed between 70 and 110 % of their maintenance requirements.

### ***Summer Treatment***

The summer treatment of the ewes had no significant effect on the pre-wean gain of their progeny (Table 2). Similar to birth mass, this must probably also be ascribed to the fact that the ewes lambed towards the end of the winter period. During the lactation period these ewes were still in their winter treatments.

### **Post wean gain (wean to 30 kg)**

#### ***Winter Treatment***

During Year 1 (1986/87) the lambs that did not receive creep feed (veld) realised a highly significantly lower ( $P < 0.01$ ) growth rate than the lambs of the other two treatments (Table 2). Regarding the two groups that received creep feed pre wean, the lambs from the silage treatment realised the highest ADG ( $P > 0.05$ ) during the post weaning stage during Year 1. Their growth rate during the second and third season was comparable to that of the lambs of the foggage/crop residue treatment (Table 2). This was probably due to compensatory growth as the lambs from the foggage/crop residue treatment realised the highest mass gains pre-wean (Table 2).

Compared to the mass gains obtained in the current study, Van Vuuren & Nel (1983) reported average daily gains (ADG) of 174 g/day for Merino lambs fed a complete feedlot ration containing 12.5 MJ digestible energy (DE)/kg and 13.6 % CP. The lower results obtained by these authors must probably be attributed to the lower energy content of their ration.

#### ***Summer Treatment***

Although the lambs from the cultivated pasture treatment showed a higher post wean gain during all the trial years, when compared to the lambs of the veld treatment (Table 2), it was only

during the first year that these differences were significant ( $P < 0.01$ ). This was, to an extent, probably also due to compensatory growth. Marais (1988) defined compensatory growth as the ability of animals previously restricted in feed intake to outgain their counterparts when given free access to good quality feed. This author cautioned against restriction of ewe lambs and concluded that it would inhibit production and would not be economically feasible.

### Replacement ewes

When the replacement ewes were six months old they were allocated to their various summer treatments (same treatment as the adult ewes) until the start of the winter period. Mass changes of these ewes for the summer and winter periods respectively, are presented in Table 3.

**TABLE 3** Average daily mass changes (g/day) of the replacement ewes while receiving the replacement ewe ration, as well as during the following winter period

	TREATMENTS						CV (%) <sup>1</sup>
	WINTER			SUMMER		Avg.	
	I	II	III	A	B		
<b>SUMMER PERIOD</b>							
YEAR 1 (1986/87)	-29.40	-16.38	-21.30	-23.59	-21.13	<b>-22.36</b>	21.84
YEAR 2 (1987/88)	-38.43 <sub>w</sub>	10.38 <sub>x</sub>	7.01 <sub>x</sub>	-10.21	-3.82	<b>-7.01</b>	17.60
YEAR 3 (1988/89)	-62.98 <sub>w</sub>	-41.55 <sub>x</sub>	-14.07 <sub>y</sub>	-35.70 <sup>a</sup>	-43.31 <sup>b</sup>	<b>-39.50</b>	24.03
<b>WINTER PERIOD</b>							
YEAR 1 (1986/87)	65.37 <sub>w</sub>	75.02 <sub>wx</sub>	78.62 <sub>x</sub>	74.80	74.21	<b>72.99</b>	19.06
YEAR 2 (1987/88)	46.24 <sub>w</sub>	22.37 <sub>x</sub>	22.94 <sub>x</sub>	30.48	30.55	<b>30.52</b>	21.07
YEAR 3 (1988/89)	62.19 <sub>w</sub>	49.39 <sub>x</sub>	24.22 <sub>x</sub>	50.15 <sub>w</sub>	40.39 <sub>x</sub>	<b>45.27</b>	22.96

<sup>1</sup> Coefficient of variation

<sup>a-d</sup> Values in the same row with different superscripts, for the respective summer and winter periods, differ significantly ( $P < 0.05$ )

<sup>w-z</sup> Values in the same row with different subscripts, for the respective summer and winter periods, differ highly significantly ( $P < 0.01$ )

#### Winter Treatments

- I - Silage
- II - Foggage/crop residues
- III - Veld

#### Summer Treatments

- A - Cultivated pastures
- B - Veld

### **Summer period**

The replacement ewes recorded a mass loss during the summer period (Table 3). From this it appears that the mature grazing towards the end of summer was not suitable for utilisation by these young replacement ewes and that an alternative strategy should rather be implemented for these animals. The fact that the grass was quite mature at this stage (as discussed previously) could also be attributed to the poor results.

#### ***Winter treatment***

During the summer period (in their respective summer treatments) the replacement ewes from the silage treatment showed the greater body mass losses, compared to the animals of the other two treatments (Table 3). These differences were only significant ( $P < 0.01$ ) during the second and third years. This must be seen in conjunction with their performance directly post wean (Table 2) when the lambs of the silage treatment showed the highest mass gain.

#### ***Summer treatment***

The only significant differences between the two summer treatments was during Year 3 when the replacement ewes, grazing cultivated pastures (Treatment A), showed a better performance than those grazing veld, during both the summer ( $P < 0.05$ ) and winter ( $P < 0.01$ ) periods.

### **Winter period**

#### ***Winter treatment***

In contrast with the autumn lambing season, and Years 2 and 3, the replacement ewes of the veld treatment had the highest gain during the winter period of Year 1. This growth rate was highly significantly higher ( $P < 0.01$ ) than the growth rate of the silage treatment. During Years 2 and 3 the replacement ewes of the silage treatment displayed the highest growth rate ( $P < 0.01$ ) compared to the animals of the other two treatments (Table 3). The only possible explanation for this must be the quality of the silage differing during the various years. Rhind *et al.* (1998) cautioned against the dangers of undernutrition of young ewes as their reproductive performance can be adversely affected.

#### ***Summer treatment***

The only significant difference regarding the summer treatments during the winter period, was the higher gain ( $P < 0.01$ ) of the cultivated pasture treatment during Year 3, probably indicating

that the superior quality of the cultivated pasture during this season was sufficient to cause significant differences.

### Wool production

During all the trial years the ewe lambs were shorn at an age of three to four months. Consequently they had a year's wool growth during the following season. The influence of the various nutritional treatments on the qualitative and quantitative wool production of these replacement ewes are presented in Table 4.

**TABLE 4** Wool production characteristics of the replacement ewes from the different treatments during the various years.

	TREATMENTS					Avg.	CV (%) <sup>1</sup>
	WINTER			SUMMER			
	I	II	III	A	B		
<b>FIBRE DIAMETER (μ)</b>							
<b>YEAR 1 (1986/87)</b>	19.61	19.77	19.34	19.73	19.35	<b>19.58</b>	15.42
<b>YEAR 2 (1987/88)</b>	20.61 <sup>ab</sup>	21.12 <sup>a</sup>	19.80 <sup>b</sup>	21.04	20.22	<b>20.62</b>	12.81
<b>YEAR 3 (1988/89)</b>	20.26	20.06	19.95	20.31	19.80	<b>20.10</b>	11.93
<b>CLEAN YIELD (%)</b>							
<b>YEAR 1 (1986/87)</b>	72.26 <sup>a</sup>	69.92 <sup>b</sup>	70.73 <sup>ab</sup>	71.25	68.80	<b>70.27</b>	16.80
<b>YEAR 2 (1987/88)</b>	69.64	71.30	72.44	70.98	71.54	<b>71.26</b>	14.35
<b>YEAR 3 (1988/89)</b>	69.64	71.30	70.30	70.35	70.52	<b>70.42</b>	13.74
<b>CLEAN WOOL MASS (KG)</b>							
<b>YEAR 1 (1986/87)</b>	3.13	3.04	2.83	3.11	2.90	<b>3.00</b>	17.00
<b>YEAR 2 (1987/88)</b>	3.60 <sup>ab</sup>	3.73 <sup>a</sup>	3.24 <sup>b</sup>	3.50	3.54	<b>3.52</b>	15.92
<b>YEAR 3 (1988/89)</b>	4.45	4.68	4.46	4.56 <sup>a</sup>	4.50	<b>4.53</b>	18.17

<sup>1</sup> Coefficient of variation

<sup>a-d</sup> Values in the same row with different superscripts, for the respective summer and winter periods, differ significantly (P<0.05)

<sup>w-z</sup> Values in the same row with different subscripts, for the respective summer and inter Treatment periods, differ highly significantly (P<0.01)

#### Winter Treatments

I - Silage  
 II - Foggage/crop residues  
 III - Veld

#### Summer Treatments

A - Cultivated pastures  
 B - Veld



### ***Winter Treatment***

During all three the trial years the fibre diameter of the ewes grazing winter veld was the lowest. However, it was only during the second season that it differed significantly ( $P < 0.05$ ) between the ewes that grazed foggage/crop residues and those wintered on veld (Table 4).

