CHAPTER 1

GENERAL INTRODUCTION

1.1 Introduction

In many parts of the world, climate limits the survival as well as the productivity of livestock. Man therefore provides shelter for animals in an effort to improve their productivity. Since the end of World War II, animals in more developed countries have been housed in increasingly closer confinement and their environments have become more and more regulated. This shift towards more closely controlled environments has contributed to increased productivity and in turn reduced production costs (Tucker & Ringer, 1982).

Intensification revolutionised meat production during the latter half of the previous century. In all countries intensification yielded more meat of a better quality, produced from a smaller national herd or flock. In practice, intensification means keeping more animals per unit of land in a well managed manner (Maree & Casey, 1993).

More than 70% of all beef consumed in South Africa is from cattle intensively fed in a feedlot (Van der Westhuizen & Van der Westhuizen, 2003). After reproduction, the feeding of animals (beef cattle) makes the second largest contribution to the total beef supply in the country.

1.2 Overview and background

As already mentioned, 70 to 80% of all beef in the formal sector in South Africa is derived from the feedlot industry and it is estimated that this sub-sector has a standing capacity of 420,000 head of cattle at any point of time. These figures entail that this specific industry has a potential throughput of 1,512 million animals annually. Normally animals enter the feedlot system at a live mass of between 200 and 220kg and remain in the feedlot for 100 days. During these 100 days spent on feed in the feedlot, the animals add approximately 100kg to their original live weight to realise a carcass weighing between 220 and 225kg. Approximately 340,000 tons of beef are produced annually by feedlots and the total amount of feed used by this industry annually accounts approximately for 1,5 million ton (SAFA, 2003).

It now becomes clear why feedlots need accurate calculations of feed-intake, feed-to-gain ratio and average daily gain (ADG) to be cost effective. After all, feed is the greatest expense in most intensive production systems (Parnell, 1996; Bosman, 1996). The total cost in a feedlot, from weaner to final carcass, includes the purchasing price of the weaner (53%), the price of feed (37.4%), overheads (5.3%), mortality and morbidity (0.5%) and marketing (3.8%) (Lombard, 2004).

As feed consumed and resultant growth gain are the most important economic components in calculating profitability, these measurements should be included in selection decisions to enhance profitability in beef cattle (Van der Westhuizen & Van der Westhuizen, 2003). In almost every situation live weight gains are most economical when the rate of gain is maximal. A high rate of gain invariably needs a high intake. Intake therefore is of prime importance and the feedlot feeder should put considerable effort into planning and management to maximise intake. The concept is simple. The animal needs a certain amount of nutrients to maintain essential functions and the maintenance requirement gets priority. Only nutrients in excess of maintenance can be utilised for gain (Maree & Casey, 1993).

The ideal method of decreasing costs would be to use feed more effective at the same growth and gaining of mass. According to Arthur *et al.* (1996) it is possible to lower the costs of production if there is an improvement in the feed conversion ratio (FCR). In the broiler industry the FCR has improved from 1:2,6kg in 1980 to 1:2,1kg in 2000, and in pork from 1:3kg in 1980 to 1:2,2kg in 2000 (Vermeulen, 2001). Similar improvements in the beef industry would be very positive for the future of intensive beef production or feedlots.

As feed costs account for 70-80% of the variable costs, efficiency of feed conversion is a key factor in profit realisation. For example, based on an estimated 650,000 cattle in Australian feedlots at any one time feed costs of $200 per ton and mean feed consumption of 12.5 kg/head/day, a 10% reduction in feed intake could save the Australian feedlot industry $59 million per year (Foster, 2001). One way to reduce feed costs is through genetic selection of more efficient animals (Robinson & Oddy, 2004), and another way to reduce the expenses in the feedlot industry would probably be to decrease the length of stay of the animals. Of the non-feed costs, some 80% is related to the length of time an animal is on feed. Rate-to-gain is therefore an important determinant of feedlot economy. The total feed requirement during the stay of an animal in the feedlot could be reduced by as much as 10% with an improvement in gain of only 200g/day. A further saving in costs would be brought about by lower non-feed costs due to the reduction in length of stay. A third advantage is that a shorter stay will favour turnover, which improves profits (Maree & Casey, 1993).

Of primary interest to the feedlot managers is the ability to identify and market groups of cattle that will consistently produce carcasses of similar weight with acceptable yield and quality grades. Accurate ultrasonic measurements of the *longissimus dorsi* area or eye muscle area (EMA), back fat thickness (BFT), P8 (fat layer on the rump) and marbling in the live animal would allow more effective marketing practices. Many researchers have therefore evaluated the use of real-time ultrasound as a method of predicting these carcass traits in live animals (Smith *et al.* 1990).

Body measurements are also a known method to evaluate growth in animals. Body weight (BW) is a frequently recorded variable in animal research. It is also the measurement mostly used to evaluate growth (Otte *et al*., 1992). Although it is an important indicator of growth, however body measurement fails to explain the body conformation of a animal. Other measurements most commonly used in cattle include heart girth (HG), shoulder height (SH) and body length (BL); however, heart girth is generally accepted as the single most reliable indicator (Benyi, 1997) of growth (body weight).

1.3 Rationale

Satisfactory progress has been made over the past decades with regard to feeding technology, feedlot outlay and the identification of animals that perform well under feedlot conditions. A factor that may have a huge impact on the performance of animals under feedlot conditions in the near future is light manipulation. Although photoperiod (the period of daily illumination an organism receives) management is used by many dairy producers to increase profits, very little research has been conducted in beef cattle, especially under South African conditions.

Dairy producers are constantly searching for new management techniques to improve production efficiency and cash flow. Photoperiod management has attracted interest lately as a cost effective method of increasing production in lactating cows. This is because the daily milk production of cows exposed to long days, with 16-18 hours of light and 6-8 hours of darkness, increases on average by 2ℓ /cow/day, relative to those on natural photoperiods (Dahl *et al.,* 2000).

While almost all animals respond to photoperiod in some way, it is usually associated with reproductive events (Tucker & Ringer, 1982). Poultry producers use lighting to stimulate layers, and sheep and horse breeders manipulate the breeding season with light exposure. Though cattle are not seasonal breeders, photoperiod can affect their reproduction: for example, long days hasten puberty in heifers relative to natural day length (Hansen, 1985).

The effect of photoperiod on milk production was first observed in 1978 by researchers at the Michigan State University. Cows were placed on 16 hours of light and 8 hours of darkness, or left on natural photoperiod at calving. Over the first 100 days postpartum, cows on long days (16L:8D) produced 2ℓ /day more milk than those on a natural photoperiod. At 100 days, the treatments were switched and cows previously on 16L:8D showed a decrease in milk yield. These results suggest that exposure to long days increases milk yield and does so across production levels (Peters *et al.,* 1978).

In another study supplementary light also improved milk production in cows that were given 16L:8D. Twenty-one cows in early and late lactation produced 6.7% (1.4kg) more milk per day than cows exposed to natural photoperiods. Dry matter intake increased by 6.1% for cows in 16L:8D, and this increase could account for increased milk yields (Peters *et al*., 1981).

The questions that arise are whether light manipulation will affect the feedlot performance of beef bulls, secondly, whether light manipulation has any effect on certain body dimensions.

1.4 Objectives of the study:

- to quantify the differences in average daily gain (ADG), back fat thickness (BFT), eye muscle area (EMA) and feed conversion ratio (FCR) of animals exposed to different levels of light supplementation;

- to quantify the economic implication of supplemented light on young beef bulls fed intensively; and
- to determine whether light manipulation has any affect on body dimensions.

1.5 Research hypotheses:

- The dry matter intake of bulls exposed to additional light will be higher than for those exposed to natural light conditions.
- Light supplementation will have a positive effect on the ADG and FCR of beef cattle bulls.
- The length of stay in the feedlot will be reduced by the influence of light supplementation.
- Supplemented light will have a positive effect on feedlot economics.

1.6 References

Arthur, P.F., Thomas, M., Exton, S., Dibley, K. & Herd R.M. 1996. Economic benefit from selecting for net feed conversion efficiency in beef cattle. Proceedings of the animal science congress of the Asian-Australian Association for Animal Production. Makuhari. Chiba, Japan 13-18 October 1996. 8: 22-23.

Benyi, 1997. Estimation of live weight from chest girth in pure and crossbred West African goats. Trop. Anim. Health Prod. 29: 124-128.

Bosman, D.J., 1996. Die waarde van intensiewe en ekstensiewe groeitoetse by vleisbeeste. Nasionale Vleisbeesprestasietoetsskema. Nuusbrief No. 75: 12-17.

Dahl, G.E., Buchanan, B.A., & Tucker, H.A. 2000. Photoperiodic effects on dairy cattle: A review. J. Dairy Sci. 83: 885-893.

Foster, M., 2001. Lot feeding, its role now and into the new millennium. Beef Quality CRC, CRC News. University of New England, Armidale, NSW 2351, pp 7-11.

Hansen, P.J., 1985. Seasonal modulation of puberty and postpartum anestrus in cattle: A review. Livestock Prod. Sci. 12: 309-327.

Lombard, H., 2004. Optimal weaner production for the feedlot industry. Cattleman's Conference: Sustainable Beef Cattle Production, Bloemfontein 8 October 2004. University of the Free State: Department of Agriculture, pp. 34-39.

Maree, C & Casey, N.H. 1993. Livestock Production Systems principles and practice. Brooklyn: Agri-Development Foundation.

Otte, M.J., Woods, A.J. & Abuabara, Y., 1992. Live weight estimation of cattle by scale and tape – A method comparison study. Trop. Anim. Health Prod. 24: 109-114.

Parnell, P., 1996. Utilization of genetic influences on feed conversion efficiency to increase beef herd profitability. Presentation on the 9th Jornadas Ganaderas at Pergamino Argentina, 7th to 8th June 1996.

Peters, R.R., Chapin, L.T., Leining, K.B. & Tucker, H.A., 1978. Supplemental lighting stimulates growth and lactation in cattle. American Association of Science. Science (Washington, DC) 199: 911-912.

Peters, R.R., Chapin, L.T., Emery, R.S. & Tucker, H.A., 1981. Milk yield, feed intake, prolactin, growth hormone, and glucocorticoid response of cows to supplemented light. J. Anim.Sci. 64: 1671-1678.

Robinson, D.L. & Oddy, V.H., 2004. Genetic parameters for feed efficiency, fatness, muscle area and feeding behaviour of feedlot finished beef cattle. L. Prod. Sci. 90: 255-270.

SAFA (2003). South African feedlot industry and the economics of beef production. Unpublished document. South African Feedlot Association, Pretoria.

