

**SOME FACTORS AFFECTING WEANING WEIGHTS OF CALVES**

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**A thesis submitted in partial fulfilment of the  
requirements for the degree of  
MASTER OF SCIENCE IN AGRICULTURE  
in the  
Department of Animal and Poultry Science  
Faculty of Agriculture  
University of Natal  
Pietermaritzburg  
1996**

## DECLARATION

I hereby declare that the whole of this thesis, except where otherwise indicated in the text, is my own original work and that the results obtained have not been previously submitted by me in respect of a degree at any other university.



N. W. Kunene  
Pietermaritzburg  
November 1996

## ACKNOWLEDGEMENTS

I wish to extend my sincerest appreciation to the following people for their contribution to this thesis:

Mr J. van der Westhuizen and Mr L. Bergh at Animal Improvement Institute, Irene for providing data.

Special thanks to Mr. Vellem Foskink and Mr. Steven Van Wyk at the Breed Society in Bloemfontein for their co-operation and assistance in providing information.

Professor A.W. Lishman, my supervisor, for his patience, supervision, guidance and constructive criticism in the preparation of this thesis.

Mr.H. Dicks for advice on statistical problems.

My parents, sisters and my brother for their motivation, support and encouragement.

Finally to Istva'n and my flatmates, Sharon, Richard, Kent, Morton, Claire and Erlene for their sincere understanding and encouragement.

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## ABSTRACT

A mixed model study was carried out on the field data records of 9798 Simmental and 1725 Hereford calves born during the period 1992 to 1994, and obtained from the Animal Improvement Institute, Irene. The records were used to evaluate the influence of type of management systems used by breeders, type of vegetation, sex of calf, age of dam, year of birth and season of birth on 205 day weight of calves and some two way interactions between these effects. The analysis were carried separately for each breed.

Type of management did not significantly affect the 205 day weight of Hereford calves, the least-squares means of calves from extensive, semi-extensive and intensive systems were 195.8, 196.9 and 197 kg, respectively. However, the effect was highly significant ( $P < .01$ ) for Simmental calves with weaning weights of 217.4, 238.3 and 261.2 kg for extensive, semi-extensive and intensive production systems, respectively. The Simmental data were divided for further analysis according to the three management systems.

All the main effects on the 205 day weight of Simmental calves were highly significant for all the management systems. Simmental calves raised in the combination of fynbos and pastures under the semi-extensive management system weaned the heaviest calves (295.8 kg) and those raised in the mixed grassveld under the extensive system weaned the least (202.4 kg). The Simmental male calves were 10, 9.8 and 17.9 kg heavier than female calves in the extensive, semi-extensive and intensive systems respectively. The mature age of the dam was between the 52 to 57, 58 to 117 and 52 to 57 month age groups with weaning weights of 230.7, 257.7 and 266.4 kg in the extensive, semi-extensive and intensive systems respectively. The deviations of weight of calves of the mature dams from those of young dams (16 to 27 months) were

26.9, 30 and 20 kg under the extensive, semi-extensive and intensive systems, respectively.

The main effects on the 205 day weight of Hereford calves, except the type of management, were highly significant ( $P < .01$ ). The Hereford calves raised in the sweetveld areas produced the highest weights (218.6 kg) but those raised on the karroo were the lightest (188.1 kg). The best calving seasons were autumn and winter, with the mean weight of 215.1 kg and 202.9 kg, respectively. Summer and spring born calves weighed 180.2 and 188.2 kg, respectively. The Hereford male calves were 13.2 kg heavier than the heifers. The maturity age of the dams was between the 72 to 95 month age group with the deviation of 20 kg in weaning weight of their calves from those of the young dams (22 to 27 months old).

The sex and age-of-dam interaction for both breeds indicated an overall correction factor for sex of calf and of age of dam. Multiple adjustment factors were used to remove sex of calf differences, whereas additive adjustment factors were used to remove age-of-dam differences.

## CHAPTER 1

## LITERATURE REVIEW

## 1.1 Introduction

Performance testing is the measuring and recording of one or more traits of animals. Measuring the performance (e.g. preweaning growth rate) of all calves produced in a herd assists in identifying the best performing ones and, more importantly, provides information about breeding values of sires and dams that produced the calves.

Anderson & Willham (1978) emphasized that the evaluation of weaning weight in beef herds is an integral part of the performance program of a cow-calf producer. The weaning weight of calves is used as an indication of the potential for rapid growth by animals and as a measure of maternal ability of the dam raising the calf (Leighton et al., 1982). In addition, as noted by Neville et al. (1974), the weaning weight is an important factor affecting net income in calf-raising and feeding operations. The weaning weight of calves is influenced by many environmental effects that obscure genetic differences. The environmental effects on records need to be removed or controlled in order to better estimate genetic differences between calves, dams and sires (Anderson & Willham, 1978).

The following discussion focuses on performance testing, factors affecting weaning weight of calves and adjustment factors that could be used to remove such environmental influences.

## 1.2 Performance Testing

Performance testing is a method of selection and selection is a primary tool available to breeders for making genetic improvement. Performance testing offers beef cattle breeders a way of measuring differences among animals in heritable characters or traits. Performance levels for these characters are related to the ability to transmit desired traits to the offspring.

Differences among animals in traits of economic value are, to a considerable extent, due to inherited differences. Systematic measurements and the use of records in selection will increase the rate of genetic improvement in individual herds and thus in a breed and ultimately the total cattle production.

According to O'Mary & Dyer (1978) performance testing is based on the fact that individual animals differ in their ability to:

- \* grow rapidly
- \* mature early
- \* convert feed to meat efficiently
- \* develop a desirable carcass
- \* produce

### 1.2.1 Selection principles

#### 1.2.1.1 *The basis for genetic improvement*

Animal differences result from genetic or hereditary differences transmitted by parents and from environmental influences. Cattle receive 50% of their inheritance from their sire and 50% from their dam. Cattle have 30 pairs of chromosomes which are carriers of genetic material found in the nucleus of the cells. The chromosomes carry inheritance units called genes which occur in pairs in most body cells. However, the ovaries and the testes produce reproductive cells (gametes) which contain only one member of each chromosome pair. One gene of each pair comes from the sire

and the other comes from the dam (Neumann,1977).

Neumann (1977) explained that it is purely a matter of chance which gene from each pair goes to each reproductive cell at fertilization. As a result, some reproductive cells contain more genes that are desirable for economic trait than others. This is the reason why some offspring have genetic merit equal to the average of their parents, while some will be genetically superior to the average of their parents and others are inferior. Those that are superior provide the opportunity for selection and genetic improvement (Warwick & Legates 1979).

#### **1.2.1.2 Traits**

Genes vary greatly in their effects. Some traits are controlled primarily by a single pair of gene, one member sometimes being dominant. The dominant gene masks the effect of the other member of the pair (recessive member) (Warwick & Legates,1979). An example given by Thomas (1986) is the gene for polled characteristic (P) which masks the gene for horns (p) when they are both present. Other examples are coat colour and dwarfism (Preston & Willis, 1974). Traits which are controlled by a single pair of genes are easy to recognise. Such traits are purely genetical and are not affected by environmental factors. These traits are termed **qualitative traits**, they are not of significant economic importance and warrant little attention in breeding of superior beef cattle (Thomas,1986).

The **quantitative traits** (polygenic characters), on the other hand, are controlled by many pairs of genes. The individual expression of these traits is also affected by changes or differences in environment. This means their phenotype (differences among appearance of individuals in a population) is determined by both genetics and environment. They are variable among groups, breeds and among individuals (Neumann, 1977). Preston & Willis (1974) gave examples of such traits which are of economic importance in

beef production. These are birth weight, weaning weight, rate of gain and mothering ability.

### **1.2.2 Factors affecting selection**

The factors affecting rate of improvement from selection are heritability, selection differential, genetic correlation among traits and generation interval.

#### **1.2.2.1 Heritability ( $h^2$ )**

A characteristic that is able to be passed on to the next generation is heritable and the degree to which it is inherited is called **heritability**. It is the proportion of differences between animals that is transmitted to the offspring (Thomas, 1986).

Heritability provides a good estimate of how much progress can be made from selection (Minish & Fox, 1979). The higher the heritability of a trait, the greater the rate of genetic improvement or the more effective selection will be (Thomas, 1986).