The only significant difference regarding the clean wool yield was the significantly lower ( $P < 0.05$ ) yield of the animals grazing harvested maize fields compare to the pen-fed animals during the first year (86/87).

During all three years the wool of the replacement ewes of the foggage/crop residue treatment measured the highest fibre diameter (Table 4). However, it was only during the second season that these differences were statistically significant. During this season the fibre diameter of ewes from the foggage/crop residue treatment were higher than ( $P < 0.05$ ) that of the animals grazing winter veld. These results are in agreement with those obtained by Langlands & Bennet (1973) and Van Pletzen *et al.* (1991) who both observed that fibre diameter was reduced by more harsh feeding conditions.

The differences in clean yield were not as pronounced as was the case with the adult ewes, probably due to the fact that these young ewes were in their various treatments for part of the various years only (Chapter 1 of both Parts 2 and 3). These differences were significant only during Year 1, when the clean yield from the silage treatment was higher ( $P < 0.05$ ) than that of animals grazing foggage/crop residues with the results of the veld treatment being intermediate. The clean yields obtained in this investigation were appreciably higher than that of Van Pletzen *et al.* (1991) and Esterhuysen *et al.* (1991) (~63 %). This must probably be ascribed to the fact that in their trials the ewes grazed on crop residues for the whole trial, while in the current investigation, the animals only grazed on harvested maize lands for a part of the wool production season ( $\pm 8$  weeks).

The animals from the foggage/crop residue treatment had the highest clean wool mass during the second and third seasons (Table 4). Although the replacement ewes grazing veld during the winter period consistently showed lower clean wool mass yields, it was only during the second season that it was significantly ( $P < 0.05$ ) lower than that of the foggage/crop residue treatment.

Van Wyk & Pretorius (1990) reported, that although there may be an early detrimental effect on wool production characteristics of Merino lambs reared until wean under restricted feeding conditions, adequate post weaning feeding levels can largely overcome these residual effects in the first 18 months of life. Masters *et al.* (1998) stated that initial liveweight and liveweight change both influenced wool growth and should be included in any management strategy aiming to improve wool growth. Denney *et al.* (1988), however, concluded that, although there may be an early

penalty to the annual wool production of the progeny reared under poor grazing conditions until weaning, adequate post weaning nutrition enables this backlog to be overcome during the first year of life. Schinckel & Short (1961), in contrast, concluded that the major effect on wool growth potential by low levels of nutrient supply during pre-natal life was a restriction in body size and total number of follicles, while restriction of nutrient intake during early post natal life reduced the capacity of the individual follicles to produce fibre.

From Table 4 it is obvious that the clean wool mass of the ewes in all the treatments increased as the trial commenced. As all the treatments stayed the same during the trial, the only logical explanation for this is that it may probably be due to better genetic male material obtained during the trial.

### ***Summer Treatment***

The various summer treatments did not cause any significant effects in the wool parameters of the replacement ewes.

### **Finishing period**

The ADG of the finishing rams and their slaughter data (carcass mass, dressing percentage and carcass grading) are presented in Table 5. Similar to the autumn lambing season some of the rams were used for other purposes after the finishing period of the first year and were not slaughtered. There were thus not enough data collected during this year to include in the statistical analysis.

### ***Winter Treatment***

No definite trend could be detected in the ADG of the animals during the finishing period (Table 5). Their mass gains must be seen in conjunction with the post wean gains of the lambs (Table 2). Compensatory growth probably influenced these mass gains to a great extent. The silage treatment were significantly ( $P < 0.05$ ) lower than veld treatment during the first year and also the fog-gage/crop residue treatment during Year 3. The animals of the veld treatment had the highest ADG during Years 2 and 3. These differences were only significant as indicated (Table 5). The only possible logical explanation for these analogies resides in the variation during the various years caused by rainfall (Table 2 – Part 2 Chapter 1) and the variation in the quality of the maize plants.

No significant differences existed regarding the carcass mass and carcass grading during the two years that the rams were slaughtered. This indicates that the treatment of the ewes had no

**TABLE 5** Average carcass mass (kg) and dressing percentage of the finished rams during the various years

	TREATMENTS						CV (%) <sup>1</sup>
	WINTER			SUMMER		Avg.	
	I	II	III	A	B		
<b>AVERAGE DAILY GAIN</b>							
YEAR 1 (1986/87)	215.47 <sup>a</sup>	219.33 <sup>ab</sup>	249.75 <sup>b</sup>	220.42	237.75	<b>228.82</b>	16.06
YEAR 2 (1987/88)	263.73	269.14	286.80	279.68	265.80	<b>237.29</b>	17.72
YEAR 3 (1988/89)	171.58 <sup>a</sup>	192.88 <sup>b</sup>	174.18 <sup>ab</sup>	182.80	174.50	<b>178.92</b>	16.27
<b>CARCASS MASS (kg)</b>							
YEAR 1 (1986/87)							
YEAR 2 (1987/88)	16.28	17.00	16.09	16.52	16.46	<b>16.50</b>	7.45
YEAR 3 (1988/89)	16.60	16.74	16.15	16.69	16.33	<b>16.53</b>	7.20
<b>DRESSING PERCENTAGE</b>							
YEAR 1 (1986/87)							
YEAR 2 (1987/88)	42.28	42.49	42.11	42.60	41.87	<b>42.31</b>	4.70
YEAR 3 (1988/89)	40.65	40.18	39.97	40.25	40.43	<b>40.33</b>	4.93
<b>CARCASS GRADING - POINT SYSTEM</b>							
YEAR 1 (1986/87)							
YEAR 2 (1987/88)	6.13	6.78	5.45	6.14	6.17	<b>6.15</b>	17.28
YEAR 3 (1988/89)	6.33	6.29	5.90	6.22	6.00	<b>6.13</b>	20.32

<sup>1</sup> Coefficient of variation

<sup>a-d</sup> Values in the same row with different superscripts, for the respective summer and winter periods, differ significantly (P<0.05)

<sup>w-z</sup> Values in the same row with different subscripts, for the respective summer and winter periods, differ highly significantly (P<0.01)

**Winter Treatments**

I - Silage  
 II - Foggage/crop residues  
 III - Veld

**Summer Treatments**

A - Cultivated pastures  
 B - Veld

permanent effect on their progeny. Denney *et al.* (1988) also concluded that pre-natal undernutrition had no permanent effect on the liveweight of the progeny. The average carcass masses between the two years were also very similar (Table 5). There was a tendency for the animals of the extensive treatment to have slightly lower carcass masses and their carcass grading was also somewhat lower. Marais *et al.* (1991) found decreased fat content of the carcass with increased levels of feed restriction. Alliden (1970) found that feed restriction during prenatal and early post

natal life had a permanent effect on mature liveweight and carcass composition. These authors, however, concluded that evidence from field experiments is not conclusive. Tayer & Bryant (1988) alleged that compensatory responses are not necessarily manifested by changes in liveweight but may be obscured by gut-fill effects that may not be evident at time of slaughter.

### ***Summer Treatment***

Regarding the various carcass characteristics of the fattened rams, the summer treatment of their dams showed no significant differences (Table 5).

## **CONCLUSIONS**

The various nutritional strategies applied to the ewes did not have any definite influence on the performance of their progeny (pre- and post wean). The fact that the lambs showed compensatory growth to varying degrees, cancelled out any negative effects on their biological performance during a previous phase.

It is important to note, however, that the mass advantage that the ewes of the silage treatment showed (Chapter 1), was not transferred to the pre-wean performance of their lambs. Supplementary feeding (natural protein sources) supplied on a permanent basis to animals utilising maize silage, may be a possible solution to the problems with their inferior lamb growth.

An alternative nutritional solution should be found for replacement ewes that are six months old and grazing cultivated pasture and veld, because the mass gain of the animals from both these treatments at this stage was disappointing.

The lambs from the extensive treatment showed varying degrees of compensatory growth. They had, in contrast to the lambs of the autumn lambing season, somewhat lower wool production (clean wool mass) than the other treatments, while their carcass masses and grading were also somewhat lower.

Variation between the different trial years was much more pronounced than between the various treatments and no definite trend could be detected which would be indicative of the superiority of any of the treatments. The final economical analysis will determine which of these treatments are the most viable, depending on the availability of the feed sources.