Smith, M.T., Oltjen, J.W., Dolezal, H.G., Gill, D.R, & Behrens, B.D., 1990. Evaluation of real-time ultrasound for predicting carcass traits of feedlot steers. Oklahoma Agric. Exp. Sta,. Anim. Sci. Res. Rep. MP-129:374.

Tucker, H.A. & Ringer, R.K. 1982. Controlled photoperiodic environments for food animals. American Association for the advancement of Science. 216: 1381-1386.

Van der Westhuizen, B. & Van der Westhuizen, J., 2003. Determining the feedlot profitability of beef cattle. SA Stud book. 3: 93, Oct.

Vermeulen, S.W., 2001. ‘n Evaluasie van die voeromsetverhouding van Bonsmara verse. M.Tech (Agric) dissertation, Technikon Free State, Bloemfontein.

CHAPTER 2

LITERATURE OVERVIEW

2.1 Introduction

The cost of feed is the single largest expense in most animal production systems. This has been well recognised by the pig and poultry industries, which have made large gains in improving feed conversion efficiency and have been able to reduce their cost of production relative to the beef industry. The cost of feed in the extensive grazing industries is more difficult to quantify than the costs in intensive production systems. The cost of feed for beef production includes the cost of supplementary feedstuffs, feedlot rations, fertiliser, irrigation, running costs of plant and machinery and labour inputs, all associated with feed production as well as the interest and opportunity cost of capital invested in grazing land and machinery (Parnell, 1996; Archer & Arthur, 1997).

Because the cost of feed is a very high component of beef production costs, it is important to use available feed resources as efficiently as possible.

2.2 Feed conversion ratio (FCR) and average daily gain (ADG)

The feed conversion ratio (FCR) as a measure of efficiency in Phase C growth tests can be defined as the ratio of output over input. Input is the amount of feed consumed and output the mass gained during the test period (Bosman, 1992).

Feed conversion ratio is of great importance, because more than 50% of all calves born in South Africa are finished in feedlots directly after being weaned. Improvement in FCR can effectively be used to compete with white meat producers in the country (Geldenhuys, 1997).

The FCR has been used as a measure of efficiency in Phase C growth tests since 1963, although in the past it was very labour intensive and measured on a limited scale, especially in countries where labour costs are high. The result is that in comparison with poultry and pigs, beef cattle have shown little improvement in FCR. A breed for which many bulls have been tested has shown an improvement of 12%. The heritability of FCR in the 140-day test period was estimated at 20% and in the 112-day test period 30% (Bosman, 1992). At the present an 84 day test period is used.

The relative importance of ADG and FCR in determining net return per head in cattle feeding was studied by researchers at Washington State University (Bosman, 1995). They found that FCR is more important than ADG in determining net return. Feed conversion ratio grew in importance with an increase in feed cost, and ADG became more important with an increase in purchase cost. Selection for ADG or FCR will result in an improvement in the other traits because they are negatively correlated. It must be remembered that there is a variation in FCR at constant values of ADG and therefore capitalisation on this variance through selection would be beneficial in that it would improve the efficiency of beef production. In addition, as practical limits in the improvement of ADG are reached, FCR will certainly become the trait of vital importance (Bosman, 1995).

2.2.1 Feed for maintenance

According to Parnell (1996) a large portion of the total feed used in the beef production chain simply goes towards maintaining the breeding herd. In a typical beef herd, turning of progeny at yearling age, about 70 to 80% of the total feed energy requirements are consumed by the breeding cows and replacement heifers, with only 20 to 30% consumed by growing animals destined for market. As the turn-off age is reduced the relative proportion of feed consumed by the breeding herd is increased. The feed consumed in the breeding and finishing segments of a beef herd can be partitioned into the requirements for maintenance, and production (i.e. growth, gestation and lactation.). The majority of feed energy is used for maintenance. For example, on average, about 75% of the feed consumed by breeding females is used for maintenance, with only 20% typically used for pregnancy and lactation, and only 5% used for deposition of body tissue (Parnell, 1996).

As an animal grows and increases in body weight from birth to maturity the relative importance of maintenance feed costs increases. In growing animals the proportion of the feed required for maintenance is about 50% during the pre-weaning stage, and increasing to about 66% during post-weaning growth. Only a portion of the total food energy consumed by an animal is actually available for metabolism. A large amount of food energy is lost in faeces, urine and gaseous products of digestion. In addition, a large proportion of remaining metabolisable energy intake is required for the performance of vital functions simply to keep the animal alive and to support its level of activity, including energy expenditures associated with digestion and assimilation of food (Parnell, 1996).

Metabolisable energy input in excess of maintenance requirements is used for production, a portion of which is lost as heat production associated with synthesis of tissue, and a portion which appears as stored energy in the animal's tissue (Fig. 2.1).

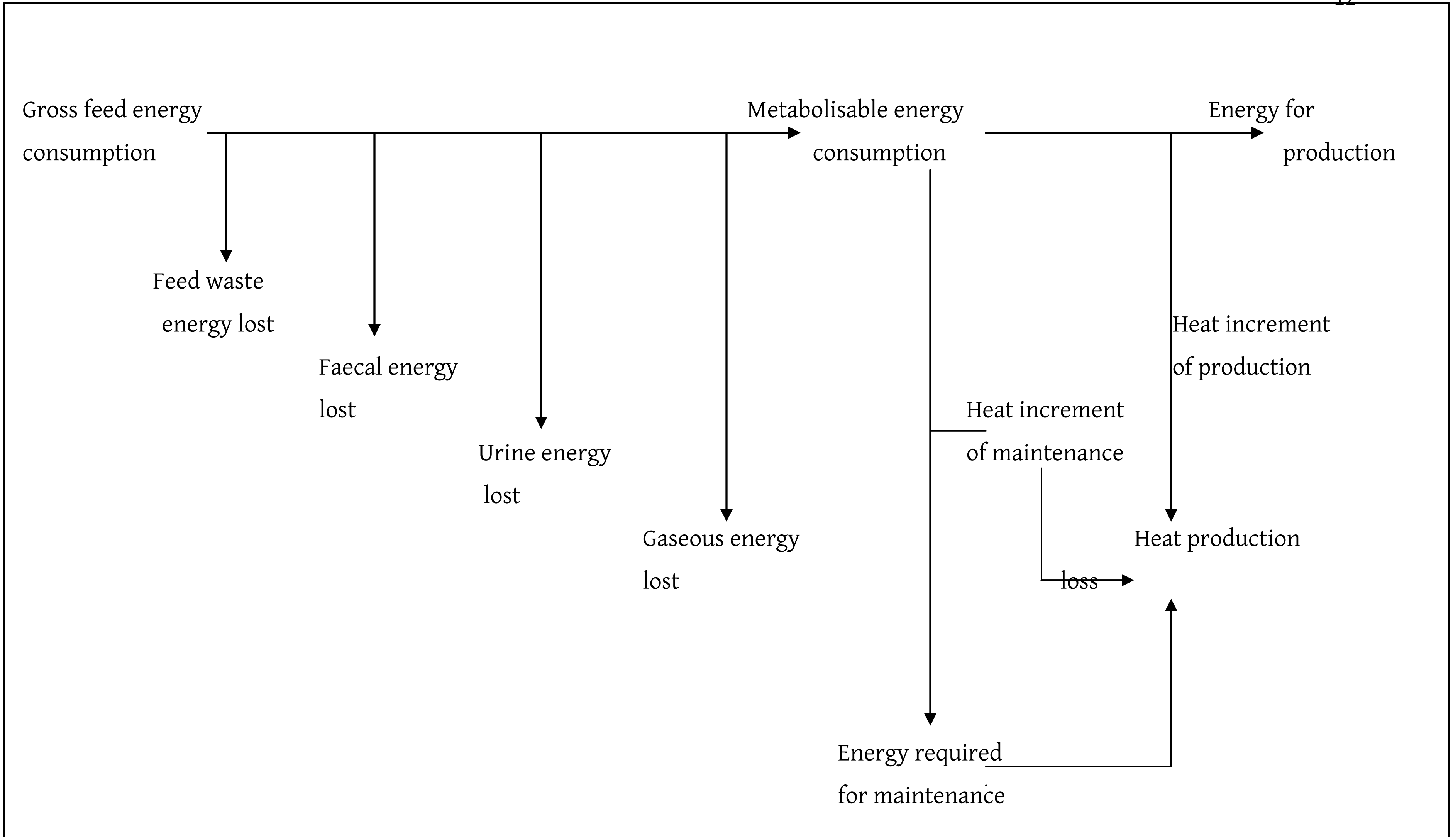

Figure 2.1: Partitioning of feed energy into maintenance and production (Parnell, 1996)

Animals that show compensatory growth in the early stages of their lives, will spend less time on feed in the feedlot, should use less feed for maintenance and more for the gaining of body mass. Animals with these kinds of characteristics will also have favourable feed conversion ratios (Simm & Smith, 1985).

2.2.2 What determines an animal's FCR

The FCR of an animal depends on many factors, including its body weight to be maintained, its growth rate, its maturity pattern, its level of physical activity, the climate and environment in which it is raised and its inherent efficiency of nutrient absorption (Parnell, 1996).

As an animal grows, the proportion of feed energy required for maintenance increases. As a result, fast-growing animals reaching a target live-weight at a younger age will be on feed for less time and will use a smaller proportion of their feed energy for maintenance requirements as well as a larger proportion for tissue growth (Parnell, 1996).

Animals of a given size with a greater ADG tend to have a greater appetite but reduced feed requirements per kg gain (i.e. improved FCR) compared to lower growth potential animals, due to greater dilution of daily maintenance costs. The typical relationships between growth performance and FCR of animals being prepared for slaughter can be seen in Table 2.1. Different levels of feed intake which have an influence on feed for gain, can be observed here.

Table 2.1 Relationship between Average Daily Gain (ADG), Feed Intake (FI) and Feed Conversion Efficiency (FCE) in a 400 kg steer (Parnell, 1996)

Daily feed intake (FI) (kg)	Average daily weight gain (ADG) (kg)	Feed for maintenance (kg)	Feed for gain (kg)	Feed/ Gain (FCR)
6.5	0.8	3.5	3.0	8.1
7.5	1.0	3.5	4.0	7.5
8.5	1.2	3.5	5.0	7.1
9.5	1.4	3.5	6.0	6.8
10.5	1.6	3.5	7.0	6.6

As illustrated in Table 2.1 a steer uses a constant amount of feed for maintenance at a specific weight. As intake increases, growth rate improves and FCR decreases.

2.3 Body measurements

2.3.1 The application of body measurements

Body size and body shape can be described by using measurements and visual assessment. How these measurements of size and shape relate to the functioning of the individual is of paramount importance in livestock production. Therefore, constant checks on the relationship between body measurements and performance traits are vital in selection programmes (Maiwashe, 2000).