Heritability is expressed by the symbol,  $h^2$  and as a percentage or decimal fraction. For instance, heritability for weaning weight, is .25 to .30 or 25% to 30% (Preston & Willis, 1974). This means that 25% of the variation in weaning weights in a group of animals is due to hereditary and 75% is due to environment. The values of  $h^2$  vary from place to place, due to errors in sampling or differences in environment and management (Thomas, 1986).

#### **1.2.2.2 Correlation between traits**

Genetic correlation is mainly brought about by **pleiotopy**, which is the capacity of a gene or genes to affect two or more traits. Two or more traits may be correlated from a genetic point of view in a positive manner. This means that selection for improvement of one trait will result in improvement in the other, even though direct selection has not been practised (Lasley, 1972). Association between growth rate and feed efficiency in cattle between 7 and 18

months of age is an example of positively correlated traits. When individuals with high growth rate are selected within a herd, then feed efficiency is also improved (Thomas, 1986). When a correlation is negative, the selection of one trait results in a decline in the other to which it is genetically correlated, e.g., between fat thickness and marbling score (Thomas, 1986).

### **1.2.2.3 Selection differential (SD)**

Thomas (1986) defined SD as the difference between selected individuals and the average of all animals from which they were selected. According to Daly (1971) a high selection differential can be achieved through keeping stock in the herd for longer periods. Thus, fewer replacements are required and the culling rate of replacement stock can be increased, to ensure only top quality stock are retained as replacements.

### **1.2.2.4 Generation interval (GI)**

Neumann (1977) described generation interval as the average age of the parents when the replacement offspring are born. Thomas (1986) suggested that keeping the generation interval short and increasing the selection differential will boost annual improvement. The formula for calculating the annual improvement for any heritable trait is:

$$\text{Annual progress} = \frac{h^2 \times SD}{GI} \quad (1)$$

(from Thomas, 1986).

The example below, given by Thomas (1986), shows how most of the genetic improvement comes from the sire because it possible to have a high SD on the male side. This is important because in beef cattle production one needs to keep a high percentage of heifers,

and just one bull needs to be mated for every 25 heifers.

Assume that the average yearling weight of herd is 273 kg and that the breeder selected replacement heifers that weighed 296 kg. This gives a selection differential of 23 kg. Assume a bull with an adjusted yearling weight of 364 kg (giving a selection differential of 91 kg) was mated to these heifers.

What should the breeder expect the adjusted yearling weight of offspring to be?

Selected heifer's differential	$296 - 273 = 23$ kg
heritability estimate ( $h^2$ )	= 40%
Expected increase from females	$(23 \times .4) = 9.2$ kg
Contribution 1/2 to offspring	= 4.6 kg
Selected bull differential	$364 - 273 = 91$ kg
Expected increase from bull	$91 \times .4 = 36.4$ kg
Contribute 1/2 to offspring	= 18.2 kg
Heifer contribution	= 4.6 more kg
Bull contribution	= 18.2 more kg
Total	= 22.8 kg
+ herd average	= 273 kg
Expected yearling weight of progeny	= 295.8 kg

### 1.2.3 Major performance traits in cattle

Fertility, calving difficulty and birth weight, mothering ability, growth rate, efficiency of gain, longevity, carcass quality and conformation are all traits that influence the efficiency of highly desirable beef cattle (Neumann, 1977).

#### 1.2.3.1 Fertility (reproductive performance)

A high level of reproductive performance is fundamental for making genetic improvements because increased calf crop decreases the percentage that must be saved for replacement and thus increases the selection differential possible for other traits. Even though heritability for reproduction is low (approximately 0.1) close

culling for fertility has improved calf crop (Neumann, 1977).

#### **1.2.3.2 Calving difficulty**

Calving difficulty reduces calf survival and post partum conception in cows and therefore decreases calf crop. Selection for a lower birth weight appears to be the best single remedy for calving difficulty. Since birth weight is affected by sex of calf and increases with advancing cow age, it is necessary to adjust birth weight for sex of calf and age of dam (Neumann, 1977).

#### **1.2.3.3 Mothering ability**

This is the ability of a cow to wean a healthy, vigorous calf. Reproduction, calving ease, maternal ability and milk production are all important components of mothering ability (Neumann, 1977). In selection for mothering ability cows are selected on the basis of performance of their calves e.g. calves with high growth rates up to weaning show that the calf's dam has a good mothering ability (Daly, 1971).

#### **1.2.3.4 Growth rate**

This character is important in beef production because of its high association with efficiency of weight gain. Since the rate to weaning is strongly influenced by the dam, the inherent capacity of animal is measured after weaning, over a period of positive weight gains (Daly, 1971).

#### **1.2.3.5 Efficiency of weight gain**

Genetic improvement can be made in efficiency of gain by selecting for it through the rate of gain, because usually fast gainers will also be efficient gainers (Neumann, 1977).

#### **1.2.3.6 Longevity**

The longer animals remain productive in the herd, the fewer the replacements required and so costs of growing replacements are reduced. Performance selection on this trait will increase

generation interval and reduce genetic progress if breeding animals are retained for longer periods. Thus, stud breeders should indirectly select for longevity. Selection for structural soundness, mothering ability, growth rate and fertility is in effect selection for longevity (Daly, 1971).

#### **1.2.3.7 Conformation**

Conformation is a performance trait to the extent that it contributes to carcass quality and longevity. The list of conformation items given by Neumann (1977) are:

- \* thickness of subcutaneous fat as an indication of lean meat.
- \* thickness of natural fleshing or muscles as an indication of carcass quality.
- \* structural soundness which indicates longevity

#### **1.2.4 Performance testing on farms and at central station**

Performance testing is done both on farms and at central testing stations. In South Africa the scheme consist of five phases of which phases A and B are herd testing programs under farm conditions. Phases C and D are growth tests for young bulls, while phase E involves the testing of carcass quality in progeny sired by promising bulls (Lesch *et al.*, 1983). In either situation, (farm or central testing station) effective programs require that animals being compared be given equal opportunities to perform under uniform feeding and management conditions. The conditions should represent nutritional and managerial regimens which are practical and similar to those under which the progeny are expected to perform (Warwick & Legates, 1979)

According to the B.I.F. (1972), Central performance testing stations are used to:

1. Compare individual performance of potential seed-stock herd sires to similar animals from other

herds.

2. Compare bulls being tested prior to sale to commercial producers.
3. Finish steers or heifers to be slaughtered for progeny test programs.
4. Estimate genetic differences between herds or between progeny of sires as regards gaining ability, feed conversion, conformation and carcass characteristics.
5. As an educational tool to acquaint breeders with records of performance.

#### 1.2.5. Weaning weight in performance testing

Weaning weight is measured in the pre-weaning phase to evaluate differences in maternal performance and growth potential of calves. For best estimates of genetic worth for weaning weight, it is necessary to adjust the records of individual calves to a standardized age of 205 days and to mature dam equivalent for comparison (Thomas, 1986). Warwick & Legates, (1979) suggested that weaning weight of calves should be recorded as close as possible to 205 days as it is practical and within a recommended range of 160 to 250 days.

The formula recommended by the B.I.F (1981) (cited by Thomas, 1986) for the computation of 205 day weight is that based on the average daily gain from birth to weaning as follows:

$$205 \text{ day weight} = \frac{(\text{actual wt.} - \text{birth wt.})}{\text{age (days)}} \times 205 + \text{birth wt.}$$

(2)

In adjusting the 205 day weight for sex to a mature dam equivalent, the following adjustments (Table 1) are made :

Table 1 Recommended additive correction factors for adjusting 205 day calf weight to a mature dam basis (Warwick & Legates, 1979)

Age of dam	Additive factors in kilograms	
	males	females
2 yrs	27.2	24.5
3 yrs	18.1	16.3
4 yrs	9.1	8.2
5 to 10 yrs	0	0
11 yrs	9.1	8.2

The weaning weight ratios are calculated from the adjusted weaning weight. The ratios are useful in ranking individual calves of each sex within a herd for making selections. The ratios provide a record of each individual's deviation from the average of its contemporaries in terms of percent (Thomas, 1986). The equation given by Thomas (1986) for calculating weaning weight ratios is:

$$\text{Wn. wt. ratio} = \frac{\text{Individual computed 205 day wt.}}{\text{average 205 day weight of group}} \times 100 \quad (3)$$

#### 1.2.5.1 Most probable producing ability (MPPA)

The MPPA is used for the ranking of dams for 205 day weaning ratio. It is needed to compare dams that do not have the same number of calf records in their averages (Thomas, 1986). The production of individual cows may be summarised to give the MPPA by the expression:

$$\text{MPPA} = H^- + \frac{nI}{1 + (n - 1) I} (c^- - H^-) \quad (4)$$

$H^-$  = 100, herd average

$n$  = # of calves in the average

$r$  = .4 repeatability of wn. wt.