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# **PART 4**

**Economical comparison of three  
different wintering strategies  
for woolled sheep in the  
Western Highveld.**

## INTRODUCTION

Systems for sheep production varies from extensive, free range to controlled grazing and zero-grazing feedlots (Van Niekerk & Schoeman, 1993). According to these authors the type of production system depends on the nutritional environment, the product, the degree of control required and the preferred management programme. As the Western Highveld is a mixed farming region, there are many possibilities in terms of alternative feed sources for woolled sheep. Most of the farmers in this region are also crop farmers and this makes the nutritional management of the animals very flexible. The main consideration would be the economic availability of the various feed sources as this will ultimately be the deciding factor in choosing a suitable system.

Because energy required for the maintenance of the ewe and replacement flocks represents a high proportion, (generally > 65 %) of the total energy inputs in the production of lambs, the biological efficiency of mutton production can be improved markedly by increasing the number of lambs per ewe per year (Fogarty *et al.*, 1992) i.e. reducing the duration of the non-productive phases. According to Long *et al.* (1990) the total weight of lamb weaned per year from a flock of sheep is the best single measure of that flock's productivity. This is mainly determined by its component traits: fertility, prolificacy, lamb survival and lamb weaning weight. Brown & Jackson (1995) also advocated 'out-of-season breeding' (accelerated lambing), while Bunge *et al.* (1993) stated that breeding ewes at a younger age is important in decreasing lamb production costs.

Meissner (1993) stated that the intensive feeding of sheep holds various advantages. Alleviation of the pressure on the veld due to a reduced stocking rate during the harsh winter months, is the primary advantage. Brand & Cloete (1990) found feed cost to be the main cost item in the finishing of farm animals under feedlot conditions. These authors reported that an oversupply of grain on local markets exerts downward pressure on the price. They stated that due to the favourable grain : meat-price ratio the utilisation of this surplus grain as a feed source for animals should receive serious consideration. Grain producers are in a favourable position as far as the use of self-produced surplus- and below grade grains for the use of animal production are concerned.

Van Pletzen *et al.* (1991) stated that the cost of supplementing grazing animals during the winter months might decrease the profitability of sheep farming. These authors propose the use of forages produced during summer and summer cash crop residues. Various other authors also accentuated the profitable utilisation of maize crop residues as this has little or no alternative use (Schoonraad *et al.*, 1988; Esterhuyse *et al.*, 1975; Gertenbach *et al.* 1998). An additional economic advantage of crop residues is the fact that it becomes available at a difficult time (mid winter) in the fodder flow programme of farm animals.

De Waal & Biel (1981) stressed the advantages of an extensive approach, with reduced input costs, where certain supplements are provided during certain critical stages of the year. However, the cost of supplementary feeding may decrease the profitability of the enterprise (Bekker & Stoltz, 1983).

The potential of mutton production from woolled sheep was also investigated by, amongst others, Coetzee & Vermeulen (1969) and Cloete *et al.* (1975). Nawaz *et al.* (1992) stressed that when a species produces more than one commodity, overall productivity estimates must encompass all outputs. In the case of woolled sheep these include wool and mutton in the form of the weaned lamb. She-taewi & Ross (1987) stated that the fleece of the ewe is as important a product as the weaned lamb. Van Niekerk & Schoeman (1993) stated that Merino and Merino types, by virtue of their numbers supply the greatest proportion of mutton and lamb meat. Greeff *et al.* (1990) concluded that lifetime production involves all the components of fitness, i.e. longevity, number of lambs born, mortality rate and growth, together with wool production.

The aim of this study was to compare the economical efficiency of autumn- and spring lambing Merino ewes subjected to three different wintering strategies. The biological data of Parts 2 and 3 were used.

As the biological differences between the two summer treatments were less prominent, than that of the winter treatments, only the latter were compared economically.

Integrated livestock research results can benefit the understanding and improvement of whole farm management (De Brouwer, 1998). Animal science research is largely scale neutral and the results obtained in such a study can be extrapolated to farming on various scales.

In the economical evaluation of the different wintering strategies for woolled sheep it is essential that the various treatments be based on a comparable unit. In this investigation gross margin (GM), representing the relative profitability of an enterprise was used. When comparing production systems with different degrees of intensification, GM/ha is the relevant unit. When the systems are compared in terms of livestock unit, GM/Large stock unit (LSU) is applied, using the definition of a LSU as described by Meissner *et al.* (1983). The average number of adult ewes present in each treatment during the investigation was used when the various treatments were compared on a GM/ewe-basis. Furthermore, in order to convert LSU's to a small stock unit (SSU) basis, which is more relevant in this case, 1 LSU was taken to equal 6 SSU's (Meissner *et al.*, 1983). With the discussion of the results and the horizontal comparison of the data it must, however, always be kept in mind that the various treatments represent different farming situations with different resource and fodder flow systems available.

## PROCEDURE

In this investigation Merino ewes were subjected to three different nutritional strategies (with varying degrees of intensification) during the winter period. Half of each treatment lambed during the autumn and the other half during spring. The winter period extended from approximately mid-April to mid-November and from mid-May to the end of November for the autumn and spring ewes respectively. Treatments are described in Part 2, Chapter 1 and can be summarised as follows:

- Treatment I : Maize silage in a pen for the duration of the winter period (Intensive treatment).
- Treatment II : Dormant fertilised cultivated pastures and maize crop residues (Semi-intensive treatment).
- Treatment III : Dormant winter veld, which had been rested for the entire summer period. (Extensive treatment).

A winter lick (Part 2, Chapter 2), and strategic supplementation [chocolate maize - 11.5 megajoules (MJ) metabolisable energy (ME)/kg and 14 % crude protein (CP)] were provided to the ewes during the winter period. Different amounts were supplied to the various treatments, depending on their production stage as described in Part 2, Chapter 1 and Part 3, Chapter 1.

After wean, up to an age of approximately six months, the lambs of the different treatments were fed in one group. The intake of the separate treatments could thus not be determined. The composition of the different rations provided during this period is given in Part 2, Chapter 2.

Feed costs of the lambs from the various treatments were based on their average feed intake during the three trial years (86/87 – 88/89). Current, local feed prices were used to calculate their individual feed cost. This was then multiplied by the number of lambs in each treatment. After approximately six months the replacement ewes were re-allocated to their various treatments, while the ram lambs were slaughtered.

Brand *et al.* (1990) stressed the economic advantage of replacing a high-quality feed source, such as lucerne hay, with a cheaper one when a high growth rate is not essential. In the current study *Eragrostis curvula* hay was included in the ration of the replacement ewes, while the finishing rams received lucerne hay as sole roughage source.

In the calculation of the gross margin, product income (mutton- and wool production) was considered as gross income, while only the direct costs involved (feed costs, health control and shearing costs) were brought into consideration. As far as health control is concerned a fixed amount of R20.00/SSU was used

for all the treatments. This included dipping, dosing and vaccination costs. Regarding shearing costs only the direct cost of R 1.10/ewe was brought into consideration as all the other costs (bales, etc.) were shared by the various treatments. These prices were obtained from a local co-operative (BKB).

Cost of the rams was also not brought into consideration as the rams were rotated between the treatments and it would be difficult to allocate a certain amount to a treatment.

Prices used in this analysis for the various commodities derived from the animals were those realised at public auctions during April 2000. Mutton prices were an average of that realised at the metropolitan abattoirs and were obtained from the South African Meat Industry Corporation (SAMIC), while clean wool prices were obtained from WOOL SA. Regarding the self produced forages R 350.00/ton was used as a price for the silage (De Brouwer 1998). An average price of R 60.00/ha were used as a rental price for cultivated pasture, while that of veld was taken as R 40.00/ha (Potgieter, 1993). As mentioned previously, for the complete rations current feed prices were used.

## **RESULTS AND DISCUSSION**

### **Animal numbers and stock flow**

Examples of the stock flow-tables are included to give an indication of the average numbers of each class of animal during the various months of the year. These are presented in Tables 1 and 2 for the autumn and spring lambing seasons respectively.

The average monthly animal numbers (Tables 1 and 2) used in the determination of the LSU's for the various treatments. These tables additionally give an indication of the composition of the various flocks.

At the start of the trial the desired number of animals were not yet achieved and this affected their numbers (not being quite the same). However, this only affected the gross income of each wintering treatment but did not have an affect when expressed on a GM/unit-basis.

Because of their somewhat larger numbers (resulting in a larger number of LSU's), the animals of the spring lambing season, for all three treatments, had a slightly larger area allocated to them. The greater number of animals, in general, affected most of the total income and cost calculations.