Historically, size was first estimated by measurements such as height or length. As scales developed, weight became more common as a measure of size. Measurement and weight are related, but their rates of maturity differ. By seven months of age, cattle reach about 80% of mature height but only 35 to 45% of mature weight. At twelve months, about 90% of mature height is reached, compared to only 50 to 60% of mature weight.

Differences between animals must be defined if progress is to be made. The visual evaluation of a dimension such as length is less accurate than an objective measurement because visual evaluation must take human errors into account. An objective method of measurement eliminates human error permitting a true measure of the trait. This type of measuring allows the detection of changes that may occur in the herd or breed earlier than they may be detected visually (Bosman, 1997).

2.3.2 Growth and development

Hammond (1955) explained the difference between growth and development. As an animal grows up two things happen:

a) it increases in weight until mature size is reached – this is growth; and
b) it changes in its body conformation and shape, and its various functions and faculties come into full being – this is known as development.

During the postnatal stage of growth live weight increases at a faster rate than any body measurement. Measurement of the skull followed by that of the height at the withers increases at a much slower rate than the measurements affected to some extent by muscle or fat development, such as circumference and width of heart girth. According to Hammond (1955) measurements of length and thickness growth of the hindquarters, such as the length and width of the pelvis, have a higher rate of growth in postnatal life than those of the head and the forequarters. From this it is concluded that at birth the skeleton is relatively better developed than the flesh which makes up the greatest proportion of the weight in the full grown animal. Furthermore the head, limbs and forequarters are better developed at birth than the hindquarters, and in postnatal life a gradient of increasing growth rate passes the head backwards to the pelvic region.

The cannon bone is amongst the earliest maturing parts. In young calves cannon bone length is 85-90% mature at birth while cannon bone width is about 55% of mature size (Hammond, 1955). According to Bonsma (1980) short cannon bones are associated with animals that mature early with heifers reaching about 50% of their mature weight at an age of 12 months and bulls at approximately 15 months. Hammond (1955) also found that the weight of a heifer is 97% of that of a bull at one month, 89% at four months, 87% at eight months, 77% at 12 months and about 65% at maturity.

Bosman (1997) drew the following conclusions according to growth and development:

a) that heart girth circumference has the highest correlation with body weight;
b) that no measurement is highly correlated to growth, feed conversion or carcass characteristics;
c) that the height measurement is not influenced by the condition of the animal; and
d) that the width measurements are influenced by the condition of the animal.

2.3.3 Heritability of body measurements

It is a well known fact that improvement in any trait is dependant on the heritability of a trait and the selection pressure applied.

Several studies have been conducted to determine the heritability of body measurements. The heritability of some body measurements are presented in Table 2.2.

Table 2.2 Heritabilities of body measurements (Bosman, 1997).

Measurements	**Heritability %**
Weight	45
Shoulder height	65
Hip height	41
Width of hip	11
Length of body	48
Heart girth circumference	48
Depth of chest	71
Scrotum circumference	55

2.4 Ultrasound

2.4.1 Background

As the livestock industry moves closer to the concept of value-based marketing, producers are becoming more concerned about carcase traits. Although livestock producers are realising the importance of carcass trait predictability, they are faced with a dilemma because of the lack of accurate methods for measuring carcass traits prior to slaughter (Houghton & Turlington, 1992). Having this problem, livestock producers became interested in ultrasound as a method of determining fat thickness and muscle development in live animals.

The use of ultrasound to measure biological tissue dates back to at least 1950 (Moeller, 2002), and was first reported by Wild (1950) who was able to measure live animal carcass traits. According to Wild (1950), the ultrasonic technique is non-destructive and humane and provides a means of quantifying muscle and fatty tissues in live animals.

This method of determining live animal carcase traits puts breeders in the position where they can select young breeding cattle for less/more fat thickness, larger rib eye size and larger rib eye size in relation to weight, rather than relying upon progeny testing that costs time and money.

2.4.2 Procedure for using ultrasound

The procedure for using ultrasound as described by Houghton & Turlington (1992), involves the application of a mineral oil to the area of the body to be measured, followed by the placement of a sensor or transducer (probe) on the chosen area. The basic principle of ultrasound is the measurement of an echo rebounding from soft tissues. After the transducer is placed in contact with the area to be measured, the ultrasound equipment transfers electrical pulses to high-frequency sound waves, therefore known as ultrasound. These sound waves travel into the body and are reflected from boundaries between different densities of tissues. The image that the ultrasound waves transmit back through the transducer is projected onto the screen of the ultrasound unit and the appropriate measurements are made.

2.4.3 Application of ultrasound on different species

Ultrasound has been used for evaluating carcase composition in cattle, sheep and pigs. Its use has increased dramatically in recent years thanks to improvements in ultrasound equipment and computer technology.

There are several ways in which this technology might be applicable in beef finishing programmes or feedlots, including the prediction of lean composition at slaughter, the prediction of days on feed to a constant body compositional end point, or the prediction of carcass chemical composition for research and industry purposes (Houghton & Turlington, 1992).

There are several times throughout the feeding period that producers may wish to use ultrasound to predict carcase traits. These include arrival at the feedlot, when cattle are re-implanted and near the end of the feeding period. Scanning cattle near the end of the feeding period should result in more accurate carcass trait predictions although there are some disadvantages associated with scanning at this time. These include additional labour, stress, and facility limitations as they relate to large market-weight cattle, increased discounts for bruising and finally a possible reduction in gain associated with movement of market weight cattle (Houghton, 1988).

Little information has been published about ultrasound use in live sheep (Kempster *et al.,* 1982) in comparison with other species especially beef. It is however also important for predicting live animal carcass traits in these animals.

The application of ultrasound technology in the swine industry dates back to the late 1950's when researchers reported research results evaluating the feasibility of using ultrasound to evaluate carcass composition on the live pig. These initial findings corresponded closely with a change in focus by the swine industry to reduce fat and increase muscle in existing swine populations and the establishment of swine testing centres throughout North America and Europe. Since the early application of ultrasound, geneticists, nutritionists, meat scientists and engineers have actively pursued advances in methodology and developed additional applications for ultrasound technology to improve the swine industry (Moeller, 2002).

Enhancing reproductive efficiency within the swine industry has also been a focus point for ultrasonic research and application.

2.5 Supplemented light (SL)

2.5.1 Introduction

Increased photoperiod has long been used, by means of supplemented light, to increase growth and production in domestic species (Dahl *et al.,* 2000). The response to photoperiod or the relative duration of light and dark exposure within a day is the most commonly adapted environmental cue used by animals to predict changes in and alter physiological responses to shifts in their physiological environment (Gwinner, 1986). The most common physiological consequence associated with photoperiod is the influence on seasonal reproductive status, although other processes are also affected by photoperiod: these include body growth, composition, and pelage changes (Dahl & Petitclerc, 2003).

Although photoperiodic effects on lactation in dairy cows have been studied most frequently, similar responses have been observed in other domestic species, including sheep (Bocquier & Theriez, 1990), goats (Terqui *et al.,* 1984), and pigs (Stevenson *et al*., 1983).

Emerging evidence suggests that photoperiod-driven physiologic changes are typical in mammalian species, including some in humans. If such physiological changes underlie human resistance to infectious disease for large portions of the year and the changes can be identified and modified, the therapeutic and preventive implications may be considerable (Dowell, 2001).

2.5.2 The effect of supplemented light on different species

2.5.2.1 Dairy cattle

Various management tools are available to dairy producers, which serve to increase milk production during an established lactation. These include bovine somatotropin (bST), milking more than twice daily and manipulation of the photoperiod. With regard to lactation, increasing light exposure from less than 12h of light/day to 16 to 18h of light/day (extended photoperiod) enhances milk production on an average of 2.5 kg/cow per day. The endocrine mechanism that underlies these effects, however, has eluded characterisation. Further, integration of photoperiod into the management scheme for an entire lactation cycle has not been fully developed yet (Dahl *et al.,* 2000).

Observation that supplemented light (SL) or extended photoperiod (EP) increased circulating prolactin in a number of species prompted investigation of the effects of photoperiod on milk yield. Peters *et al.* (1978) made the discovery that SL increased milk yield in cows relative to those exposed to ambient photoperiod between September and April in Michigan. At least seven different trials confirmed that SL increases milk yield (Table 2.3). Milk composition is generally unaffected by SL, although some studies indicate that a slight depression of milk fat percentage may occur during exposure to SL (Table 2.3). Effects of SL on dry matter intake (DMI) in lactating cows are not always observed, but generally, DMI increases in longer term studies to meet the increased demand for energy output from the mammary gland (Table 2.3).

Table 2.3 Summary of studies reporting effects of EP on milk yield in lactating cows

			Reponses to long days		
Authors	**Location (latitude)**	**Light type**	**Milk yield increase (kg/d)**	**Fat %**	**DMI increase**
Peters *et al.*(1978)	Michigan (42ºN)	Fluorescent	2	NC	NC
Peters *et al.*(1981)	Michigan (42ºN)	Fluorescent	1.4	NC	6.10%
Stanisiewski, *et al.* (1985)	Michigan (42ºN)	Fluorescent	2.2	0.16↓	NC
Phillips & Schofield (1989)	Wales (53ºN)	Fluorescent	3.3	0.18↓	NC

Dahl, *et al.* (1997)	Maryland (39ºN)	Metal halide	2.2	NC	NC
Reksen, *et al.* (1999)	Norway (60-62ºN)	Fluorescent	0.5	NC	NC
Miller *et al.* (1999)	Maryland (39ºN)	Metal halide	1.9	NC	3.50%

NC = No change; arrow indicates direction of change.

Overwhelmingly, the evidence supports the concept that SL is galactopoietic in cattle. The endocrine mechanism underlying the response, however, is not understood (Dahl *et al*., 2000).

2.5.2.2 Beef cattle

Investigations into the effects of different levels of photoperiod on beef cattle have produced a variety of results. Some have shown increased growth rates with the use of SL (Peters *et al.,* 1980; Small *et al.,* 2003; Kennedy *et al.,* 2004) while others recorded no effect (Phillips *et al*., 1997; Kendall *et al.,* 2003).

According to the research done by Peters *et al.* (1978), the average daily weight gains of heifers exposed to 16 hours of light and 8 hours of darkness (16L:8D) were 10 to 15% greater than that of heifers subjected to 9 to 12 hours of light. Furthermore, heifers exposed to 16L:8D eat more and are more efficient at converting feed into body mass than heifers given less than 12 hours of light per day. Even when feed intakes were restricted, increased rates of weight gain persisted in animals exposed daily to 16L:8D.