$c^-$  = average wn. wt. ratio for all calves the cow has produced (Thomas, 1986).

### 1.3 Factors Affecting Weaning Weight of Calves

As mentioned previously, the differences among animals (phenotypic variation) are due to two major causes, **genetic and environment**.  $h^2$  for weaning weight is 25 to 30% and a high percentage (70 to 75%) of variation in weaning weight in a group of animals is due to environment. The environmental factors affecting genetic worth of beef cattle, as measured by weaning weight, are **age of calf at weaning, sex of calf, age of dam, milk production of dam, creep feeding (management), season of birth, year of birth, birth weight, growth-stimulating implants and breed of calf**.

#### 1.3.1 Age of calf

Weaning weight of calves is affected by the age of calf because calves usually differ in age on the weaning day of the herd. It is expected that weaning weight will increase with weaning age. Minyard & Dinkel (1965) observed a highly significant effect of age on calf weaning weight and they found a linear regression of weight on age (within ranch, year, month of birth subclass) of 0.55. Similarly, Cunningham & Henderson (1965) recorded figures of 0.77 and 0.55 for inbred lines of Shorthorn.

However, Johnson & Dinkel (1951) (cited by Preston & Willis, 1974) found that the growth rate of calves on range was linear from birth to 155 days of age and thereafter decreased progressively. Similar results were obtained by Pell & Thayne (1978) and Woodward *et al.* (1989). They concluded that both the linear and quadratic effects of age were highly significant on weaning weight in both Hereford and Angus breeds.

#### 1.3.2 Sex of calf

Sex of calf is an important factor which has been seen to have a significant effect on the weaning weight of calves. Most

investigators have found the live weights at weaning to be higher for male than for female calves.

In the analysis of 28 500 Angus, Hereford and Santa Gertrudis, Warren *et al.* (1965) found bulls to be 19.7 kg heavier than heifers at weaning. In a study of Hereford and Angus breeds, Cundiff *et al.* (1966a) noted that bulls were 25 kg heavier than heifers. Anderson and Willham (1978) reported a difference of 20 kg in the analysis of Angus data. A difference of 25.6 kg and 18.8 kg in Angus and Hereford data, respectively, was reported by Nelson & Kress (1981) and Leighton *et al.* (1982) reported a difference of 19 kg in Hereford analysis.

Work by Cartwright & Carpenter (1961) showed that male calves suckled more frequently and took in more milk than females. This was confirmed by Pope *et al.* (1963), McCuskey *et al.* (1986) and Daley *et al.* (1987) who reported that dams of bull calves produced more milk. Rutledge *et al.* (1971) and Boggs *et al.* (1980) also reported that larger calves stimulated their dams to produce more milk, but Melton *et al.* (1967) recorded a greater milk yield of dams of Angus bulls even though the bulls were only 0.1 kg heavier than heifers. However, Reynolds *et al.* (1978), Chennete & Frahm (1981) and Marston *et al.* (1992) observed little or no effect of calf sex on dam's milk production.

### 1.3.3 Age of dam

The age of the dam is the most important source of variation in weaning weight, with the largest differences in production of cows occurring among the younger age groups (Preston & Willis, 1974). In most of the studies reported, investigators have found that cows's production, with regard to weaning weight, increases steadily from 2 to 6 years and then declines.

Niemann & Heydenrich (1965) reported an increase in weaning weight of calves until the Afrikaner cows reached an age of 6 to 8 years. Cows between 6 to 8 years produced the heaviest weaners. They found that once the cows had reached the age of 8 years the average weaning weights of their calves decreased gradually. Similar results were obtained by Cundiff *et al.* (1966a), Sellers *et al.* (1970), Anderson & Willham (1978), Nelson & Kress (1981) and Leighton *et al.* (1982). Deviations were found by Pell & Thayne (1978) who reported a slightly later mature age of 7 to 8 years in Hereford and 8 to 9 years in Angus dams.

Jameson *et al.* (1965) and Cundiff *et al.* (1966a) noted that age is more important in the first 4 years. Cundiff *et al.* (1966a) found an increase of 22 kg in weaning weight as the age of the dam increased from 2 to 4 years. It was emphasized that increments of 3 to 5 months within this period would result in more accurate correction factors than classification into yearly increments. This was confirmed by Leighton *et al.* (1982) who recommended that cows calving at 2 years should be separated from cows calving at 2 1/2 years old. They noted a significant difference of 6 kg in weaning weight of calves between the cows of the above ages.

#### 1.3.4 Milk production

Milk production in beef cows has a significant effect upon growth and weaning weight of calves. Neville (1962) and Rutledge *et al.* (1971) found that milk production of beef cows accounts for approximately 60% of the variance in weaning weight of calves.

Heyns (1960) stated that the level of milk production of the dam has a marked effect ( $r = .64$ ) on the gain in weight of calf. It was noted that cows with an average of more than 6.8 kg of milk per day weaned calves with an average 230 kg. Furthermore, cows with an average of 4.5 to 6.8 kg milk weaned calves with average weights of 196 kg, while cows which produced less than 4.5 kg milk per day

weaned calves with an average weight of 163 kg. Similarly, results obtained by Meyer *et al.* (1994) indicated that milk yield was the main determinant for maternal effects on the growth of beef calves. Factors which affect the milk production of a lactating cow are breed of cow, age and size of dam and nutrition (Preston & Willis, 1974).

#### **1.3.4.1 Breed of dam**

Furr & Nelson (1964) and Christian *et al.* (1965) recorded mean milk yields ranging from 2.7 to 4.3 kg/day for Hereford cows. Brahmans yielding 2 kg/day in a 7 month lactating period were reported by Reynolds *et al.* (1967). Reyneke & Bonsman (1964) compared calves reared by Bonsmara and Hereford dams in South Africa. It was concluded that Herefords did not have sufficient milk to produce high weaning weights, although they were perfectly adaptable to subtropical conditions.

Notter *et al.* (1978) showed that Jersey x Simmental cross cows gave the most milk when compared to Limousin x Charolais cross cows. Purebred Hereford and Angus cows yielded the least.

#### **1.3.4.2 Age and size of dam**

Neville *et al.* (1974) found that age of dam significantly influenced milk production in beef cows. In Hereford cows, milk production increased up to 5 and 6 years of age. Similarly, Christian *et al.* (1965) and Melton *et al.* (1967) reported that older cows gave more milk.

Heyns (1960) recorded average total milk yield of 1.12 kg for young cows, 3.48 kg for mature cows (6 to 7 years) and 1.42 kg for aged cows. The respective weaning weights were 172 kg, 207 kg and 202 kg. Robison *et al.* (1978) found that in Hereford cows the quantity of milk increased from 2 to 5 years of age. Very little difference was seen between 5 to 8 years and a decline occurred in cows older than 8 years of age. Rutledge *et al.* (1971) showed that it was the

quantity not the quality of milk that was important. They found that between 20% and 60% of the variation in 205 day weight was accounted by milk volume.

The correlation between body size and milk production is 0.4 (Preston & Willis, 1974). Gere & Vo-Hong-Hue (1976) observed that cow live weight had a significant effect on food conversion efficiency for milk production, with heavy cows producing more milk than and converting their food more efficiently than lighter cows. They reported a correlation of 0.3 to 0.47 between live weight and milk yield. Richardson *et al.* (1977) noted that milk yield of beef cows increased with weight of cow at calving. Thus, heifers that gained or maintained weight during lactation produced more milk than those which lost weight. Wright (1987) supported these findings by stating that cows in a better condition at parturition move their energy towards milk production.

#### **1.3.4.3 Nutrition.**

Nutrition is a deciding factor for both dairy and beef cow as reflected in body weight of calf at weaning. It is also reflected in body weight for age for all classes of stock, in weight and size of the mature cow as well as the body weight and quality of a marketable steer. Nutrition also determines the calving percentage and mortality rate of the herd as a whole (Schalk, 1991) and emphasized that for maximum quantity of beef per hectare, veld management should be the first consideration.