### **Area allocation**

An average silage production of 12 tons/ha (De Brouwer, 1998) was used to calculate the area

**Table 1 Monthly animal numbers and annual average large stock units (LSU) for the three various wintering strategies of the autumn lambing season**

Class of animal	Treatment	Month											LSU	
		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	(1 LSU = 6 SSU's)
Adult ewes	I	44	5	5	40	34	34	34	44	44	44	44	44	5.20
	II	44	4	4	41	38	35	46	46	46	46	46	46	5.39
	III	39	5	5	5	36	36	36	44	43	43	43	42	4.71
Lactating ewes	I		37	37										1.36
	II		39	39										1.43
	III		35	35	35									1.93
Lambs (pre-wean)	I		47	47										
	II		46	46										
	III		33	33	31									
Replacement Ewes	I	19	19	19	19	19	19	19		21	21	21	21	2.53
	II	19	19	19	19	19	19	19		20	20	20	20	2.49
	III	19	19	19	19	19	19	19		20	20	20	20	2.49
Lambs (post wean) (<30 kg body mass)	I				38	40	39							0.98
	II				41	45	45							1.09
	III					33	33							0.55
Lambs (post wean) (>30 kg body mass)	I							39	19	10				0.74
	II							45	17	11				0.79
	III							32	16	13	10			0.87

**Winter Treatments:**

- I - Silage
- II - Foggage/crop residues
- III - Veld

**Annual average number of Small stock units (SSU):**

- I - 64.80
- II - 67.11
- III - 62.72



**Table 2 Monthly animal numbers and annual average large stock units (LSU) for the three various wintering strategies of the spring lambing season**

Class of animal	Treatment	Month												LSU
		May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	(1 LSU = 6 SSU's)
Adult ewes	I	60	60	60	59	8	10	12	54	52	52	52	47	6.58
	II	72	72	72	72	9	9	9	69	68	68	68	68	8.20
	III	61	61	60	58	10	11	11	60	60	60	60	60	7.26
Lactating ewes	I					50	48	45						2.62
	II					60	60	60						3.3
	III					47	46	46						2.55
Lambs (pre-wean)	I					65	63	60						
	II					78	76	75						
	III					62	61	60						
Replacement Ewes	I	15	14	14	14	14	14	14	14	14	14	14	22	2.07
	II	21	21	21	21	21	21	21	21	21	21	21	24	2.98
	III	20	20	20	20	20	20	20	20	20	20	20	24	2.85
Lambs (post wean) (<30 kg body mass)	I					B			48					
	II								63					
	III								46					
Lambs (post wean) (>30 kg body mass)	I									41	35	22		1.06
	II									59	37	34		1.41
	III									31	30	21		0.89

**Winter Treatments:**

- I Silage
- II - Foggage/crop residues
- III - Veld

**Annual average number of Small stock units (SSU)**

- I - 76.34
- II - 98.45
- III - 83.58

required for the silage production of Treatment I (Intensive treatment). The total quantity of silage consumed by the animals of the intensive treatment was used to calculate this area. As far as the maize crop residues are concerned, an area of approximately 40 ha was available for the animals of both lambing seasons and the cost was divided between the two lambing seasons on LSU-basis. For the cultivated pastures and veld, stocking rates of 2.5 and 5 ha/LSU respectively were used (Drewes, 1991; De Brouwer, 1998). The pasture scientists of this institute are currently using this figure.

The areas allocated to the various treatments of the two lambing seasons are indicated in Table 3.

It must be kept in mind, that, due to the varying levels of intensity, the areas allocated to the various treatments were not quite comparable. The areas for the cultivated crops are more capital intensive as far as their management (cultivation, fertilisation, harvesting, etc.) are concerned in relation to, for example, veld which is considered to be a cheap feed source (De Waal, 1990).

### **Gross income**

Gross product income (GPI) of the various woolled sheep wintering treatments was based on their mutton production and their wool production. Meissner *et al.* (1993) stated that, whilst Merinos are not an ideal feedlot type, income from wool can be a substantial additional benefit. Greeff *et al.* (1990) also accentuated the additional benefit of a wool income, additional to the mutton income.

### ***Mutton and lamb production***

According to Van Niekerk & Schoeman (1993) mutton production holds advantages in the sense that response time to market influences is half that of beef production. The total mutton production and the income realised by the various treatments of both lambing seasons, are indicated in Table 4. For the fattened rams a mutton price of R 14.22/kg carcass was used. This was the average price for Class A1 during April 2000. Class A1 was used as a price for lamb meat in this investigation. The mutton price used for the adult ewes differed because of their carcass grading. The average prices used, were the following:

<b>Class</b>	<b>c/kg</b>
B1	1121.5
B2	1149.9
B3	1087.7
C1	1021.7
C2	1050.8
C3	1034.5

**Table 3** Total area allocations for the ewes and replacement ewes of the three various wintering strategies of the two different lambing seasons.

LAMBING SEASON	Treatment I (Intensive)	Treatment II (Semi-intensive)	Treatment III (Extensive)
	Total area (ha)	Total area (ha)	Total area (ha)
<b><u>AUTUMN</u></b>			
Silage	4.2	--	--
Cultivated pastures	4.8	14.0	4.3
Crop residues	--	18.4	--
Veld	9.6	9.8	32.7
<b>Total</b>	<b>18.6</b>	<b>42.2</b>	<b>37.0</b>
<b><u>SPRING</u></b>			
Silage	5.4	--	--
Cultivated pastures	5.5	19.3	6.7
Crop residues	--	21.6	--
Veld	11.0	14.9	44.0
<b>Total</b>	<b>21.9</b>	<b>55.8</b>	<b>50.7</b>

#### Winter Treatments

- I - Silage
- II - Foggage/crop residues
- III - Veld

#### **Autumn lambing season**

The animals on the intensive and extensive treatments of the autumn lambing season (total mutton production) realised approximately the same average income per SSU during the three trial years (Table 4). The higher figure realised for the foggage/crop residue treatment must be attributed to a greater number of animals slaughtered in relation to the total SSU's. Due to poor performance more ewes were culled from the veld treatment and this was also reflected in the lower mutton income realised from their finishing lambs (Table 4). This is probably a treatment effect.

#### **Spring lambing season**

The animals of the foggage crop residue treatment realised the highest gross income (GI) from their mutton production for the animals of the spring lambing season (Table 4). The silage treatment realised approximately the same income per SSU than their contemporaries of the autumn

**Table 4 Total annual mutton production and income for the animals of the three various wintering strategies of the two different lambing seasons.**

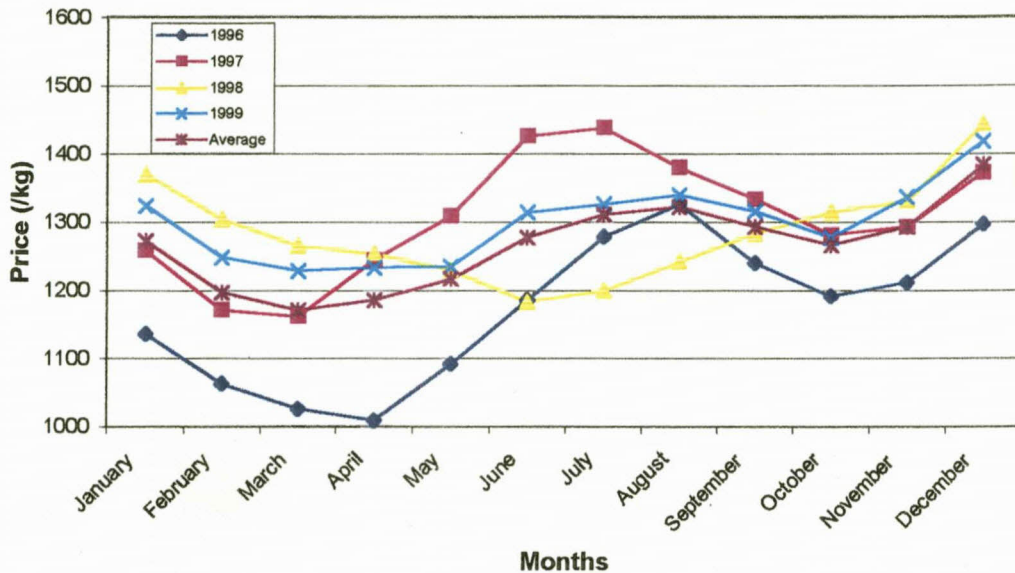
LAMBING SEASON	Treatment I (intensive system)		Treatment II (semi-intensive system)		Treatment III (extensive system)	
	Total produc- tion (kg)	Total income (R)	Total produc- tion (kg)	Total income (R)	Total produc- tion (kg)	Total income (R)
<b><u>AUTUMN</u></b>						
Finishing lambs	361.2	5 136	387.2	5 506	276.0	3 925
Culled ewes	100.8	1 065	172.8	1 818	222.2	2 336
<b>Total</b>		<b>6 201</b>		<b>7 324</b>		<b>6 261</b>
<b>Avg. mutton income/SSU (R)</b>		<b>95.69</b>		<b>109.11</b>		<b>98.82</b>
<b><u>SPRING</u></b>						
Finishing lambs	344.1	4 893	455.0	6 470	316.0	4 494
Culled ewes	201.6	2 343	182.4	2 052	160.3	1 839
<b>Total</b>		<b>7 236</b>		<b>8 522</b>		<b>6 333</b>
<b>Avg. mutton income/SSU (R)</b>		<b>94.79</b>		<b>86.56</b>		<b>75.77</b>

**Winter Treatments**

- I - Silage
- II - Foggage/crop residues
- III - Veld

autumn lambing season. The average income/SSU for animals of the veld treatment of the spring lambing season was much lower than that of the other two treatments (Table 4). Furthermore, this treatment (veld) had the lowest income of all the six treatments.