Tucker & Ringer (1982) found that the body weight gains of animals exposed to SL are not fat, and that the percentage protein in the SL carcasses is higher than that in of animals exposed to NP. Carcase fatness was reduced by SL in heifers and steers (Phillips *et al*., 1997; Kennedy *et al*., 2004). Phillips *et al.* (1997) suggested that declining day length stimulates lipogenesis (the conversion of carbohydrates and organic acids to fat) in cattle, which can be avoided by SL.

The mechanism whereby photoperiod controls growth in cattle has not been elucidated, but the anterior pituitary hormone prolactin could be involved. Of all the hormones measured in cattle, prolactin is most affected by changing photoperiod. Gradually reducing light exposure from 16 to 8 hours decreases prolactin concentrations, and increasing the daily light exposure from 8 to 16 hours increases prolactin secretion (Peters *et al*., 1980; Tucker & Ringer, 1982).

2.5.2.3 Poultry

In the natural environment of temperate zones, chickens exhibit annual variations in reproductive activity. However, through maintenance of a continuous feed supply and the application of SL, reproductive activity in chickens can be sustained throughout the year. Specifically, photoperiod regulation is used to control the onset of egg production and to maintain sustained egg production in commercial flocks. Manipulation of photoperiod, by means of SL, has been practised for more than 60 years to control the onset of egg production, to stimulate egg laying and to regulate body growth in chickens (Tucker & Ringer, 1982).

Without photoperiod management there would be marked seasonal variations in the price and availability of eggs and broilers.

The periodicity of light influences egg laying by domestic chickens through two processes; an annual cycle and a circadian rhythm. The two modes interact although their mechanisms of action differ. The annual cycle delineates the onset and termination of egg production and light is the sole signal. In the circadian rhythm, the daily light-dark cycle is normally the most important cue in setting the time of oviposition, although when exposure to light is continuous, temperature or noise may determine the time of oviposition.

Greater egg production can be sustained by exposure to 6 to 10 hours of light per day. Progressively longer days maximise the egg-laying rate, while progressively shorter days reduce egg production. The latter response is more pronounced than the former. In general, exposing chickens to incrementally increasing periods of daily light beyond 17 hours in duration yields no further increase in number of eggs laid (Tucker & Ringer, 1982). In Table 2.4 the effect on age at sexual maturity and on egg production to 550 days of age is given for birds kept on constant long or short day lengths, and on changing day lengths.

Genetic selection has largely removed the natural tendency towards inactivity in the autumn or winter. Nevertheless, the advantage of using artificial lighting in winter is an increase in egg yield of about 30%, which would justify the expenditure on power installations and running costs (Maree & Casey, 1993).

Table 2.4 Effect of constant and changing day lengths on egg production (Morris, 1968)

Treatment	**Hours**	**Production**			
		24 weeks production		**48 weeks production**	
	6				
Constant	10				
Photoperiods 0-500	14	110	130	218	249
days	18	123	122	235	244
		Percent Hen Day Production			
		At 35 weeks of age		**At 39 weeks of age**	
Constant					
photoperiods 18-40	14	73.0			
weeks of age	6	70.9		61.9	64.0
Photoperiods					
changed at 35	From 14-6				
weeks of age	from 6-14	70.2	67.2	25.4	81.2

The minimum intensity of lighting required for maximum egg production is between 2 and 10 lux (Tucker & Ringer, 1982).

2.5.2.4 Pigs

One of the major problems of the pig industry is the neonatal (the first four weeks of life after birth) death rate in swine. This is because 20 to 25% of pigs farrowed alive die before weaning. Unfortunately, maternal performance of sows during lactation has not improved significantly in the past few years, even though progress has been made in nutrition and breeding programmes (Mabry *et al*., 1983). Of this neonatal mortality, 20 to 30% is due to a lack of adequate nutrition and 20 to 50% is due to crushing by the sow (Fahmy & Bernard, 1971). At least some of the pigs lain on by the sow are inactive due to inanition. It is probable that increased energy intake by the neonatal pigs would decrease mortality before weaning.

One method of increasing the energy intake of the piglet would be to increase the milk production of the sow. Exposing the sows to SL could do this. Milk production has been shown to increase as the photoperiod of the sow during lactation is increased from 8 to 16 hours (Mabry *et al*., 1982). An increase in piglet survival was also noted with the exposure to SL. The reason why SL is associated with increased milk production is not known. One possible explanation is that the SL stimulates the piglets to nurse more frequently during the night. It is known that piglets suckle more frequently during the daytime than at night under NP (Mabry *et al*., 1983). In addition it has been shown in dairy cattle that milking three times daily increases milk production when compared with twice-daily milking (Pearson *et al*., 1979).

2.6 Feedlot economics

Feedlots involve the provision of an artificial environment in which cattle are placed in a confined area to consume a predetermined diet. Increases in profits result from better growth of the animal and an improved carcase relative to the cost of the extra feed and other inputs. Invariably marginal returns make it necessary to use feedlots (Bertram & Phillips, 2004).

Many different back-grounding programmes are used in the feedlot industry. Consequently, cattle enter the feedlot and subsequently the packing plant with differences in age, previous ration and length of time on feed. Time on feed in turn depends on length of previous back-grounding or grazing. If the industry moves to a value-based marketing system, value will be assessed primarily on carcase merit. Additionally, different back-grounding programmes are associated with a variety of costs including pasture, feed, and interest costs, as affected by length of ownership. If producers wish to benefit from a value-based selling system, they must understand how genetic and environmental (i.e., management) factors affect carcase value and economics (Hill *et al.,* 1995).

There are approximately 70 feedlots in South Africa at present. These feedlots account for approximately 70 to 80% of cattle in the feedlot industry, depending on the number of animals standing in the feedlot at a specific point in time. This accounts for about 50 to 60% of the total number of animals slaughtered annually (SAFA, 2003).

Then there are also the farmer feeders or seasonal feeders. They enter or exit the market at will, usually at the end of the year when the prices are higher.

The deregulation of the South African meat industry resulted in a number of the larger feedlots to diversify into the slaughtering of their own cattle, and also into wholesaling. A few of them even retail some of their own branded quality beef products.

The prices at which feedlots purchase weaners are generally determined by the forces of supply and demand. Feedlots can purchase weaners on auctions or from the farmer himself, which is known as farm gate purchasing. The auction system has lost prominence in the red meat industry as the farm gate method has gained prominence. Producers and farmers will be on the lookout for the best prices to realise the best price. Feedlots are prepared to pay for quality and farmers producing the right type of animal receive premiums from the feedlot.

Negative buying price and positive feed margins are a general characteristic of the industry. The viability of feeding cattle is based on the beef : grain price ratio. Relatively high grain prices have regulated the feedlot industry in terms of the use of grain products, with hominy chop being the main food source. Cognisance should also be taken of the fact that, because the South African feedlot industry does not have a final carcass realisation price before the feeder calf is purchased, the feedlot owner does not know the price at which he/she will sell the carcase at the time he/she purchases the weaner. This contributes to the high-risk nature of the feedlot industry.

The feedlot industry is a biological production system supported by a relatively high degree of capital layout. Animals that are market ready cannot be withheld from the market when prices decrease. Discrimination of the market against over-fat and heavy carcasses are well known and cattle have to be slaughtered when ready regardless of the ruling market price. Feedlots also aim to operate at optimum capacity in order to realise the best positive feeding margin. Thus, when a feedlot requires feeder calves to fill the vacant pens, purchasing of calves takes place even though the market price may be unfavourable.

The margins in the feedlot industry are minimal. Any adverse management decisions during the feedlot operation are likely to be costly and result in a negative return on investment. Feed is the major cost in a feedlot operation, hence feedlots tend to be sited close to ready supplies of grain.

2.7 References

Archer, J. & Arthur, P., 1997. Lowering the Cost of Beef Production by Breeding for Net Feed Conversion Efficiency. Beef and Sheep Technology – Trangie 1997. pp.15-18.

Bertram, J. & Phillips, A., 2004. Basic Guidelines for a Feedlot Operation. Animal

Production. Alice Springs. pp.1-6.

Bocquier, F. & Theriez, G., 1990. Relationships between secretary patterns of growth hormone, prolactin and body reserves and milk yield in dairy ewes under different photoperiod and feeding conditions. British J. Anim Prod. 51: 115-125.

Bonsma, J., 1980. Livestock Production – A global approach. Tafelberg Publishers, Cape Town. pp.52 – 77.

Bosman, D.J., 1992. Feed conversion ratio. National Beef Cattle Performance Testing and Progeny Scheme. Newsletter No. 63: 4.

Bosman, D.J., 1995. Feed conversion ratio. National Beef Cattle Performance Testing and Progeny Scheme. Newsletter No. 72: 6.

Bosman, D.J., 1997. Body Measurements and their application in beef cattle. National Beef Cattle Performance Testing and Progeny Scheme. Newsletter No. 97: 9-13.

Dahl, G.E., Elsasser, T.H., Capuco, A.V., Erdman, R.A. & Peters, R.R., 1997. Effects of a Long Daily Photoperiod on Milk Yield and Circulating Concentrations of Insulin-Like Growth Factor-I. J. Dairy. Sci. 80: 2784-2789.

Dahl, G.E., Buchanan, B.A., & Tucker, H.A., 2000. Photoperiodic effects on dairy cattle: A review. J. Dairy. Sci. 83: 885-893.

Dahl, G.E., & Petitclerc, D., 2003. Management of photoperiod in the dairy herd for improved production and health. J. Anim. Sci. 81:11-17.

Dowell, S.F. 2001. Seasonal variation in host susceptibility and cycles of certain infectious diseases. Emerging Infectious Diseases. 2001 May-Jun; 7: 369-374.

Fahmy, M.H. & Bernard, C., 1971. Causes of mortality in Yorkshire pigs from birth to 20 weeks of age. Can. J. Anim. Sci. 51: 351.

Geldenhuys, J., 1997. Feed Conversion – Technical Update. South African presentation at the 1997 World Angus Forum In Australia, 1997.

Gwinner, E., 1986. Circannual Rhythms: Endogenous Annual Clocks in the Organization of Seasonal Processes. Springer Verlag, New York.

Hammond, J., 1955. Progress in the physiology of farm animals. Butterworth Scientific Publications, London.

Hill, W.J., McCollum, F.T., Gill, D.R. & Strasia, C.A., 1995. The effects of age, date on feed and corn processing on carcass characteristics. Okla. Agr. Exp. Res. Rep. 943.

Houghton, P.L., 1988. Application of ultrasound in commercial feedlots and beef breeding programs. Beef improvement federation Proc. Albuquerque, NM. P89-99.