Nutrients are required to maintain basic body functions and to allow for production parameters such as growth, pregnancy and lactation (Van Ryssen, 1992). The important nutrients essential for a cow herd are energy, protein, mineral and vitamins (Thomas, 1986). Neville (1962) found that calf growth rate due to nutrition can be affected by average milk production of the dam, which is affected by inherent milk production ability and nutrition of dam. A deficiency of nutrients in pastures or in the natural veld will

decrease the reproductive performance of beef cows. The nutrients which are likely to be lacking in forage grazed during the summer are energy, protein, sodium chloride, iodine, calcium, phosphorus, magnesium, cobalt, copper, molybdenum, fluorine and selenium (O'Mary & Dyer, 1978).

#### **1.3.4.3.1 Supplementary feeding**

Supplements are nutritional additives (protein, phosphorus, salt or other nutrients) intended to remedy deficiencies in the grazing animal's diet. They improve forage utilization, the animal's performance or provide additional carrying capacity. The benefits from supplementation may be substantial during the periods of significant stress (severe winter, drought, extreme weed infestation and heavy stocking rates) (Vallentine, 1990).

Lesch *et al.* (1983) stated that the veld, which is the main roughage used in beef production, varies considerably in its nutrient composition throughout the year. It is recommended that supplements be adapted to correct, as far as possible, the deficiencies that occur during different times of the year. It is also emphasized that special care should be taken to supply feed of good quality (protein, energy) to lactating cows. When underfed cows use body reserves for milk production they do not easily attain their target body weight and body condition at the onset of the breeding season. Lesch *et al.* (1983) also advised that under extensive conditions, good veld and suitable licks should be made available to the cows after calving. Furthermore, first calvers should be separated from the older cows because first calvers still need extra feed to complete their growth. The rate of weight gain by the calf is directly related to the milk yield of the cow, especially during the first 3 months of the calf's life. It is therefore essential that the plane of nutrition of the cow be maintained at a level sufficient for adequate milk production. In addition, the nutrient requirements of the cow are high during the period of late pregnancy (2 months before birth), because of the

accelerating growth of the unborn calf and the need to build up milk secreting tissues within the udder (Fraser *et al.*, 1970).

According to Lesch *et al.* (1983) the effect of supplementary feeding on animal performance depends on :

- \* availability of feed sufficient to satisfy the animal's appetite.
- \* feeding the correct supplement, that is supplying the deficient nutrients and/or minerals in appropriate quantities for the type of animal involved.

#### 1.3.5 Creep feeding

Lishman (1992) defined creep feeding as the supplying of a balanced concentrate ration to suckling calves to compensate for shortcomings in the mother's milk supply or in the grazing to maximize the pre-weaning growth of the calf. As the rumen of the young calf has not yet developed and the cellulose cannot be digested, creep feeding not only supplements the dam's milk and grazing but, if correctly formulated, corrects deficiencies (energy or minerals) of the pastures. Cundiff *et al.* (1966a) found that creep feeding improved 205 day weight by 12.8 kg. Creep feeding also reduced seasonal effects on weaning weight in that deviations from the mean were less than when there was no creep feeding. Sellers *et al.* (1970) reported that Hereford and Angus calves weaned heavier when they were creep fed than when they were not creep-fed. Similarly, Anderson & Willham (1978) observed that creep-fed calves had a higher 205 day weight than non-creep-fed calves. Creep fed steers and bulls were 14 and 13 kg heavier respectively, than those that were not creep fed. For heifers, the advantage of creep feeding was 10 kg and 11 kg from 2 different data analyses.

According to Preston & Willis (1974), the response to creep feeding depends on the dam's nutritional status. Furr & Nelson (1959)

increased weaning weights by 40 kg by creep feeding when cows had a low wintering nutritional level compared with only 24 kg when the dams were on a high plane of nutrition. Anthony & Starling (1968) observed that creep feeding gave greater calf weight gains when the dams were also supplemented. Supplementation of the cow increased her weight gain but not that of calf, while creep feeding without supplementation of the dam increased both calf and cow weight gain.

#### *1.3.5.1 Economic aspects of creep feeding*

Economic aspects of creep feeding would depend on the growth potential of the animal. In areas where pasture land has a relatively high value, creep feeding can be economic since creep-fed calves reach a specified weight much earlier (Preston & Willis, 1974).

Thomas (1986) expressed the fact that though creep feeding may add 11 to 23 kg to a calf's weaning weight, those extra kilograms require 4.5 or more kilograms of feed. Creep feeding is only likely to be profitable when the following conditions are met:

- \* dams are first or second calf heifers
- \* calves are born in the fall, when grazing is not possible.
- \* pastures begin to decline in quality or quantity.
- \* calf prices are high in relation to feed prices.
- \* cows and calves are kept in confinement.

Similarly Thomas (1980) gave the conditions under which creep feeding is not likely to be beneficial:

- \* price of feed is high in relation to calf prices.
- \* pasture quality and quantity remains good throughout the grazing season.
- \* dams are in good condition.
- \* calves are to be wintered on a high roughage, growing diet.
- \* heifers are to be kept for herd replacements.

### 1.3.6 Season of birth

Season of birth is another factor which has been found to have an effect on the weaning weight of calves. Heyns (1960) observed that the milk production of the cows was affected by the season of calving. Accordingly, the growth of the calf and its weaning weight were affected through this medium. Niemann & Heydenrych (1965) suggested that the effect of season of birth on weaning weight of calves is primarily due to a decrease in nutritive value of the natural pasture, which in turn affects the milk production of the dam and consequently the performance of calf. The effect of nutritive pasture becomes more direct as the calf becomes more dependant on the pasture.

Louw & Lishman (1992) recommended that a restricted breeding season should be planned to coincide with the time of the year when the veld is reaching its nutritional peak, in terms of quality and quantity. Spring calving in the sourveld areas of South Africa meets the relatively high feed requirements of the lactating cow because of the high quality and quantity of the veld during the summer months. Even the low requirements of dry cows are matched to the use of low quality spared veld and crop residues during winter. When breeding is done throughout the year, a high plane of nutrition should be maintained at all times or else cows calving in winter on poor natural pastures, will lose weight, produce little milk and will have poor reconception rates (Louw & Lishman, 1992).

Several researchers have reported differences in weaning weights between calves born in different seasons. A similar trend was shown by Brown (1961), Cundiff *et al.* (1966a) and Sellers *et al.* (1970) who found that winter and spring calves had weaned heavier than summer and fall born calves. Similarly, Mc-Carter *et al.* (1989), in an Oklahoma study, concluded that spring calving had an advantage over autumn calving in weaning weight of calves. On

the other hand, Gaertner *et al.* (1992) observed that fall calving in the humid South Eastern United States resulted in heavier calves at weaning, compared to winter or spring calving.

The breed of cattle is also important when planning for the breeding season. Some breeds can withstand heat and humidity better and other breeds are able to withstand severe cold weather (Sellers *et al.*, 1970).

### 1.3.7 Year of birth

Year of birth is another factor which has been found to have an effect on the performance of grazing animals. Gammon (1992) suggested that this was because of factors such as amount and distribution of rainfall, temperatures and the occurrence of frost. Niemann & Heydenrych (1965) found the year of birth to affect the weaning weight of Afrikaner calves in the Orange Free State. This was because the nutritive value of natural pastures in the summer rainfall area of South Africa fluctuate considerably from year to year. Similarly, Segura-Correa & Sugura-Correa (1991) reported that year-of-birth was significantly affecting the 210 day weight of Zebu calves and concluded that the year-of-birth effect appeared to be largely attributable to grazing conditions.

### 1.3.8 Birth weight

Contradictory reports regarding the effects of birth weight of cattle on weight at weaning have appeared in literature. Preston & Willis (1974) stated that even though birth weight has a significant effect on weaning weight, the relationship is not close. Heyns (1960) obtained a highly significant correlation ( $r = .75$ ) between birth weight and total milk production of dams. A calf weighing 4.5 kg more at birth received the benefit of an extra 455 kg of milk during the lactation period of eight months. These results agree with those of Drewry *et al.* (1959) and Gifford (1953)

(cited by Rutledge *et al.*, 1971) who reported that the weight of the calf in early lactation influences the dam's subsequent yield. Vaccaro and Dillard (1966) showed that each kilogram increase in birth weight increased total gain to 280 days by 1.9 kg. Ferreira *et al.* (1981) reported the genetic correlation between birth weight and weaning weight to be 0.29. However, Christian *et al.* (1965) found no significant correlation between birth weight and milk production.