In the determination of a market strategy or production system the market prices for mutton as they vary throughout the year also may have a significant influence (Boshoff, 1981). The average mutton price (Class A) for all the metropolitan abattoirs in South Africa during the past five years (1996–1999), as well as the average price for this period, are presented in Figure 1.



**Figure 1** Average lamb/mutton price (Class A) for the past five years (1996–1999), as well as the average price.

From Figure 1 it is evident that the best marketing time, as far as the price is concerned, is during August/September. This coincided with the stage at which the finished rams of the autumn lambing season were ready to be slaughtered. This is, therefore, also an aspect subservient to the fodder flow, to consider when deciding on which lambing season to use. However, this variable was not included in the economical analysis. The only differentiation between treatments was based on carcass grading (in case of the culled ewes) and the total amount of mutton (kg) produced by each treatment.

### ***Wool production***

According to Boshoff (1981) the income from wool production is dependent on the prevailing market price and the direct costs such as shearing and marketing costs, involved. In the current study the direct costs were kept the same (per ewe) for all the treatments and the only differentiation between treatments was made on the total clean wool production (kg) and the fibre thickness of the wool. Prices used were those realised on the first auction of April (5 April 2000). The average wool income per adult ewe was R22.00/kg and that of the replacement ewes R 30.00/kg. However, it must be kept in mind that the tensile strength of the wool was not measured and that the wool of the silage treatment may have suffered a nutritional fineness (as discussed in the previous chapters). For the hogget fleeces, figures were obtained from a local wool co-operative (BKB) in terms of both the production of lambs at various ages and the price realised for such wool.

Total annual wool production for the animals of the three wintering strategies in the two lambing seasons are indicated in Table 5.

From Table 5 it is evident that, for both lambing seasons, the foggage/crop residue treatment realised the highest income both in terms of GI and income per SSU. This confirms what was earlier assumed that crop residues, in combination with cultivated pastures, appears to be an invaluable feed source which becomes available at a critical time of the year (Van Pletzen *et al.*, 1991), especially for woolled sheep. The fact that the silage treatment realised a higher income than the animals grazing winter veld can be mainly attributed to the poor quality of winter veld (De Waal & Biel, 1989). The questionable wool quality of the silage treatment must, however, also be kept in mind. It is noticeable that there is relatively little difference between the income per SSU between the two lambing seasons within a wintering treatment. The ranking of wintering strategies in terms of wool income per SSU was similar for both lambing seasons.

### ***Feed cost***

Various authors stressed the overriding importance of feed cost in a sheep production system (Bekker & Stolts, 1983; Woolliams & Wiener, 1983; Meissner, 1993). Greeff *et al.* (1990) stated that in a lamb production system the main input cost item is the amount of feed required by the breeding ewes.

The nutritional costs involved in each of the various wintering strategies for both lambing seasons are indicated in Table 6. These costs include silage, crop residues, cultivated pastures, veld, supplementation, creep feed, licks (winter and summer) as well as the feeding costs of the lambs after they were weaned (approximately two to six months of age).

**Table 5 Total annual wool production and - income for the animals of the three various wintering strategies of the two different lambing seasons.**

LAMBING SEASON	Treatment I (intensive system)		Treatment II (semi-intensive system)		Treatment III (extensive system)	
	Total produc- tion (kg)	Total income (R)	Total produc- tion (kg)	Total income (R)	Total produc- tion (kg)	Total income (R)
<b><u>AUTUMN</u></b>						
Ewes	140.9	3 101	144.8	3 186	125.3	2758
Replacement ewes	38.2	1 145	47.2	1 415	40.9	1228
Lambs (R 35/lamb)		1 188		1 485		938
<b>Total</b>		<b>5 434</b>		<b>6 086</b>		<b>4 922</b>
<b>Avg. wool income/SSU (R)</b>		<b>83.84</b>		<b>90.68</b>		<b>78.47</b>
<b><u>SPRING</u></b>						
Ewes	156.4	3 441	200.2	4 405	158.0	3 477
Replacement ewes	68.8	2 065	110.1	3 302	72.4	2 147
Lambs (R 15/lamb)		1 080		1 417		675
<b>Total</b>		<b>6 586</b>		<b>9 124</b>		<b>6 299</b>
<b>Avg. wool income/SSU (R)</b>		<b>86.27</b>		<b>92.86</b>		<b>75.36</b>

**Winter Treatments**

- I - Silage
- II - Foggage/crop residues
- III - Veld

**Table 6 Total annual feed costs for the animals of the three various wintering strategies of the two different lambing seasons.**

LAMBING SEASON	Treatment I (intensive system)		Treatment II (semi-intensive system)		Treatment III (extensive system)	
	Total production (kg)	Total cost (R)	Total production (kg)	Total cost (R)	Total production (kg)	Total cost (R)
<b>AUTUMN</b>						
Silage	50 267	3 770				
Supplementation (chocolate maize)	830	564	2 354	1 601	2 989	2 033
Cultivated pastures (ha)	4.8	288	14.0	840	4.3	258
Veld (ha)	9.6	384	9.8	392	32.7	1 308
Crop residues (ha)	--	--	18	1 102	--	--
Creep feed	485	340	406	284	--	--
Lambs (2-6 months)	38	3 040	42	3 360	37	2 960
Winter lick	913	644	856	603	828	584
Summer lick	88	15	78	13	73	12
<b>Total</b>		<b>9 045</b>		<b>8 195</b>		<b>7 155</b>
<b>Avg. feed cost/SSU (R)</b>		<b>139.57</b>		<b>122.11</b>		<b>114.08</b>
<b>SPRING</b>						
Silage	65 274	4 929				
Supplementation (chocolate maize)	480	326	1 767	1 202	3 205	2 179
Cultivated pastures (ha)	5.5	330	19.3	1 158	6.7	402
Veld (ha)	11.0	440	14.3	572	44.0	1 760
Crop residues (ha)	--	--	22	1 298	--	--
Creep feed	431	302	367	257	--	--
Lambs (2-6 months)	44	3 520	59	4 720	36	2 880
Winter lick	1 141	804	788	556	953	672
Summer lick	66	11	86	14	70	12
<b>Total</b>		<b>10 662</b>		<b>9 776</b>		<b>7 905</b>
<b>Avg. feed cost/SSU (R)</b>		<b>139.51</b>		<b>99.31</b>		<b>94.85</b>

**Winter Treatments**

- I - Silage
- II - Fodder/crop residues
- III - Veld



From Table 6 it can be seen that the silage treatment had the highest feed costs for the animals of both the lambing seasons (both in terms of the total cost and cost per SSU). Meissner (1993) also postulated that feed cost is the main cost item when animals are pen fed and that it can account for 70 to 80 % of variable costs.

In both lambing seasons the veld treatment (extensive low cost approach) had the lowest overall feed cost, with the semi-intensive treatment being intermediate. This cost could probably even have been lower if the supplementation costs (28.4 % of the total cost) was not so high. The general perception exists that the stocking rate was, because of the relative high rainfall during the trial years, too low (as indicated by the grass that matured relatively early during the years that the trial was executed). This probably resulted in poorer animal performance. Supplementation, which escalated the costs, had to be supplied to these animals. To a lesser extent this argument is also valid for the animals grazing foggage. Viglizzo (1994) stated that available evidence suggests that low input (extensive) systems are more sensitive to climatic conditions. In this investigation the concept sensitivity refers to, in contrast to what is normally meant, over-abundance of the grass or insufficient numbers of livestock to utilise the available material effectively. Another option might be the introduction of cattle, in combination with sheep.