Houghton, P.L. & Turlington, L.M., 1992. Application of Ultrasound for Feeding and Finishing Animals: A Review. J. Anim. Sci. 70: 930-941.

Kempster, A.J., Arnall, D., Alliston, J.C & Barker, J.D., 1982. An evaluation of two ultrasonic machines (Scanogram and Danscanner) for predicting body composition of live sheep. Anim. Prod. Sci. 34:249.

Kendall, P.E., Auchtung, T.L., Swanson, K.S., Radcliff, R.P., Lucy, M.C., Drackley, J.K.

& Dahl,G.E., 2003. Effect of photoperiod on hepatic growth hormone receptor 1A expression in steer calves. J. Anim. Sci. 81: 1440-1446.

Kennedy, A.D., Bergen, R.D., Lawson, T.J., Small, J.A. & Veira, D.M., 2004. Effects of evening feeding and extended photoperiod on growth, feed efficiency, live animal carcass traits and plasma prolactin of beef heifers housed outdoors during two Manitoba winters. Can. J. Anim Sci. 84: 492-500.

Mabry, J.W., Cunningham, F.L., Krealing, R.R & Rampacek, G.B., 1982. Effect of artificially extended photoperiod during lactation on maternal performance of the sow. J. Anim. Sci. 54: 918.

Mabry, J.W., Coffey, M.T. & Seerley., R.W., 1983. A comparison of an 8- versus 16-hour photoperiod during lactation on suckling frequency of the baby pig and maternal performance of the sow. J. Anim. Sci. 54: 293-295.

Maiwashe, A.N., 2000. The value of recording body measurements in beef cattle. M.Sc. (Agric) dissertation, UOFS, Bloemfontein.

Maree, C. & Casey, N.H., 1993. Livestock Production Systems principles and practice. Brooklyn: Agri-Development Foundation.

Miller, A.R.E., Stanisiewski, E.P., Erdman, R.A., Douglas, L.W. & Dahl, G.E., 1999. Effects of long daily photoperiod and bovine somatotropin (Trobest) on milk yield in cows. J. Dairy. Sci. 82: 1716-1722.

Moeller, S.J., 2002. Evolution and use of ultrasonic technology in the swine industry. J. Anim. Sci. 80: E19-E27.

Morris, T.R., 1968. Light requirements of the fowl. Environmental control in poultry production. Oliver and Boyd Limited, Edinburgh.

Parnell, P., 1996. Utilization of genetic influences on feed conversion efficiency to increase beef herd profitability. Presentation on the 9th Jornadas Ganaderas at Pergamino Argentina, 7th to 8th June 1996.

Pearson, L.A., Thompson, P.D. & Smith, J.W., 1979. Three times a day milking during the first half of lactation. J. Dairy. Sci. 62: 1941.

Peters, R.R., Chapin, L.T., Leining, K.B. & Tucker. H.A., 1978. Supplemental lighting stimulates growth and lactation in cattle. American Association of Science. (Washington, DC) 199: 911-912.

Peters, R.R., Chapin, L.T., Emery, R.S. & Tucker, H.A., 1980. Growth and hormonal response of heifers to various photoperiods. J. Anim. Sci. 51: 1148-1153.

Peters, R.R., Chapin, L.T., Emery, R.S. & Tucker, H.A., 1981.Milk yield, feed intake, prolactin, growth hormone, and glucocorticoid response of cows to supplemented light. J. Anim. Sci. 64: 1671-1678 .

Phillips, C.J.C. & Schofield, S.A., 1989. The effect of supplementary light on the production and behaviour of dairy cows. British J. Anim. Sci. 48: 293-303.

Phillips, C.J.C., Johnson, P.N. & Arab, T.M., 1997. The effect of supplementary light during winter on the growth, body composition and behaviour of steers and heifers. British J. Anim. Sci. 65: 173-181.

Reksen, O., Tverdal, A., Landsverk, K., Kommisrud, E., Boe, K.E. & Ropstad, E., 1999. Effects of Photointensity and Photoperiod on Milk Yield and Reproductive Performance of Norwegian Red Cattle. J. Dairy. Sci. 82: 810-816.

SAFA (2003). South African feedlot industry and the economics of beef production. Unpublished document. South African Feedlot Association, Pretoria.

Simm, G. & Smith, C., 1985. Environmental effects on bull performance test results. Anim. Prod. Sci. 41: 177-185.

Small, J.A., Glover, N.D., Kennedy, A.D., McCaughey, W.P. & Ward, D.R., 2003. Photoperiod effects on the development of beef heifers. Can. J. Anim. Sci. 83: 721-730.

Stanisiewski, E.P., Mellenberger, R.W., Anderson, C.R. & Tucker, H.A., 1985. Effect of photoperiod on milk yield and milk fat in commercial dairy herds. J. Dairy. Sci. 68: 1134-1140.

Stevenson, J.S., Pollmann, D.S., Davis., D.L. & Murphy, J.P., 1983. Influence of supplemented light on sow performance during and after lactation. J. Anim. Sci. 59: 1282-1286.

Terqui, M., Delouis, C. & Ortavant, R., 1984. *Photoperiodism and hormones in sheep and goats.* Manipulation of Growth in Farm Animals. Martinus Nijhof, The Hague, The Netherlands. pp. 246-259.

Tucker, H.A. & Ringer, R.K. 1982., Controlled photoperiodic environments for food animals. American Association for the Advancement of Science. 216: 1381-1386.

Wild, J.J., 1950. The use of ultrasonic pulses for the measurement of biological tissues and the detection of tissue density changes. Surgery 27: 183.

CHAPTER 3

MATERIALS AND METHODS

3.1 Study site

The research was conducted from June to September 2005, at the Agriculture Research Council's (ARC) Bull Testing Station at Glen. This station was donated by the Meat Board and handed over by the chairman to the Minister of Agriculture and Water Supply on 31st October 1985. It is situated near Bloemfontein in the Free State Province, 28º 95'S latitude, 26º 33' E longitude, at an altitude of 1304 m above sea level. The annual rainfall is between 550 and 600mm, mostly occurring between December and March. The average minimum and maximum temperatures for the area vary between -2.1 and 18.6ºC during the winter months and 14.6 to 30.2ºC during the summer (South African Weather Station at Glen, 2005).

3.2 Animals

Thirty Bonsmara bulls from the same farm, with an average age (203 ⬅ 14 days) and weight (257 ⬅ 15.1 kg) measured on day one of the adaptation phase, were used in the trial. The bulls were randomly divided into three homogeneous groups that consisted of 10 animals per group. Upon arrival the animals were vaccinated with Bovi Tech P (Pasteurella), Supavax 3 in 1 (Black quarter, Anthrax and Botulism) and Multimin SE, treated for internal and external parasites (Ivotan) and injected with vitamins A, D and E.

The animals were adapted for 28 days after which performance data were recorded from all groups during the 84 days trial period (Standard procedure for phase C testing).

3.2.1 History of the Bonsmara

In the years before World War II a need was felt for a breed of beef cattle that would be able to produce beef economically in the subtropical savannah regions of the former Transvaal and Natal. Although the adaptability to climate of the Afrikaner-type cattle was acceptable, they did not have the desired growth potential, they were relatively late in reaching sexual maturity and many of the cows did not calve regularly. At the time there were several British beef breeds available, with good performance in more temperate regions, but whose production decreased in the warmer regions. These exotic breeds were also more susceptible to the tick-borne-diseases commonly known in the sub-tropics (Campher *et al.,* 1998).

At that time the Department of Agriculture started to weigh up several crosses between indigenous and exotic breeds on their experimental farms, Mara and Messina, in the hot Northern Province. Five British beef breed bulls were used on Afrikaner cows and the progeny performance tested. After pilot trials it was decided to continue only with the better performing Hereford and Shorthorn cross-breeds. Eventually three-quarter Afrikaners were mated to half-breeds to obtain progeny with five-eights Afrikaner and three-eights Hereford or Shorthorn blood (Campher *et al.,* 1998).

Progressive development was made with strict selection of breeding animals and within twenty years of the initial crossbreeding trials a beef cattle breed, performing better than other breeds in the bushveld of the Northern Province, was established. It was decided that the Afrikaner blood had to be in the majority and the breed evolved as five-eights *Bos indicus* and three-eights *Bos taurus.* Mr E A (Jim) Galpin decided that the breed was to be named "Bonsmara" as a tribute to the late Prof J C Bonsma who played a major role in the development of the breed, and the Mara test station where the animals were bred.

The productivity of this adaptable, functionally efficient breed was impressive to all and the number of breeders increased rapidly. Currently the Bonsmara is showing good results for calving percentage, weights of heifers as well as veld and feedlot adaptability, it is also the only breed that originated from planned scientific cross-breeding, supported by research and performance testing (Scholtz *et al.,* 1999).

3.3 Lighting

The animals were housed in open pens of which approximately one third was under the roof of a shed. Lighting under the roof was supplied by 4 twin tube (2 x 58W) fluorescent lights, mounted above the feeding troughs. Two wide beam floodlights were mounted at the middle ends of the pen opposite to each other. One was equipped with a 250W high pressure sodium light, positioned eight metres from the feeding troughs, three metres above ground level, and facing away in the opposite direction of the feeding troughs. The other, equipped with a 400W high pressure sodium light, was positioned at the far end of the feeding troughs, three metres above ground level, facing in the direction of the feeding troughs, providing an average light intensity of 124 lux at eye level (Peters *et al.,* 1980; Peters *et al.,* 1981; Critser *et al.,* 1987; Enright *et al.,* 1995; Kendall *et al.,* 2003). A digital illumination meter (INS DX 200) was used to measure light intensity at evenly spaced locations in both of the pens that received EP with the light metre facing up (vertical) at a height of one metre above ground level (approximately at eye level of animals) (Small *et al.,* 2003).

The following treatments were applied:

Group 1: The lights were manually switched on at dawn, half an hour before sunset, so that the animals did not experience natural sunset before the beginning of supplemented light. This group were subjected to hours light.

Group 2: The lights were switched on by means of an automatic timer and the duration was adjusted twice a week as the daylight decreased in order to expose the bulls to 16 hours light and 8 hours darkness/day. These bulls were housed in a closed shed.

Group 3: This group served as the control group and only received natural photoperiods. The pen was 100 metres away from groups one and two, and was enclosed with a black sail (250 micron four metres high) preventing artificial light from reflecting on this group, and from having an influence on the natural light conditions.