### 1.3.9 Growth-promoting implants

Growth stimulants increase the rate of liveweight gain and weaning weight of calves. The growth-promoting implants are one of the cheapest management tools used to increase the weight of calf weaned per cow exposed to the bull (Thomas, 1986).

The growth stimulants act by increasing protein deposition without changing protein and energy intake. Animals given these compounds will be less fat, at any given weight, than if they had not received the compound. Suckling calves implanted at 90 days will have 9 to 14 kilograms heavier weaning weights (Minish & Fox, 1979).

### 1.3.10 Breed of the calf

Some of the studies done have shown that certain breeds perform better than others. Preston & Willis (1974) observed that the Brahman was usually shown to be inferior regarding weaning weight to other breeds developed from it such as the Angus and Santa Gertrudis (Table 2). Cundiff *et al.* (1966a) found that Angus calves weaned 2.2 kg heavier than the Hereford calves in Oklahoma. Similarly, Nelson & Kress (1981) found that Angus bulls in Montana had an advantage of 3.6 kg over Hereford bulls, whereas Angus heifers weighed less by 3.2 kg than Hereford heifers. The effect of breed on weaning weight is summarised in Table 2.

Table 2 Effect of breed on weaning weight in kilograms

Location	Weaning age (days)	Angus	Brahman	Charolais	Hereford	Shorthorn	Santa Gertrudis	Other <i>B. taurus</i>	Other <i>B. indicus</i>	Authors
Hungary	275				237			131 (2) <sup>a</sup>		Belic, 1965
Kentucky	180				182 (11)					Bradley <i>et al.</i> , 1966
Montana	230				180					Brinks <i>et al.</i> , 1961
Montana	243				263 (-)					Brinks <i>et al.</i> , 1964b
Florida	215	168	178			168	210		188 <sup>b</sup>	Burgess & Bowman, 1965
Florida	240	175	170						197 <sup>b</sup>	Cobb <i>et al.</i> , 1964
Florida	188				189					Damon <i>et al.</i> , 1959a
Florida	200	198 (22)			176	190				Gaines <i>et al.</i> , 1966
Florida	200				193 (17)	195 (19)				Gregory <i>et al.</i> , 1966a, b
Florida	200				181 (10)					Harwin <i>et al.</i> , 1966
Florida	180							158 (10) <sup>c</sup>		Joubert, 1957
Florida	205	147	150		206			159 <sup>d</sup>		Kirder <i>et al.</i> , 1964
Florida	260			279						Klosterman <i>et al.</i> , 1965a
Florida	210				170 (12)			154 <sup>e</sup>		Lasley <i>et al.</i> , 1961
Florida	210				163					Lawson & Peters, 1964
Hawaii	240				210 (17)					Mahmud & Cobb, 1963
Mississippi	205	188 (11)			175 (10)					Meade <i>et al.</i> , 1959a
Costa Rica	230		194		218 (16)		210	209 <sup>f</sup>		Muñoz <i>et al.</i> , 1964
Florida	205		168			140				Pahnish <i>et al.</i> , 1964
Mexico	205		152					139 <sup>f</sup>		Peacock <i>et al.</i> , 1960
Mexico	205						175 (10)			Plasse, 1968
California	240				198					Rollins & Wagnon, 1956a
Missouri	205	154		189	153					Sagebiel <i>et al.</i> , 1967b
Missouri	200				206 (21)					Swiger <i>et al.</i> , 1961a
Missouri	205				231 (40)					Taylor, 1967
Missouri	200				183					Tovar <i>et al.</i> , 1966
Yugoslavia	90		101 (6)	120 (6)			113 (3)	118 (14) <sup>f</sup>	128 (6) <sup>g</sup>	Walker, 1964
Yugoslavia	90									Willis & Preston, 1968a

Figure in brackets is reduction in weight of females, otherwise a single figure relates to the mean of both sexes. Red Pied Lowland. <sup>b</sup> Brangus. <sup>c</sup> South Devon. <sup>d</sup> Devon. <sup>e</sup> Highland. <sup>f</sup> Criollo. <sup>g</sup> Angoni.

(from Preston & Willis, 1974)

#### 1.4 Correction Factors

Livestock breeders need to estimate the breeding values of their livestock accurately to optimize selection programs. This requires that non-genetic causes of variation be eliminated or reduced (Nelson & Kress, 1981). Some of these environmental influences can be adjusted statistically and others can be controlled environmentally. Historically, correction factors have been used to eliminate variation attributable to certain effects before the corrected or adjusted records are used in schemes for estimating the genetic merit of animals available for selection as replacement breeding stock (Leighton *et al.*, 1982). The correction factors allow the scheme to evaluate animals independently of these environmental effects. The environmental sources of variation for which weaning weights are adjusted in the Beef Performance Testing Scheme are sex of calf, age of dam, age of calf at weaning. There is evidence that recommended adjustment factors given in Table 1 are not appropriate for all breeds (Thomas, 1986). Warwick & Legates (1979) and Thomas (1986) emphasized that when sufficient

facts is available that correction factors other than the ones listed are more appropriate for a given breed, their use is preferred.

Koch *et al.*, (1959), Brinks *et al.*, (1961), Cundiff *et al.*, (1966b) and Anderson & Willham (1978) recommended that multiplicative adjustment factors should be used for sex of calf and additive adjustments for age of dam. The interactions of sex of calf and age-of-dam effects require separate correction for age-of-dam and sex of calf. Many of the sex and age-of-dam correction factors for weaning weight in beef cattle have been computed using the least squares procedures. However, Elzo *et al.*, (1987) used a sire-maternal grandsire model to estimate age of dam for Simmental calves.

## CHAPTER TWO

## FACTORS AFFECTING WEANING WEIGHT OF SIMMENTAL AND HEREFORD CALVES

## 2.1 Introduction

To allow producers more effective use of weaning weight in their breeding programs, many research studies have been conducted to identify and quantify the factors influencing weaning weight. As noted in the previous chapter, age of calf at weaning, sex of calf, age of dam raising the calf, year of birth, preweaning management and some interactions among these factors have been identified as important non-genetic factors contributing to variation in weaning weight.

The real genetic differences between animals needs to be identified by removing variation due to environmental factors. The correction factors have been used to eliminate variations attributable to some factors before the adjusted records are used in schemes for estimating the genetic merit of animals available for selection as replacement breeding stock (Leighton *et al.*, 1982). The B.I.F. (1975) recommended that each beef breed association develop appropriate weaning weight adjustment factors based on data collected from their own breeds and environment.

The objectives of this study thus were:

1. To investigate the influence of sex of calf, age of dam, year of birth, management system, type of vegetation (forage) and some two way interactions among these factors on 205 day weaning weight of Simmental and Hereford calves using field data from South Africa.
2. To develop adjustment factors for correcting 205 day weaning weights for age of dam and sex of calves for each breed.

## 2.2 Materials and Methods

Two data records, one for Simmental and the other for Hereford calves were used for the analysis. The data were obtained from the Animal Improvement Institute, Irene near Pretoria, South Africa. There were 15000 records of Simmental calves born between 1992 and 1994 and 5905 Hereford calves born during the same period. The records for each calf included the vegetation type (veld), where it was raised, sex of calf, age of dam, type of production system (management) and date of birth.

5202 and 4180 records for Simmental and Hereford calves, respectively, were eliminated because there was either no record on weaning weight or on birth weight of calf. There were 9798 records remaining on Simmental calves and 1725 on Hereford calves for analysis. Hereford breeders did not record weaning weights for 1994 and thus only calves born in 1992 and 1993 remained for analysis.

After editing the Hereford data, the number of records that remained for certain subclasses were not sufficient to make conclusions on the overall performance of Hereford calves. Accordingly, no comparison was made between the two breeds. A preliminary analysis was carried out and it showed that for both sets of data the 12 months of birth could be classified into four seasons which are, spring, summer, autumn and winter.

The appropriate age-of-dam classifications for the Simmental data was similar to that suggested by Cundiff *et al.* (1966a) for the young dams and Anderson & Willham (1978) for the mature dams. This classification is the same as that used at the Animal Improvement Institute, Irene. However, when the same classification was used for the Hereford data, there was no consistent trend. The subclasses were changed until a reasonable fit was found with the subclasses used by Leighton *et al.* (1982) as basis.