The higher feed costs of the semi-intensive and extensive treatments for the autumn lambing season can be attributed to the higher supplementation costs of the lactating ewes during early and mid winter. The ewes of the spring lambing season who raised their lambs requiring less supplementation.

### **Gross margin**

The GM for the autumn and spring lambing seasons are presented in Tables 7 and 8 respectively. The total GM, the GM/SSU, the GM/ewe and the GM/ha were calculated.

#### ***Autumn lambing season***

Treatment II (foggage/crop residues) realised the highest gross income. The GI of the intensive treatment was, however, only 4 % higher than that of the extensive treatment. The GI of the foggage/crop residue treatment were 15.3 and 19.9 % higher than that of the silage and veld treatments respectively.

The total cost of the various wintering treatments were directly correlated to the level of intensification. The greatest cost factor involved with semi-intensive and extensive treatments were the feed costs for the finishing rams and replacement ewes between the age of six months (Table 6). A more cost-effective approach is a probability in the finishing of the lambs. This could especially be true for

**TABLE 7** Gross margin (R) of the ewes from the various wintering strategies during an autumn lambing season

ITEM	Intensive System	Semi-intensive System	Extensive System
<b><u>INCOME:</u></b>			
Mutton:	6 201	7 324	6 261
Wool:	5 434	6 086	4 922
<b><u>GROSS INCOME:</u></b>	11 635	13 410	11 185
<b><u>VARIABLE COSTS:</u></b>			
<b>TOTAL FEED COSTS</b>	9 045	8 195	7 155
<b>Other costs:</b>			
Health control (R 20/SSU*)	1 280	1 340	1 240
Shearing cost (R 1.10/head)	63	77	69
<b>TOTAL OTHER COSTS</b>	1 343	1 417	1 309
<b><u>TOTAL COSTS</u></b>	10 388	9 612	8 464
<b>TOTAL GROSS MARGIN</b>	1 247	3 798	2 721
Gross margin/SSU	19.24	56.59	43.38
Gross margin/ewe	29.69	90.43	69.77
Gross margin/ha	67.04	90.00	73.54

\* - SSU = Small stock unit

**TABLE 8** Gross margin (R) of the ewes from the various wintering strategies during an spring lambing season

ITEM	Intensive System	Semi-intensive System	Extensive System
<b><u>INCOME:</u></b>			
Mutton	7 236	8 522	6 333
Wool	6 586	9 124	6 299
<b><u>GROSS INCOME:</u></b>	<b>13 822</b>	<b>17 646</b>	<b>12 632</b>
<b><u>VARIABLE COSTS:</u></b>			
<b>Feed costs:</b>			
<b>TOTAL FEED COSTS</b>	<b>10 662</b>	<b>9 477</b>	<b>7 905</b>
<b>Other costs:</b>			
Health control (R 20/SSU*)	1 522	1 965	1 661
Shearing cost (R 1.10/head)	75	102	93
<b>TOTAL OTHER COSTS</b>	<b>1 597</b>	<b>2 067</b>	<b>1 754</b>
<b><u>TOTAL COSTS</u></b>	<b>12 259</b>	<b>11 844</b>	<b>9 659</b>
<b>TOTAL GROSS MARGIN</b>	<b>1 563</b>	<b>5 802</b>	<b>2 973</b>
<b>Gross margin/SSU</b>	<b>20.47</b>	<b>58.93</b>	<b>35.57</b>
<b>Gross margin/ewe</b>	<b>26.95</b>	<b>82.98</b>	<b>47.19</b>
<b>Gross margin/ha</b>	<b>71.37</b>	<b>103.61</b>	<b>50.70</b>

\* - SSU = Small stock unit

the more extensive treatments where a slower growth rate may be realised, with accompanied delayed marketing, but low costs involved.

As far as the relatively disappointing GM figures are concerned this must be seen against the low lambing and weaning percentages as was pointed out in Part 2, Chapter 1 and Part 3, Chapter 1 for the autumn and spring lambing seasons respectively. This could not be attributed to treatment effects.

Table 7 indicates that, for all factors included, the silage treatment realised the lowest GM. This was mainly due to the cost of the silage (41.7 % of the feed cost). Despite the fact that the silage treatment utilised only 44 % of the area utilised by Treatment II, it still realised only approximately 75 % of the gross margin. In contrast to the results of De Brouwer (1998) with beef cattle the GM did not increase as the level of intensification decreased. The price of silage (R 70.00/ton in this case) could vary widely and depends on factors such as availability, dry matter production and grain production of the cash crop. The GM of the veld treatment was only approximately R 13/SSU below that of the foggage/crop residue treatment, while it was approximately R20/ewe and R 16/ha lower than that of the semi-intensive treatment. It must be kept in mind that although the crop residue area are allocated to a specific treatment, this area is only utilised for two months of the year.

### ***Spring lambing season***

Similar to the autumn lambing season, the animals of the spring lambing season that utilised foggage/crop residues once again realised the highest GI (Table 8). The GI of this treatment was on average 33.4 % higher than that of the other two treatments.

In contrast to the autumn lambing season, the income obtained from wool production in the winter veld treatment, was however, marginally higher than that of the silage treatment (Table 7).

The GI for the silage treatment was 9.4 % higher but its total cost was 26.9 % higher than that of the veld treatment. In accordance with the autumn lambing season this higher feed cost must once again be attributed to the cost of the silage.

In comparison to the autumn lambing season the GM of the foggage/crop residue treatment was somewhat higher, both in terms of GM/SSU and GM/ewe, while that of the winter veld treatment was marginally lower in both cases. This resulted in the GM/ha for the silage treatment being somewhat higher than that of the veld treatment. Once again the management intensity, however, comes into consideration.

Regarding the riskiness of various enterprises, Boshoff (1981) and Schutte (1994), however, stressed the fact that it must be kept in mind that silage is less risky because the feed reserves can be stored, where-as cultivated pastures and veld (more extensive systems) are more subject to droughts during summer and incidental fires during winter. However, it must be kept in mind that during drought situations, the maize plants had approximately the same nutritional value than plants with good cob development, despite their lower grain production (Von Le Chevallier *et al.* (1971). These plants, consequently, still has an adequate nutritional value (in terms of both silage and grazing by animals).

As was the case with the autumn lambing season, in terms of all the parameters under consideration the semi-intensive treatment realised the best results.

## CONCLUSIONS

The Western Highveld is mainly mixed a farming region. This holds the advantage that the nutritional management of sheep is flexible and the deciding factor, on which system to use, will be dictated by the availability of feed sources. Each system has its limitations but all of them realised a positive GM. It must be kept in mind that calculations were only done up to a GM-level. Fixed costs were probably higher in the more intensive treatments.

With reference to the various wintering strategies the silage treatment realised the lowest GM per SSU and per GM/reproducing ewe. The wool growth results of this treatment were also disappointing despite their superior live masses (compared to the other two treatments). The price of the silage may vary and this could also have a significant influence on the profitability of this enterprise.

The foggage/crop residue treatment realised the highest GM in terms of all the parameters compared (per SSU, per ewe and per ha) for both the lambing seasons. However, rainfall (both in terms of quantity and the distribution) is of vital importance. From the results of this study it is evident that the quantity, rather than the quality, of the foggage is the limiting factor. Crop residues are an invaluable, high energy feed source, which becomes available at a crucial time in the fodder flow of woolled sheep. This feed source also has little or no other commercial value.

The extensive treatment also returned disappointing results when compared to the foggage/crop residue treatment. The fact that the stocking rate was probably too low for these specific years (as indicated by the maturity of the grass) possibly contributed to the fact that the supplementation costs of this 'low cost treatment' escalated disproportionately. This was especially true for the ewes of the autumn lambing season, which raised their lambs during the early and mid winter months.

The growing out of the replacement ewes and the finishing of the rams could be more cost-effective, especially for the more extensive treatments. It would be advisable to adopt a low cost approach where a slower growth rate is realised, associated with considerably lower input costs.

Provided that the feed sources are available, Treatment II (fodder/crop residue treatment) proved to be the most profitable wintering system in this investigation for both the autumn and spring lambing seasons. These results are in agreement with the general accepted practice on the Western Highveld for crop residues to be utilised by livestock during the winter months.