3.4 Feeding regimen

Each of the feeding troughs was equipped with CALAN gates, the same as those used in phase C tests (Figure 3.1). Each of the bulls carried a transponder around its neck, which was linked to an individual receiver at the CALAN gates. The receiver responded when the bulls came to feed at their individual feeding stations by opening the gates and giving each individual bull access to feed. During week one of the adaptation phase all the CALAN gates were opened and the bulls had access to all the feeding troughs. At the beginning of Week 2 the gates were closed and the bulls received a universal transponder so that they could open any of the gates, and in the final stages of adaptation each bull had an individual transponder that could only open its own feeding station. This final method was used throughout the 84-day trial period to determine individual feed FCR. Animals had free access to fresh water.

Figure 3.1: Photograph of bulls feeding at the feeding stations equipped with CALAN gates.

3.5 Feed composition

The animals were fed a diet containing 11MJ ME/kg DM and 14% CP (Table 3.1) (standard ration for bulls used during phase C testing).

Table 3.1: Nutrient specifications for the phase C bull test diet, dry material base (ARC-Glen, 2005).

Nutrient	Minimum	Maximum
ME (MJ/kg DM)	11.0	-
Crude protein (CP)	135 g/kg	150 g/kg
Undegradable intake protein (UIP)	45 g/kg	-
Urea	-	7 g/kg
Protein from NPN (% of CP)	-	20%
Fibre	125 g/kg	-
Roughage	200 g/kg	-
Fat	30 g/kg	70 g/kg
Calcium	6 g/kg	10 g/kg
Phosphorous	3 g/kg	5 g/kg
Ca: p	1.5:1	2.5:1
Sulphur	1.5 g/kg	3 g/kg
N: S	8:1	12:1
Potassium	5 g/kg	13 g/kg
Magnesium	2.5 g/kg	-
Vitamin A**	4500 000 IU*/ton	-
Vitamin D3	2500 000IU*/ton	-
Vitamin E	5000 IU/ton	-
Vitamin B1 (Thymine)	3000 IU/ton	-
Niacin	100 000 mg/ton	-
Copper**	15 g/ton	-
Manganese	40 g/ton	-
Zinc	54 g/ton	-
Cobalt	0.5 g/ton	-
Iodine	2 g/ton	-
Iron	50 g/ton	-
Selenium	0.15 g/ton	-
Monensin-NA	29 g/ton	-
Zn-basitracine	25 g/ton	-

*	IU = International Units

**	It may be presumed that the soil elements do not contain sufficient vitamins and micro-minerals, therefore they need to be supplemented in the form of a premix.

3.6 Measurements

During the trial period ultrasound was used to measure subcutaneous fat depth between the 12^{th} and 13^{th} ribs (BFT), longissimus dorsi (EMA) (Figure 3.2) and P8 (fat layer on the rump) (Figure 3.3) on days 1, 22, 51, 62 and 84 (end of the trial). A trained operator did the ultrasound measuring, using a PIE Medical Falco 100 scanner equipped with a Linear Array probe.

Figure 3.2: Image of the EMA taken with the PIE Medical Falco 100 scanner

The following body measurements were recorded during the trial:

i. Body weight (BW) (kg) (taken every seven days starting on day one of the trial).

ii. Shoulder height (cm), measured vertically from the thoracic vertebrae to the ground (taken on day 1, 22, 51, 62 and 84).

iii. Body length (BL) (cm) as measured from the sternum (manubrium) to the aitchbone (tuber ischiadicum) (taken on day 1, 22, 51, 62 and 84).

iv. Heart girth was measured with a measuring tape around the chest just behind the front legs (taken on day1 , 22, 51, 62 and 84) (Greyling & Taylor, 1999; Fourie *et al.,* 2002).

Figure 3.3: Image of the P8 (fat layer on the rump) taken with the PIE Medical Falco 100 scanner. (The space between the 2 markers at the top of the image is the fat layer on the rump)

3.7 Data analysis

Data were analysed using the General Linear Model procedures of SAS (SAS, 1988). Product moment correlations between the different variables were calculated. A one-way ANOVA was carried out to determine the individual influence of body measurements on performance. A significant level of $P < 0.05$ was used to determine the significance of the partial contribution of each effect. Starting weight and age were included as covariates.

3.8 References

Agriculture Research Coucil, 2005. Glen Bull testing station.

Campher, J.P., Hunlun, C. & Van Zyl., G.J., (*eds.*) 1998. South African Livestock Breeding. South African Stud Book and Livestock Improvement Association. Bloemfontein. pp. 54-55.

Critser, J.K., Lindstrom, M.J., Hinshelwood, M.M. & Hauser, E.R., 1987. Effect of photoperiod on LH, FSH and prolactin patterns in ovariectomized oestradiol-treated heifers. J. Reprod. Fert. 79, 599-608.

Enright, W.J., Zinn, S.A., Reynolds, V.S., & Roche. J.F., 1995. The Effect of Supplementary Light on Winter Performance of Prepubertal and Postpubertal Friesian Heifers. Irish Journal of Agricultural and Food Research. 34: 107-113.

Fourie, P.J., Neser, F.W.C., Olivier, J.J. & Van der Westhuizen, C., 2002. Relationship between production performance and body measurements of Dorper rams. S. Afr. J. Anim. Sci. 32: 256-262.

Greyling, J.P.C. & Taylor, G.J., 1999. The effect of the anabolic agent, nandrolone laurate, on certain production and reproduction parameters in ram lambs, under intensive and extensive feeding regimes. S. Afr. J. Anim. Sci. 19: 179-188.

Kendall, P.E., Auchtung, T.L., Swanson, K.S., Radcliff, R.P., Lucy, M.C., Drackley, J.K. & Dahl, G.E., 2003. Effect of photoperiod on hepatic growth hormone receptor 1A expression in steer calves. J. Anim. Sci. 81:1440-1446.

Peters, R.R., Chapin, L.T., Emery, R.S. & Tucker, H.A., 1980. Growth and hormonal response of heifers to various photoperiods. J. Anim. Sci. 51: 1148-1153.

Peters, R.R., Chapin, L.T., Emery, R.S. & Tucker, H.A., 1981. Milk yield, feed intake, prolactin, growth hormone, and glucocorticoid response of cows to supplemented light. J. Anim. Sci. 64: 1671-1678.

SAS, 1988. SAS Institute Inc. SAS® Procedures Guide, Release 6.03 Edition, Cary, NC.

Scholtz, M.M., Bergh, L. & Bosman, D.J., (*eds.*) 1999. Beef breeding in South Africa. Agricultural Research Council Animal Improvement Institute, Irene. p. 123.

Small, J.A., Glover, N.D., Kennedy, A.D., McCaughey, W.P. & Ward, D.R., 2003. Photoperiod effects on the development of beef heifers. Can. J. Anim. Sci. 83: 721-730.

South African weather bureau, 2005. Monthly weather report. Glen.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

Manipulation of photoperiod has been practised commercially for more than 60 years to control the onset of egg production, to stimulate egg laying and regulate body growth in chickens (Tucker & Ringer, 1982).

Evidence has been found since 1978 that supplemented lighting increases milk production in dairy cows by as much as 10% in comparison with similar cows exposed to natural light (Peters *et al.* 1978). According to Peters *et al.* (1981) DMI also increases when dairy cattle is exposed to supplemented light.

Several studies have been conducted on the effect of supplemented light on beef heifers and significant results were found in terms of growth and carcass composition (Small *et al.,* 2003; Kennedy *et al.,* 2004). The results of Zinn *et al.* (1989), however concluded that supplemented light had no effect on growth or carcass composition of beef steers.

4.2 Growth parameters

The ADG of bulls subjected to 24L:0D between July and September was 10% (0.17kg) and 11.5% (0.19kg) ($P<0.05$) greater than the ADG of animals that received NP and

16L:8D, respectively (Table 4.1). The ADG of bulls subjected to NP and 16L:8D, however, did not differ significantly (P<0.05).

Table 4.1: The effect of supplemented light on ADG, FCR and FI (mean ⬅ S.E.) of young beef bulls fed intensively

Parameter	NP (n = 10)	16L: 8D (n = 10)	24L: 0D (n = 10)
Average daily gain (ADG) (kg)	1.67 ⬅ 0.03 ^{a}	1.65 ⬅ 0.05 ^{a}	1.84 ⬅ 0.06 ^{b}
Feed conversion ratio (FCR) (kg)	5.91 ⬅ 0.22 ^{a}	5.77 ⬅ 0.11 ^{a}	5.18 ⬅ 0.13 ^{b}
Feed Intake (FI) (kg)	827.20 ⬅ 28.18 ^{a}	801.10 ⬅ 24.83 ^{a}	795.50 ⬅ 25.32 ^{b}
Body weight (End) (kg)	428 ⬅ 23.68 ^{a}	412.7 ⬅ 40.24 ^{b}	434.4 ⬅ 45.32 ^{a}

Means with different letters within the same row differ significantly: $P < 0.05$.

Body weights (Fig. 4.1) of young beef bulls exposed to NP, 16L:8D and 24L:0D averaged at 287.6 ⬅ 22.89, 273.7 ⬅ 29.74 and 280.2 ⬅ 33.21kg respectively at the start of the trial (July 05) and increased to 428 ⬅ 23.68, 412.7 ⬅ 40.24 and 434.4 ⬅ 45.32kg respectively at the end of the trial (September 27). The weights of the animals subjected to NP were on average 13.9 and 7.3kg heavier than those subjected to 16L:8D and 24L:0D at the start of the trial in July. The weights of the NP and 24L: 0D treatments were similar at Week 7 to 8 with the 16L: 8D group having lower weights (Figure 4.1). However, from Week 9, growth rates of the bulls subjected to 24L:0D were greater than those of bulls subjected to NP or 16L:8D. The total weight gained for the NP group was 140.4kg and for the 24L:0D group, 154.2kg. These results differ significantly from each other (P<0.05).

These results are in agreement with those of Peters *et al.,* (1981), who also found that SL increases body weight gains of cattle fed under intensive conditions. However, in that study, the 16L:8D group outperformed the 24L:0D group.

The FCRs of bulls subjected to 24L: 0D were 14 and 11% ($P<0.05$) less than those of NP and 16L:8D treatments (Table 4.1). The FI of bulls exposed to NP, 16L:8D and 24L:0D averaged 827.20 ⬅ 28.18, 801.10 ⬅ 24.83 and 795.50 ⬅ 25.32kg respectively over the trial period of 84 days. Thus, the 24L:0D treatment group had an increased ADG from 10 to 11.5% from July to September while requiring 4% less feed. Peters *et al.* (1978) concluded that supplemental light increased growth rates of dairy cattle from 10 to 15% without requiring additional feed.