The subclasses for the different factors which were used in this study were coded as follows:

Age of Dam (aod)

Simmental data

0: 16 to 27 months	1: 28 to 33 months
2: 34 to 39 months	3: 40 to 45 months
4: 46 to 51 months	5: 52 to 57 months
6: 58 to 117 months	7: 118 months and above.

The maximum age for dams was 207 months.

Hereford data

0: 20 to 27 months	1: 28 to 35 months
2: 36 to 47 months	3: 48 to 59 months
4: 60 to 71 months	5: 72 to 95 months
6: 96 to 119 months	
7: 120 to 185 months	

The maximum age for dams was 185 months.

Vegetation (re)

The vegetation was defined according to veld types of South Africa reviewed by Tainton (1988) from Acocks 1953. The classes allocated to the 6 vegetation types were as follows:

Simmental data

0: Succulent karroo	1: Bushveld	2: mixed grassveld
3: Sweet grassveld	4: Sourveld	5: Fynbos and pastures
6: Pastures		

Hereford data

0: Succulent karroo	1: Mixed grassveld
2: Sweet grassveld	3: Sour grassveld
4: Pasture	5: Pasture and sour grassveld

Type of production system (mgt)

- 0: Extensive
- 1: Semi-extensive
- 2: Intensive

Year of birth (yr)

- 0: 1992
- 1: 1993
- 2: 1994

Season of birth (se)

- 0: December, January, February (summer)
- 1: March, April, May (autumn)
- 2: June, July, August (winter)
- 3: September, October, November (spring)

Sex of calf (sx)

- 0: Females
- 1: Males

**2.2.1 Statistical analysis**

Analysis of weaning weights was done by using a GLM procedure of Minitab Inc. (1994). Because of the unequal subclass numbers, least squares means for weaning weight were calculated to compare the data. With the Simmental data, it appeared appropriate to divide the data into 3 different data files, each representing a single production system.

The models used, included the main effects and some interactions between these factors. It was not possible to obtain certain interactions between the main effects because of the empty spaces created by unequal subclasses (Minitab Inc., 1994).

The models for the 5 data files were as follows:

### Simmental

All data combined:

$$Y_{1jklgn} = u + v_i + m_j + s_k + a_l + y_g + d_n + (vs)_{ik} + (va)_{il} + (ms)_{jk} + (ma)_{jl} + (my)_{jg} + (sa)_{kl} + (sy)_{kg} + (sd)_{kn} + (ay)_{lg} + (ad)_{ln} + e_{1jklgn}$$

Extensive productive system

$$Y_{1klgn} = u + v_i + s_k + a_l + y_g + d_n + (vs)_{ik} + (sa)_{kl} + (sy)_{kg} + (sd)_{kn} + (ay)_{lg} + (ad)_{ln} + e_{1klgn}$$

Semi-extensive production system

$$Y_{1klgn} = u + v_i + s_k + a_l + y_g + d_n + (vs)_{ik} + (sa)_{kl} + (sy)_{kg} + (sd)_{kn} + (ay)_{lg} + (ad)_{ln} + e_{1klgn}$$

Intensive system production system

$$Y_{1klgn} = u + v_i + s_k + a_l + y_g + d_n + (vs)_{ik} + (va)_{il} + (sa)_{kl} + (sy)_{kg} + (sd)_{kn} + (ay)_{lg} + e_{1klgn}$$

### Hereford

$$Y_{gnkj11} = u + y_g + d_n + s_k + m_j + a_l + v_i + (yd)_{gn} + (ys)_{gk} + (ym)_{gj} + (ya)_{gl} + (yv)_{gl} + (ds)_{nk} + (dm)_{nj} + (da)_{nl} + (sm)_{kj} + (sa)_{kl} + (sv)_{kl} + l_{gnkj11}$$

where:

$Y_{1jklgn}$  = 205 day weight of calf (all Simmental data combined)

$Y_{1klgn}$  = 205 day weight of calf (each production system)

$Y_{gnkj11}$  = 205 day weight of calf (Hereford data)

$u$  is an effect common to all calves.

$v$  is the effect due to veld type :  $i = 0, .6$  (SF<sup>1</sup>),  $0, ..5$  (HF<sup>2</sup>).

$m$  is the effect due to management system:  $j = 0, 1, 2$ .

---

<sup>1</sup>Simmentaler data

<sup>2</sup> Hereford data

s is the effect due to sex of calf :  $k = 0, 1$ .  
a is the effect due to age of dam :  $l = 0, \dots, 7$ .  
y is the effect due to year of birth :  $g = 0, 1, 2$  (SF),  $0, 1$  (HF).  
d is the effect due to season of birth :  $n = 0, \dots, 3$ .

## 2.3 Simmental Data

### 2.3.1 Effect of type of production system (management)

#### 2.3.1.1 Introduction

Three types of beef production systems were used by farmers in this study. Each farmer used either an extensive, semi-extensive or an intensive type of beef production system.

This part of the study aims to show the effect of management on weaning weight of calves and differences in performance of calves raised by dams under the three different systems.

##### 2.3.1.1.1 Extensive

In this system cattle were maintained on natural veld. The nutritional status of the animals depended on the efficiency of veld management in providing the maximum quantity of highest quality grazing. The types of vegetation found in this system were succulent karroo, bushveld, sweet, sour and mixed grasslands. These are described later (see pages 39 to 43 ).

##### 2.3.1.1.2 Semi-extensive

In this system the beef producers utilised the natural veld as well as providing animals with a lick supplement. The type of vegetation was the same as in the extensive system. However, some farmers had the fynbos type of vegetation and cultivate pastures to supplement the poor grass found in this veld type. Similarly, some of farmers in the sourveld have cultivated pastures as a supplement. Accordingly, livestock are then grazed on veld and pastures.

##### 2.3.1.1.3 Intensive

In this system the animals were maintained on pastures as well as being provided with supplementary feed. It was not possible to determine the type of pasture, as well as the licks utilised by

individual farmers.

### 2.3.1.2 Results and discussion

Table 3, reflects the analysis of all the records before the data was sub-divided according to management system. The type of management had a highly significant ( $P < .01$ ) effect on weaning weight of calves. The least-squares means of weaning weight of calves under each productive system are given in Table 4.

Table 3 Analysis of variance for 205 day weaning weight

Source	DF	Seq SS	Adj SS	Adj MS	F	P
re	5	995457	606638	121328	83.15	0.000
mgt	2	858195	753431	376715	258.16	0.000
sx	1	512293	93936	93936	64.37	0.000
aod	7	692250	171777	24540	16.82	0.000
yr	2	4763	95245	47622	32.64	0.000
se	3	110568	143631	47877	32.81	0.000
re*sx	5	4218	8925	1785	1.22	0.296
re*aod	35	172238	180083	5145	3.53	0.000
mgt*sx	2	26652	14359	7180	4.92	0.007
mgt*aod	14	63631	57040	4074	2.79	0.000
mgt*yr	4	486379	475954	118989	81.54	0.000
sx*aod	7	21956	22546	3221	2.21	0.032
sx*yr	2	5647	1860	930	0.64	0.529
sx*se	3	18896	18687	6229	4.27	0.005
aod*yr	14	82529	74541	5324	3.65	0.000
aod*se	21	76756	76756	3655	2.50	0.000
Error	9670	14110646	14110646	1459		
Total	9797	18243074				
R <sup>2</sup>	-	-	-	-	22.65	

Table 4 Least-squares means for weaning weight (kg) in three management systems

Management	Least-squares means	standard error	no.of obs
Extensive	217.4	1.465 <sup>c</sup>	1788
Semi-extensive	238.3	1.025 <sup>b</sup>	6283
Intensive	261.2	1.390 <sup>a</sup>	1727

<sup>a,b,c</sup> Subclass means followed by different superscripts are significantly different ( $P < .01$ )

Calves raised in the intensive system were 43.8kg heavier at weaning than the calves from the extensive type of management and weighed 22.9kg more than calves weaned in the semi-extensive system. Similarly, calves from the semi-extensive system showed a weaning weight 20.9kg greater than for calves from the extensive system. The differences between the weaning weights for the extensive and the other two production systems, can be accounted for by the fact that natural grazing does not provide sufficient nutrients throughout the year. According to Harwin (1989), grazing stock, especially pregnant cows (during their last stage of pregnancy) and lactating cows have high nutrient requirements during these periods. Their performance is affected by severe winters, droughts and by heavy stocking rates when they depend solely on natural grass, without any kind of supplementation provided. The results suggest that where the lick-supplements are normally provided, some deficiencies in the extensive type of production system are alleviated. This follows from the 21kg weight advantage of calves raised under the semi-extensive system as compared to those raised in a system where no supplementation is normally provided. The provision of additional feed, particularly where cultivated pastures are used, resulted in the highest level of production as seen in the intensive system. The additional feed probably eliminated the period of nutritional stress in the livestock and their production performance was at a maximum.