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## GENERAL CONCLUSIONS

The results of this study indicated that, with the correct utilisation of available feed resources, farming with woolled sheep could be successfully implemented in the Western Highveld of South Africa.

### Utilisation of Smuts Finger grass

The quantity and quality of cultivated pasture in winter were greatly influenced by both the quantity and distribution of the annual rainfall [577 mm vs. a long-term average (lta) of 685]. This, consequently, influenced pasture utilisation. In the current trial, under the dry circumstances as mentioned, it was found that the quantity, rather than the quality, of the foggage was the limiting factor in winter. The three lowest stocking rates (*vis.* 2; 4 and 6 sheep/ha) only managed to satisfy maintenance requirements. This implies that a maximum of 6 sheep/ha can be applied during dry seasons. It is clear that winter Smuts finger foggage, supplemented with a protein lick, is sufficient for maintenance, but not production. According to the disappointing mass gains obtained, foggage should not be utilised during spring. It is possible that, during seasons with higher rainfall, an increased stocking rate of 8 sheep/ha can be implemented successfully. Due to the unpredictability of the rainfall in the Western Highveld, the common recommendation that grass should be cut during mid January to ensure foggage of a high quality in winter, may be risky. Resting the pasture for the entire summer, preceding utilisation, influenced the results of this trial favourably in terms of available grazing material.

In accordance with the winter trial, a dry period was also experienced during the summer trial. (470 mm vs. a lta of 563 mm during the summer months - October to April). This was also characterised by a poor distribution of the rainfall. Very poor animal performance was realised, as reflected by their disappointing mass gains. If mass gain/ha and the grazing period are considered as suitable indicators of performance, the best results were obtained with a stocking rate of 8 sheep/ha. During these dry seasons a fertilisation rate higher than 60 kg N + 10 kg P/ha/year had no beneficial effect as far as mass gain/ha is concerned. Continuous grazing could also have influenced the results detrimentally. The results obtained in this trial may have differed substantially under circumstances of higher rainfall and a rotational grazing system.

### Wintering feeding strategies

In contrast to the Smuts finger trials, above normal rainfall occurred during the feeding system studies.

The biological differences among treatments of the two lambing seasons were basically comparable. Differences were, however, less prominent in the case of the spring lambing season. The biological

and economical results indicated that the utilisation of Smuts finger cultivated pasture and maize crop residues during winter realised the best results for both an autumn- and a spring lambing season. Nevertheless, the resource situation on a specific farm should ultimately be the deciding factor in choosing a suitable system. The mass advantage by feeding silage during the winter period, was to a great extent, nullified at the end of each year. This can be ascribed to the compensatory growth that occurred in the more extensive treatment during the subsequent summer period.

### **Treatment I (Silage)**

Although the quantity of the maize silage [1 Kg dry matter (DM)] provided to these non-lactating ewes was in accordance with the guidelines provided by the NRC (1985) for maintenance requirements, these ewes showed a gain in body mass during all three the winter periods. Similarly, the young replacement ewes that received silage had to be restricted to 1 kg DM because they tended to become too fat. However, the energy and crude protein (CP) supplied by means of the winter lick should also be kept in mind. The winter lick intake of these penned animals was exceptionally high when silage provision was restricted.

The adult ewes, as well as replacement ewes, of the silage treatment realised the highest body mass and best gains throughout the winter, as well as the first part of summer (until they were shorn). This mass advantage, however, was neither transferred to their progeny (mass gain of the lambs), nor to their own wool production. The lack of effect on wool production may be due to the high non-protein nitrogen (NPN) -content of the silage. A natural protein supplement, in excess of that supplied by the winter lick, should probably be considered for woolled sheep fed maize silage. The total cost of such a strategy, compared to the potential advantage gained, will ultimately be the deciding factor. On average the ewes of the silage treatment, for both the lambing seasons, resulted in the lowest fibre diameter.

During late pregnancy, ewes did not consume their daily silage allowance. This was probably due to the bulkiness of the silage combined with the reduced rumen capacity of the ewes with the result that they were not able to ingest sufficient nutrients. In order to prevent pregnancy toxemia, energy supplementation is necessary prior to lambing.

The cost of silage, however, has a major influence on the profitability of this enterprise. For both the autumn and spring lambing seasons, silage provided to the ewes was the highest feed cost item. This treatment, consequently, realised the lowest gross margin (GM)/SSU. However, silage has certain advantages as winter-feed source of which the most important being that it can be stored with little risk of loss. Cultivated pastures and veld (more extensive systems), as alternative winter-feeds, are more subject to droughts during summer. This, as well as, accidental fires are very important factors to consider (Boshoff, 1981).

The intensive treatment lambs remained penned with their dams for the duration of the winter period. This probably increased creep feed intake, which was considerably higher than that of the foggage/crop residue treatment. However, this expected advantage could not be detected in the pre- and post wean performance of the lambs. Despite a lower creep feed intake, the lambs from the foggage/crop residue treatment realised higher growth rates than those of the silage treatment, throughout the trial.

In conclusion it can be stated that silage as sole feed source for woolled sheep could not be recommended. The role of silage in sheep production should rather be in the finishing of lambs (Boshoff, 1981). Furthermore, the strategic feeding of silage (supplemented with natural protein sources) to ewes can play an important role in drought and feed shortage (quantitative and qualitative) situations.

### **Treatment II (Foggage/crop residues)**

The foggage/crop residue treatment showed the best biological and economical results and seems to be the most appropriate wintering strategy for Merino sheep in the Western Highveld region. Crop residues remain an invaluable, high-energy feed that becomes available during a difficult time (approximately mid June to mid August – depending on the harvesting date of the maize) in the fodder flow of livestock. This feed source also has little or no other commercial value. The advantage, specifically for woolled sheep, lies in the fact that it normally becomes available during the mid-winter period when a feed restriction occurs. This is especially important during certain physiological stages, such as late pregnancy and lactation, as well as for wool production. The highest fibre diameter was observed in this treatment.

Under circumstances of high rainfall, the utilisation of mature grass (both Smuts finger grass and veld) caused a problem, especially during the pre-wean period. This could possibly be rectified by the introduction of cattle or a higher stocking rate, in general. An alternative feeding strategy for replacement ewes needs further investigation. The utilisation of maize silage and/or supplementation could possibly be considered.

### **Treatment III (Veld)**

The average mass of ewes in the extensive (winter veld) treatment was the lowest throughout the trial. This was especially true for the ewes in the autumn lambing season. At the end of the third season their body mass was approximately 16 % lower than the body mass of the ewes in the other winter treatments. From this it appears that these animals would probably be inferior to those of the other two treatments in the long term as far as their animal performance are con-

cerned. This assumption is supported by the inferior wool and reproduction performance during the latter seasons.

As already mentioned, these animals also experienced problems with over-abundance of the grass during high rainfall.

Although the veld treatment realised better economic results compared to the silage treatment, it cannot be recommended for Merino sheep in the Western Highveld, especially for the autumn lambing season. A decline over the long-term was observed in body mass reproduction and wool production of the ewes and the performance of their progeny.

### **Summer feeding strategies**

Although the ewes utilising cultivated pastures during summer, in general, tended to show better biological results compared to the animals of the veld treatment, these differences were not as prominent as was the case with the wintering strategies.

In brief the results of the present study can be summarised by the following:

- Rainfall, both in terms of quantity and distribution is the most critical factor regarding the utilisation of Smuts finger grass, during both summer and winter. The quantity, rather than the quality of the foggage was the limiting factor in winter when dry conditions prevail. Rotational grazing, instead of continuous grazing, during summer, may also influence results favourably.
- Ewes wintered on maize silage, as the sole roughage source, returned the highest body mass and the best mass gains. However, this advantage was not transferred to the performance of their progeny and the quantity and quality of the wool produced.
- Crop residues proved to be an invaluable, high energy feed source that becomes available at a crucial time in the fodder flow of woolled sheep. Despite the lowest clean wool percentage, it still realised, in combination with cultivated pasture, the highest average clean wool mass. The greater fibre diameter observed was also not so severe as to cause a reduction in price.
- The poor performance of ewes on winter veld indicated that this is not a viable option for the wintering of woolled sheep and, where available, an alternative nutritional strategy should be implemented.
- Ewes lambing during spring required less supplementation.