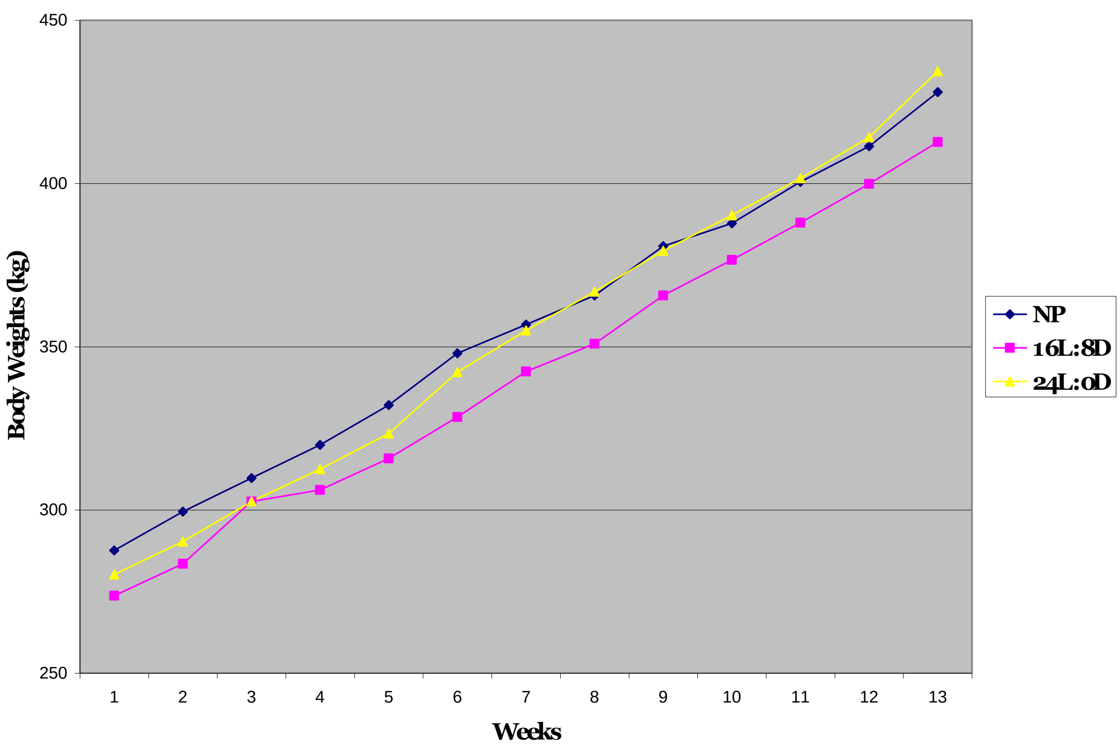

Figure 4.1: Weekly weights of young beef bulls exposed to different levels of light supplementation, for a period of 84 days

4.3 Ultrasound measurements

The overall difference in BFT, EMA and P8 was not significantly different (P>0.05) for the three different treatment groups (Table 4.2) over the period of 84 days. However during the last 22 days of the trial there was a reduction in BFT for the 16L:8D and 24L:0D treatment groups (Fig. 4.2).

Table 4.2: The effect of different light treatments on P8, BFT and EMA (mean ⬅ S.E.) of young beef bulls fed intensively

Parameter	NP (n = 10)	16L: 8D (n = 10)	24L: 0D (n = 10)
Fat layer on the rump (P8) (mm)	5.15 ⬅ 0.19 ^{a}	5.03 ⬅ 0.23 ^{a}	4.66 ⬅ 0.29 ^{a}
Longissimus dorsi (BFT) (mm)	3.62 ⬅ 0.56 ^{a}	3.30 ⬅ 0.26 ^{a}	2.94 ⬅ 0.32 ^{a}
Eye muscle area (EMA) (cm^2)	65.78 ⬅ 1.19 ^{a}	63.32 ⬅ 1.17 ^{a}	64.3 ⬅ 1.40 ^{a}

Means with different letters within the same row differ significantly: $P < 0.05$.

The results of Kennedy *et al.* (2004) show a reduction in BFT of 15% on day 156 of beef heifers exposed to SL. The research of Phillips *et al.* (1997) and Small *et al.* (2003) also suggest that the carcass fat of animals receiving SL decreases. If these results are repeatable it means that beef cattle can remain on feed longer without depositing excessive fat. In this way, heavier but leaner carcasses can be produced. This phenomena is called lean growth.

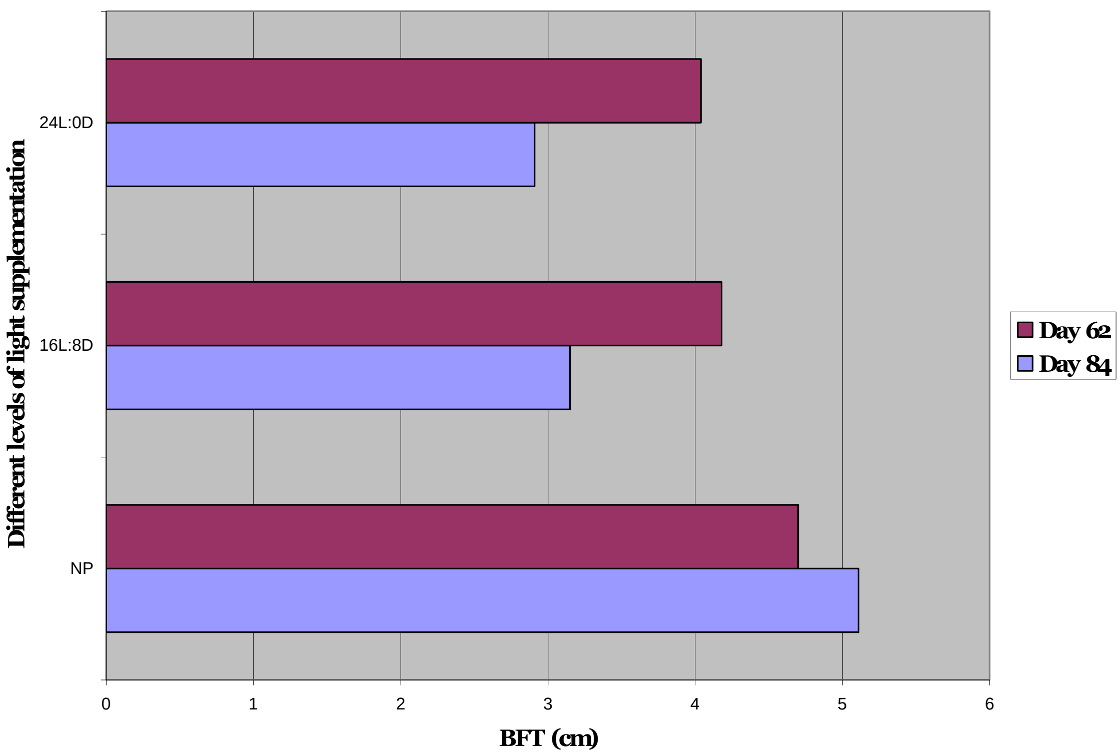

Figure 4.2: Changes in BFT from day 62 to 84 (end of the trial).

4.4 Body measurements

Body measurements were taken on Days 1, 22, 51, 62 and 84 on every individual of each group to quantify growth in body dimensions.

Table 4.3: Certain body measurements (mean ± S.E.) of young beef bulls fed intensively

Parameter	NP (n = 10)	16L: 8D (n = 10)	24L: 0D (n = 10)
Body length (cm)	127.02 ± 0.84 [a]	126.49 ± 0.87 [a]	127.57 ± 0.8 [a]
Shoulder height (cm)	116.92 ± 1.11 [a]	115.66 ± 1.14 [a]	115.76 ± 1.39 [a]
Heart girth (cm)	166.92 ± 1.18 [a]	163.44 ± 1.30 [b]	164.38 ± 1.50 [b]

Means with different letters within the same row differ significantly: $P < 0.05$.

According to Fourie *et al.* (2002) there is a medium-high correlation of 0.59 between heart girth and growth under extensive conditions in Dorper rams. As the NP group's heart girth was significantly greater on average than those of 16L:8D and 24L:0D (Table 4.3), one would expect that the NP group's ADG would be higher than those of the other two groups. The difference in the total heart girth gain between the 24L: 0D and the NP group was non-significant, although the 24L:0D grew 2.9cm more than the NP group did (Table 4.4). This is in agreement with the findings of Peters *et al.* (1978).

Table 4.4: The effect of supplemented light on total growth of certain body measurements (mean ⬅ S.E.) of young beef bulls fed intensively

Parameter	NP (n = 10)	16L: 8D (n = 10)	24L: 0D (n = 10)
Body length (cm)	11.3 ⬅ 2.20^{a}	11.3 ⬅ 2.75^{a}	11.4 ⬅ 1.85^{a}
Shoulder height (cm)	7.2 ⬅ 1.16^{a}	7.7 ⬅ 1.16^{a}	8.3 ⬅ 1.39^{a}
Heart girth gain (cm)	18.3 ⬅ 3.17^{a}	20.7 ⬅ 3.17^{a}	21.2 ⬅ 2.03^{a}

Means with different letters within the same row differ significantly: $P < 0.05$.

There were also non-significant differences in total body length and shoulder height growth between the three groups so this will not be further discussed.

4.5 Correlations

The product moment correlations of young beef bulls exposed to NP, 16L: 8D and 24L:0D are presented in Table 4.5.

The highest correlation (Table 4.5) of 0.84 (P<0.0001) was found between HG and body weight (BW). This correlation is even higher than the correlation between body length (BL) and body weight, which had a correlation of 0.77 (P<0.0001). Fourie *et al.* (2002)

reported correlations of 0.80 (P<0.001) between HG and BW and a correlation of 0.76 (P<0.001) between BL and BW. Campbell (1983) reported higher correlations between BL and BW (0.74) than between HG and BW (0.72). Koenen & Groen (1998) also found a very high correlation between HG and BW of 0.74, in 7344 lactating Holstein heifers from 560 herds.

Table 4.5: Phenotypic correlations between parameters of young beef bulls exposed to natural photoperiod, 16L:8D and 24L:0D combined

VARIA-BLE	P8	BFT	EMA	BW	ADG	FCR	FI	SH	BL	HG
P8										
BFT	0.3982									
EMA	0.3110	0.3866								
BW	0.2902	0.2632	0.7961							
ADG	0.1330	-0.0658	0.6399	0.7257						
FCR	0.0666	0.3804	-0.0345	0.1491	-0.5016					
FI	0.2353	0.3341	0.5742	0.7253	0.4615	0.5304				
SH	0.3966	0.2437	0.5404	0.6804	0.2981	0.2114	0.5038			
BL	0.3569	0.3716	0.6341	0.7713	0.3135	0.2357	0.5400	0.6682		
HG	0.3554	0.4552	0.7580	0.8372	0.5784	0.6572	0.6574	0.6136	0.7366	

P8 (Fat layer on the rump), BFT (Back fat thickness), EMA (Eye muscle area), BW (Body weight), ADG (Average daily gain), FCR (Feed conversion ratio), FI (Feed intake), SH (Shoulder height), BL (Body length) and HG (Heart girth)

According to Bosman (1995) there is a highly negative correlation between ADG and FCR (-0.60). The better the growth of the animal the more efficient (lower) its FCR will be. FI has a highly positive correlation with ADG, which means that when the intake of the animal increases, the tempo of growth of the animal will also be enhanced. The FI and FCR are not highly correlated, which indicates that the FCR will be higher with an increase in FI (Bosman, 1995).