The interactions between **management and sex**, **management and age-of-dam**, **management and year** were all highly significant. The magnitude of these interactions and the differences in weaning weight which are observed between these management systems indicate that correction factors for age-of-dam and sex of calf should be applied within a single management scheme.

## 2.3.2 Effect of veld type

### 2.3.2.1 Introduction

Vegetation is very important in beef production because it is the major source of nutrition, especially in the extensive and the semi-extensive production systems where the main source of feed is the natural veld.

This phase demonstrates the effect of veld type on weaning weight of calves as well as providing a detailed analysis of the difference in performance of calves raised in areas where pastures and those where natural veld apply. The six vegetation types of South Africa that have relevance to both Simmental and Hereford data are described in the following paragraphs. The distribution of these veld types in South Africa is depicted in Figure 1.

#### 2.3.2.1.1 Succulent karroo

According to Tainton (1988), this vegetation is situated immediately south of the great escarpment and along the low lying arid belt of the west coast at an altitude of 300 to 600m. Acocks (1953) observed that succulent plants and mesembs predominate and are mixed with species of non succulent karroo bushes in parts.

According to Tainton (1988) the beef cattle production is practised in the mountainous areas of karroo because of the more grassy vegetation. The potential grazing capacity is low, but it varies with higher potential in the east to relatively low potential in the west. Due to the variable rainfall in this region, the amount and quality of natural fodder is also variable. Both spring and summer are periods of active growth and, as a result, high grazing intensity is avoided at these times. In winter, animals tend to prefer shrubs to frosted grass and this results in high grazing intensity on the shrublets. The autumn produces a favourable supply of food because rainfall is reliable at this time and karroo shrublets and grasses respond to late summer and autumn rains

(Tainton 1988). Veld management is applied by dividing the grazing into camps. The grazing period in these camps ranges from 2 to 6 months and the rest periods normally exceed about 6 months. The length and time of useful rest are usually longer than for other grassveld because the rainfall is low and extremely variable (Tainton 1988).

#### 2.3.2.1.2 *Bushveld*

Like the karroo, much of this veld is sweet. This veld covers approximately 40% of South Africa. The savanna vegetation has developed in more tropical regions of the country where the rainfall is seasonal (dry period in winter) and where temperatures are high (Tainton 1988). Tainton (1988) also reported that fodder produced from this veld consists of grazeable material from the herbaceous grass layer and browseable material from the woody tree and shrub layers. Cattle and goats are the best adapted livestock species for this ecosystem. The savanna areas are reasonably productive and have a moderate potential carrying capacity.

Pienaar (1968) advocated that the veld be stocked according to the grazing capacity of the desirable grass species in the summer. The animals graze on these species and the increaser grass species are permitted to become moribund because the livestock are never forced to utilise them. The desirable grass species eventually predominate at the expense of undesirable species as the latter becomes less competitive and die out if they are not defoliated. Rotational grazing has been found to be very effective in this veld (Tainton 1988).

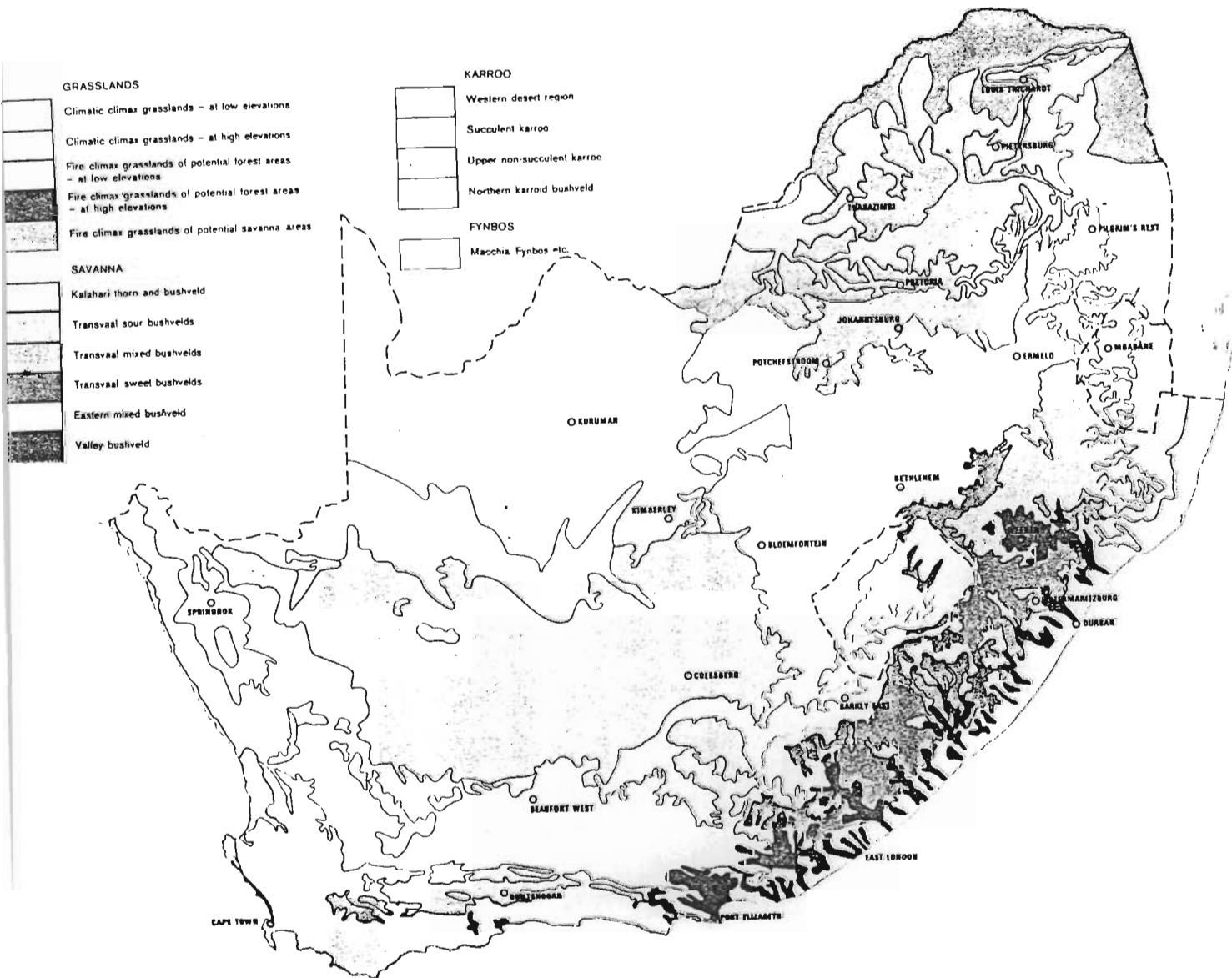


Figure 1. The vegetation types of South Africa (from Tainton, 1988) (adapted from Acocks, 1953)

#### 2.3.2.1.3 *Sour grassveld*

This grassveld is found in high rainfall areas at high altitudes in the eastern and southern parts of South Africa. It provides palatable material only in the growing season. The veld supports animals for 6 to 8 months of year and most classes of cattle are well adapted to produce during spring and summer. The veld is grazeable at this time and becomes unpalatable to stock in autumn. If sufficient grazing is available in spring, young beef calves can realise livemass gains up to 1 kg/day and spring-calved beef cows can successfully wean heavy calves from this veld. The carrying capacity is usually higher than that of sweetveld because the rainfall is relatively high and growth is more rapid and better sustained than that of sweetveld (Tainton 1988). The veld on most farms has been fenced into camps because it is heterogenous, with some areas more palatable than others. The camps allow rotational grazing and easier livestock management. The appetite stimulating sprays and licks have been shown to affect the extension of the useful grazing period on sourveld. Winter camps are rotated from year to year to avoid severe winter grazing. The rotational grazing is practised so that the vigour of more desirable, species especially in the early spring, is maintained (Tainton 1988).