- Foggage/crop residues, for both lambing seasons, showed the best GI throughout. In this regard it is important to remember that, in the case of the autumn lambing season, lambs are slaughtered when the highest average mutton price is realised.
- Silage provided to ewes during winter was the most cost-intensive.
- The foggage/crop residue treatment during winter realised the highest, and the silage treatment the lowest, GM for all the parameters tested for both the lambing seasons respectively. GM/ha was the only exception. In this regard, the GM/ha for the intensive treatment was higher than that of the extensive treatment for a spring lambing season. The costs of intensification, however, are a major disadvantage.
- Economical results obtained in this investigation could be influenced by a variation in cost and product prices. However, biological results obtained in the present study can be used in simulation models to evaluate different wintering strategies.

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**ABSTRACT**

The aim of this study was to evaluate the biological and economical feasibility of wool sheep farming in the Western Highveld of South Africa.

The performance of young sheep utilising *Digitaria eriantha* Steud. (Smuts finger grass) both during the winter and summer periods, fertilised at rates of 60 kg N + 10 kg P/ha vs. 120 kg N + 20 kg P/ha, was investigated. Rainfall, both in terms of quantity and distribution, was the most critical factor during both the summer and winter seasons. During the winter period, the quantity rather than the quality, of the foggage was the limiting factor. The results of this study, with the below normal rainfall recorded, showed that stocking rates of two, four and six sheep/ha for a six month period are sufficient for the maintenance requirements of woolled sheep. During these dry seasons a fertilisation rate higher than 60 kg N + 10 kg P/ha had no beneficial effect as far as mass gain/ha is concerned. The results obtained during the summer period were also very disappointing, mainly due to a lack of available pasture. Rotational grazing, instead of continuous grazing, should probably rather be applied during the summer period.

The biological and economical feasibility of three various wintering strategies (silage, foggage/crop residues and veld) of Merino ewes and their progeny, for both an autumn and a spring lambing season, were also evaluated. This study indicated that the utilisation of Smuts finger grass foggage and crop residues during winter, realised the best results for animals of both lambing seasons. However, the biological and economical availability of the various feed sources would ultimately be the deciding factor on the most appropriate system. Although the animals of the intensive treatment (silage) had the best performance (mainly in terms of body mass and mass gain), the animals of the foggage/crop residue treatment showed compensatory growth during the summer period. This resulted in little or no differences in the body mass of these two treatments at the end of the summer period. In the case of ewes utilising winter veld, their compensatory growth was insufficient for a total recovery in body mass.

Ewes wintered on maize silage as the sole roughage source returned the highest body masses and body mass gains. However, this advantage was not transferred to the performance of their progeny and the quality and quantity of the wool produced. The conclusion was made that natural protein supplementation should be provided, additional to the silage, especially for woolled sheep. Cost of the silage will also exert a great influence on the financial viability of this enterprise, as this proved to be the highest feed cost.

Maize crop residues proved to be an invaluable, high energy feed source that becomes available at a crucial time in the fodder flow for woolled sheep. This product also has little or no other commercial

value. Despite the lower clean wool percentage, animals of this treatment still realised the highest clean wool mass (kg). The greater fibre diameter was also not so severe as to cause a reduction in price.

The poor performance of the ewes on winter veld was disappointing. In the long term, this does not appear to be a viable option. Where available, an alternative nutritional strategy should be applied. This extensive treatment can also be seen as a 'low cost approach' with reduced inputs and, consequently, a reduced income.

Ewes lambing during spring required less supplementation. This was mainly due to the fact that they utilised crop residues during late pregnancy and they raised their lambs during spring.

For both the lambing seasons the utilisation of foggage/crop residue realised the highest and the animals of the silage treatment the lowest gross margin for all the parameters tested (gross margin per small stock unit and per ewe), the only exception being the gross margin/ha, which was higher for the intensive treatment than that of the extensive treatment during the spring lambing season. The cost of intensification should, however, be kept in mind.

The results of this investigation clearly indicated the biological and economical advantages of utilising foggage/maize crop residues during the winter months.



## UITTREKSEL

Die doel van die studie was om die biologiese en ekonomiese doeltreffendheid van wolksaapboerdery in die Westelike Hoëveld van Suid Afrika te bepaal.

Met die benutting van *Digitaria eriantha* Steud. (Smutsvingergras), beide gedurende die somer- en winterperiodes, bemes teen peile van 60 kg N + 10 kg P/ha vs. 120 kg N + 20 kg P/ha, blyk reënval ten opsigte van hoeveelheid, sowel as die verspreiding, die mees kritiese faktor te wees. Gedurende die winter was die hoeveelheid, eerder as die kwaliteit, van die staande hooi die beperkende faktor. Gesien in die lig van die lae reënval wat gedurende hierdie ondersoek aangeteken is, was veeladings van twee, vier en ses skape/ha slegs voldoende vir die massa-onderhoud van wolksape. Die resultate wat gedurende die somerperiode behaal is, was ook baie teleurstellend. Gedurende hierdie droë seisoene wil dit voorkom asof bemestingspeilie bo 60 kg N + 10 kg P/ha geen voordeel, ten opsigte van massatoename/ha, inhou nie. Dit was hoofsaaklik as gevolg van 'n gebrek aan beskikbare weiding. Wisselweiding, in plaas van aanhoudende beweiding, gedurende die somer sou waarskynlik beter resultate tot gevolg gehad het.

Die biologiese en ekonomiese lewensvatbaarheid van drie oorwinteringstrategieë (kuilvoer, staande hooi/oesreste en veld) van Merino-ooie en hul nageslag is, ten opsigte van beide 'n herfs- en lentelamseisoen, ondersoek. Die resultate van hierdie ondersoek het getoon dat die benutting van Smutsvingergras- staande hooi, tesame met oesreste gedurende die winter, die beste ekonomiese resultate gelewer het, ten opsigte van beide lamseisoene. Die mees geskikte sisteem sal uiteindelik egter grootliks deur die biologiese en ekonomiese beskikbaarheid van voerbronne bepaal word. Alhoewel die diere van die intensiewe behandelings gedurende die winter (hoofsaaklik ten opsigte van liggaamsmassa en massatoename), beter presteer het, het die diere van die staande hooi/oesreste-behandeling kompenserende groei gedurende die somer getoon. Dit het tot gevolg gehad dat die diere van dié twee behandelings (in terme van liggaamsmassa) min of geen verskil aan die einde van die somer getoon het nie. Die ooie wat winterveld benut het, het egter nie voldoende kompenserende groei getoon om 'n totale herstel in liggaamsmassa te bewerkstellig nie.

Ten spyte van die feit dat ooie wat op mieliekuilvoer as enigste ruvoerbron oorwinter het die hoogste liggaamsmassa en massatoename gedurende die winterperiode getoon het, was hierdie voordeel nie waarneembaar in die prestasie van hul lamers en hul wolproduksie nie. Die gevolgtrekking is gemaak dat 'n natuurlike proteïenbron as aanvulling tot mieliekuilvoer noodsaaklik is vir wolksape. Aangesien kuilvoer die hoogste voerkoste by hierdie behandeling verteenwoordig het, sal die prys van die kuilvoer die bepalende faktor in die winsgewendheid van hierdie onderneming wees.

Mielieoesreste bly steeds 'n waardevolle hoë-energie voedingsbron, met min of geen ander kommersiële waarde. Hierdie voerbron is op 'n kritieke tydstip in die voervloei-program vir skape gereed vir benutting. Ten spyte van die laer skoonopbrengs van hul wol, het die ooie van hierdie behandeling nog steeds die hoogste skoonwolmassa gelewer. Die veseldikte was ook nie soveel hoër dat dit 'n laer prys gerealiseer het nie.

Die teleurstellende prestasie van die ooie wat op winterveld gewei het, toon aan dat, waar beskikbaar, 'n alternatiewe voerbron gedurende die winter benut moet word. Hierdie ekstensiewe benadering kan egter ook beskou word as 'n lae-koste benadering met laer insette en gevolglike laer diereprestasie en, gevolglik ook, laer inkomste.

Die feit dat die ooie van die lentelamseisoen gedurende laat dragtigheid op oesreste wei en hul lammers gedurende die lente soog, het tot gevolg gehad dat hul minder aanvulling benodig.

By beide lamseisoene het die ooie wat staande hooi/oesreste gedurende die winter benut het die hoogste, en dié wat kuilvoer benut het die laagste, bruto marge (per kleinvee-eenheid en per ooi) gerealiseer. Al uitsondering hier is die bruto marge/ha. Die bruto marge/ha van die intensiewe behandeling se ooie was hoër as dié van die ekstensiewe behandeling. Die koste verbonde aan intensifikasie moet egter hier in gedagte gehou word.

Die resultate van hierdie ondersoek het die biologiese en ekonomiese voordele verbonde aan die benutting van oesreste/staande hooi gedurende die winter duidelik beklemtoon.