Negative correlations were observed between FCR and its component trait, ADG, of -0.53 (P<0.005). The research of Arthur *et al.* (2001) indicated a negative correlation of -

0.74 between FCR and ADG. This is even higher (negatively) than the -0.60 correlation of Bosman (1995). This indicates that faster-growing animals tend to have improved (lower) feed conversion ratios. A medium correlation of 0.46 was found between ADG and FI which is in agreement with the correlation of 0.41 reported by Arthur *et al.* (2001).

The correlations between the ultrasound measures and FCR, ADG and FI obtained in this study were low, except for the correlation between ADG and EMA which were high (0.64) ($P<0.0001$). The correlations between FCR and EMA was -0.03 and the correlation between FCR and BFT was 0.38. For ADG and BFT the correlations were -0.07. These results are in contrast with the results of Nkrumah *et al.* (2004) whose correlations between P8 and FI were low (0.24). Arthur *et al.* (2001) also reported very low correlations between P8 and FI of 0.16.

Heart girth (HG), which is a good indicator of growth (body weight) (Benyi, 1997), had a high correlation of 0.76 ($P<0.0001$) with EMA while the correlations between BW and EMA were even higher (0.80) ($P>0.0001$). This indicates that the area (cm^2) of the EMA will grow in relation to the growth of HG and BW. A correlation of 0.66 was found between FCR and HG, while HG and ADG showed a correlation of 0.58. This is in agreement with the findings of Fourie *et al.* (2002) who reported a medium correlation between HG and the extensive growth performance of Dorper rams.

Body length was highly correlated with HG (0.74) ($P<0.0001$). Body length also had high correlation with SH (0.67) ($P<0.0001$). Fourie *et al.* (2002) reported medium–high correlations (0.57) between BL and SH in Dorper rams and Vermeulen (2001) reported high positive correlations of 0.61 between BL and SH in beef heifers.

4.3 References

Arthur, P.F., Archer, J.A., Johnston, D.J., Herd, R.M., Richardson, E.C. & Parnell, P.F., 2001. Genetic and phenotypic variance and covariance components for feed intake, feed efficiency, and other post-weaning traits in Angus cattle. J. Anim. Sci. 79: 2805-2811.

Benyi, K., 1997. Estimation of live weight from chest girth in pure and crossbred West African goats. Trop. Anim. Health Prod. 29, 124-128.

Bosman, D.J., 1995. Fenotipiese korrelasies tussen verskillende eienskappe. National Beef Cattle Performance Testing and Progeny Scheme. Newsletter No. 73: 5-7.

Campbell, Q.P., 1983. Make money with mutton sheep. Dreyer Printers, Bloemfontein.

Fourie, P.J., Neser, F.W.C., Olivier, J.J & Van der Westhuizen, C., 2002. Relationship between production performance and body measurements of Dorper rams. S. Afr. J. Anim. Sci. 32: 256-262.

Kennedy, A.D., Bergen, R.D., Lawson, T.J., Small, J.A. & Veira, D.M., 2004. Effects of evening feeding and extended photoperiod on growth, feed efficiency, live animal carcass traits and plasma prolactin of beef heifers housed outdoors during two Manitoba winters. Can. J. Anim.Sci. 84: 492-500.

Koenen, E.P.C. & Groen, A.F., 1998. Genetic evaluation of body weight of lactating Holstein heifers using body measurements and conformation traits. J. Dairy Sci. 81: 1709-1713.

Peters, R.R., Chapin, L.T., Leining, K.B. & Tucker. H.A., 1978. Supplemental lighting stimulates growth and lactation in cattle. American Association of Science. Science (Washington, DC) 199: 911-912.

Peters, R.R., Chapin, L.T., Emery, R.S. & Tucker, H.A., 1981 .Milk yield, feed intake, prolactin, growth hormone, and glucocorticoid response of cows to supplemented ight. J. Anim. Sci. 64: 1671-1678.

Phillips, C.J.C., Johnson, P.N. & Arab, T.M., 1997. The effect of supplementary light during winter on the growth, body composition and behaviour of steers and heifers. *Animal Science* 1997, 65: 173-181.

Small, J.A., Glover, N.D., Kennedy, A.D., McCaughey, W.P. & Ward, D.R., 2003. Photoperiod effects on the development of beef heifers. Can. J. Anim. Sci. 83: 721-730.

Tucker, H.A. & Ringer, R.K., 1982. Controlled photoperiodic environments for food animals. American Association for the advancement of Science. 216: 1381-1386.

Vermeulen, S.W., 2001. 'n Evaluasie van die voeromsetverhouding van Bonsmara verse. M.Tech (Agric) dissertation, Technikon Free State, Bloemfontein.

Zinn, S.A., Chapin, L.T., Enright, W.J. & Tucker, H.A., 1989. Failure of photoperiod to alter body growth and carcass composition in beef steers. J. Anim. Sci. 67: 1249-1257.

CHAPTER 5

THE ECONOMIC VIABILITY OF SUPPLEMENTED LIGHT IN AN AVERAGE FEEDLOT

5.1 The feedlot

For the purpose of this discussion an average feedlot with the following layout, dimensions and features is used.

The layout of the feedlot consists of a double row set with 13 pens in each row. Each pen measures 2500m² which is enough space for 100 head of cattle. The two rows of 13 pens each measures 65 000m² and can hold 2600 head of cattle at any given time.

5.2 Lighting

To ensure that there is sufficient light and that the light is evenly spread over the feedlot, the following should be used: 96 wide beam floodlights with 400 watt high pressure sodium lamps per row. These lights must be mounted on 13 poles per row of pens. The poles must be eight metres long, as 1,5m will be planted into the ground, and 6,5m must be above the ground in order to distribute the light evenly throughout the feedlot.

5.3 The costs

The costs of lighting the feedlot can be divided between the initial capital cost and the running costs.

5.3.1 Capital cost

Quotations for the following capital investments were collected during April 2006.

96 lights @ R 1280 each	122 880
13 x 8m steel/galvanized poles @ R1800 each	23 400
13 x brackets/fittings for lights @ R500 per pole	6 500
Pillar box, concrete base, cables, wiring etc. per row of 13 pens	60 443
Installation cost (labour)	20 000
Total cost of lighting per row of 13 pens	233 223
Total capital cost for two rows of 13 pens	466 446

5.3.2 Running costs

Electricity

96 lights @ 400W each = 38 400W or 38.4 kW.

Daily usage

Lights must be switched on 30 minutes before sunset and switched of 30 minutes after sunrise. Although day light length will differ between summer and winter time, on average the lights will be on for twelve hours daily. The daily usage of all 96 lights would be 460.8 kilowatt hours. The cost of Eskom electricity for a farm in the North-West province is R0.477/kilowatt hour.

The daily cost of electricity for the lights of the two rows of pens will be (460.8 x 2) x R0.477 = R440.

5.4 Interest on capital

Interest on capital cost should be calculated at a market related rate. The prime overdraft rate of 9.5% during the second term of 2006 will be used in the calculations.

Daily cost of interest = Prime rate x total capital cost

Daily cost of interest = 9.5% x R466 446/365

Daily cost of interest = R121

5.5 Economic gains

5.5.1 Feed margin supplemented light (24h)

Income

ADG x price/kg x dressing % x trial period

= 1.84kg/day x R18/kg x 84 days

= R 1557.96

Feed cost

Intake x price of feed/kg

= R 795.50 x R 1/kg

= R 795.50

Feed margin

Income – feed cost

= R 1557.96 – R 795.50

= R 762.46

5.5.2 Feed margin natural photoperiod

Income

ADG x price/kg x dressing % x trial period

= 1.67 x R18/kg x 56% x 84 days

= R 1414.02

Feed cost

Intake x price of feed/kg

= 827.20kg x R 1/kg

= R 827.20

<u>Feed margin</u>

Income – feed cost

= R 1414.02 – R 827.20

= R 586.82

5.5.3 Feed margin SL vs. Feed margin NP

$$\text{Increase in Feed margin} = \frac{\text{Feed margin SL} - \text{Feed margin NP}}{\text{Trial Period}}$$

$$= \frac{762.46 - 586.82}{84 \text{ days}}$$

= R 2.09/animal/day

Net profit/animal/day = Increased profit/animal/day – Elec. cost/animal/day – Interest cost/animal/day

= R 2.09 – R 0.17 – R 0.05

= R 1.87

5.6 Period over which original capital outlay can be recovered

$$= \frac{\text{Total capital cost}}{\text{Net profit/animal/day x number of animals}}$$

$$= \frac{\text{R 466 446}}{\text{R 1.87/animal/day x 2600 animals}}$$

$$= \frac{\text{R 466 446}}{\text{R 4862}}$$

= 96 days

CHAPTER 6

GENERAL SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

More than 70% of all beef consumed in South Africa is from cattle intensively fed in a feedlot. This specific industry has a potential throughput of 1,512 million animals annually. After the purchasing price of the weaner, the price of feed is the second highest cost in a feedlot operation. Roughly speaking about 340,000 tons of beef is produced annually by feedlots and the total amount of feed used by this industry annually accounts for approximately 1,5 million ton. Improvements in ADG, FCR and FI will be of paramount importance to the feedlot industry.

From this study it is evident that SL has a positive effect on ADG and FCR of young beef bulls under intensive feeding conditions. The overall difference in BFT, EMA and P8 was not significantly different for the three different treatment groups over the period of 84 days. However during the last 22 days of the trial there was a reduction in BFT for the 16L:8D and 24L:0D treatment groups. If these results are highly repeatable it means that bulls can be fed more economically for a longer period because of less fat accumulation. It will also be economically viable as supplemented light increases profit with R1.87/animal/day. The original capital outlay can be recovered in 96 days.

Currently there is no proof that supplemented light has a positive effect on castrated animals. It is therefore recommended that feedlots feed the bulls separately applying supplemented light. According to this study, SL had no effect on body dimensions in terms of body measurements.

Further research needs to be done on this topic, including different breeds of beef cattle using castrated animals as testosterone secretion may have had an influence on lean growth.