#### 2.3.2.1.4. *Sweet and mixed veld*

The sweet veld is found mainly in the arid and semi arid areas of the western interior where it occurs mostly as karroo or climax grassveld. In the Western Cape it occurs as fynbos and in the low lying areas in the east, mainly as savanna (Tainton 1988). The mixed veld is wedged in between the sweet and sourveld. It is the intermediate between sweet and sourveld and has characteristics which tend towards either sweetveld or sourveld depending on whether the veld is sweet mixed or sour mixed. The major part of the sweet, sour and mixed grazing lands is extremely productive relative to natural vegetation (Tainton 1988). Cattle are the animals best adapted to using and maintaining the grassveld. The grasslands are primarily suited to the breeding and fattening of

cattle even though there is a proportion of edible shrubs, bushes and trees which may be grazed by small stock (Tainton 1988). The carrying capacity of grasslands is considered by Tainton (1988), to be the most productive of all the types, but decreases with a decline in rainfall. The sweetveld is palatable the whole year round and is able to maintain animals in good condition throughout the year. The mixed veld is intermediate between sweet and sourveld and has characteristics which tend toward either sweetveld or sourveld, depending on whether the veld is sweet, mixed or sour-mixed (Tainton 1988). The number of grazing camps per herd for efficient management increases with the increasing rainfall from the driest variation of sweetveld to the more favourable rainfall regions of the mixed veld. The general practice is that all natural grazing should be spared for the growing season once in four years as stipulated in the Soil Conservation Act 1969 (Tainton 1988).

#### 2.3.2.1.5 *Fynbos*

This vegetation occupies the winter rainfall regions of the Western Cape and extends along the south coast as far as the Border area (Tainton 1988). According to Tainton (1988), the fynbos vegetation is characterised by the dominance of macchia type shrubs which have either relatively large, hard or small, hard scale-like leaves. The grass or grass-like plants are not common and the vegetation is mixed in such a way that it does not show the characteristic of species dominance. Tainton (1988) concluded that the fynbos is not a valuable forage source since many of the plants and particularly those of later successional stages are inedible. Livestock here are largely dependent on artificial sources of feed.

In this study, the farmers who farm in this veld type have combined it with cultivated pastures to graze their animals. The reason could be that it is not a productive veld type (Tainton, 1988).

#### *2.3.2.1.6 Cultivated pastures*

These are grazing areas that have been artificially established by farmers for their livestock. They are primarily intended for grazing as well as hay making. The pastures are either introduced (accomplished with minimum soil disturbance) or cultivated, that is, have been established by removal of existing vegetation (Tainton 1988). The cultivated pastures are either leys or permanent pastures. The leys are cultivated pastures sown as part of a rotation of crops in order to increase the productivity of the soil. After some years they are ploughed up and the cropping phase continues. The permanent pastures are cultivated pastures which provide grazing for an indefinite number of years. They can be irrigated in areas which receive an annual rainfall of 600mm or developed readily in areas of 600 to 750mm of rainfall. In areas with an annual rainfall of more than 750mm, there is usually sufficient rainfall to ensure sustained high production on dryland sites (Tainton 1988).

Different grasses and legumes are adapted to different environments and various environmental factors. Therefore, various environmental factors and properties of species are considered in relation to the selection of grass and legume species for use in pasture.

#### *2.3.2.2 Results and discussion*

The analysis of variance for the weaning weight of calves are presented in Tables 5,6 and 7 for each system of production. The effect of vegetation was highly significant ( $P < .01$ ) within each management. The analysis of variance indicated that nutrition contributed to the variation in the weaning weight of calves.

**Table 5 Analysis of variance for 205 day weaning weight of calves  
(Extensive production system)**

Source	DF	Seq SS	Adj SS	Adj MS	F	P
re	4	302266	99187	24797	18.06	0.000
sx	1	88419	13579	13579	9.89	0.002
aod	7	122167	59658	8523	6.21	0.000
yr	2	93149	33809	16905	12.31	0.000
se	3	271975	213691	71230	51.88	0.000
re*sx	4	2442	6273	1568	1.14	0.335
sx*aod	7	11522	4324	618	0.45	0.871
sx*yr	2	15699	13917	6958	5.07	0.006
sx*se	3	1552	1782	594	0.43	0.730
aod*yr	14	62433	36884	2635	1.92	0.021
aod*se	21	80301	80301	3824	2.79	0.000
Error	1719	2360086	2360086	1373		
Total	1787	3412012				
R <sup>2</sup>	-	-	-	-	30.8	

**Table 6 Analysis of variance for 205 day weaning weight of calves  
(Semi-extensive type of production system)**

Source	DF	Seq SS	Adj SS	Adj MS	F	P
re	5	984933	1317233	263446	190.66	0.000
sx	1	259701	16448	16448	11.90	0.001
aod	7	534937	438310	62616	45.32	0.000
yr	2	23226	48099	24049	17.41	0.000
se	3	437366	283529	94510	68.40	0.000
re*sx	5	17367	15364	3073	2.22	0.050
sx*aod	7	13373	14555	2079	1.50	0.162
sx*yr	2	2228	486	243	0.18	0.839
sx*se	3	25317	25138	8379	6.06	0.000
aod*yr	14	83023	99810	7129	5.16	0.000
aod*se	21	99302	99302	4729	3.42	0.000
Error	6212	8583394	8583394	1382		
Total	6282	11064165				
R <sup>2</sup>	-	-	-	-	22.42	

**Table 7 Analysis of variance for 205 day weight of calves  
(Intensive system of production)**

Source	DF	Seq SS	Adj SS	Adj MS	F	P
re	4	26796	37999	9500	7.15	0.000
sx	1	182995	63407	63407	47.70	0.000
aod	7	119082	99205	14172	10.66	0.000
yr	2	38456	22655	11328	8.52	0.000
se	2	6736	15261	7630	5.74	0.003
re*sx	4	3323	3449	862	0.65	0.628
re*aod	28	83911	87012	3108	2.34	0.000
sx*aod	7	6357	4673	668	0.50	0.833
sx*yr	2	394	3586	1793	1.35	0.260
sx*se	2	6592	4652	2326	1.75	0.174
aod*yr	14	20618	20618	1473	1.11	0.346
Error	1653	2197511	2197511	1329		
Total	1726	2692770				
R <sup>2</sup>	-	-	-	-	18.3	

The least-squares means and standard errors for the different vegetation types within each management type are shown in Table 8. The results indicate that even where supplementation is not normally provided, the vegetation of the **succulent karroo** supported good weaning weights in Simmental calves. The performance of animals was improved where supplements are common. Thus, calves raised by dams which received licks in addition to the forage from grass were 25.7 kg heavier than calves raised by dams who depended only on the natural veld in the succulent karroo.

The **sourveld** produced the heaviest-weaning calves in the **extensive** type of management. However, it is difficult to draw definite conclusions since the calves (in the **semi-extensive** system) raised by dams on the same vegetation type showed the lowest weaning weight (209.9 kg) even though lick supplements are normally given. When looking at the number of observations it is possible that the results for the extensive management system were influenced by a single good herd.

**Table 8** Least-squares means for weaning weight (kg), for each veld type under each management system

Veld type <sup>3</sup>	Extensive			Semi-extensive			Intensive		
	n <sup>4</sup>	lsm <sup>5</sup>	se <sup>6</sup>	n	lsm	se	n	lsm	se
s.kar(0)	200	227.2	3.4 <sup>bf</sup>	32	252.9	7.0 <sup>be</sup>	-	-	-
bushv(1)	1145	218.8	2.1 <sup>cg</sup>	1056	234.0	1.3 <sup>cf</sup>	360	255.2	3.2 <sup>bde</sup>
mx.gv(2)	215	202.4	4.0 <sup>dg</sup>	434	237.3	1.9 <sup>cf</sup>	353	257.8	3.8 <sup>be</sup>
sw.gv(3)	142	205.3	4.4 <sup>dg</sup>	2766	236.9	0.9 <sup>cf</sup>	595	268.5	2.7 <sup>ae</sup>
sr.v (4)	86	257.1	5.9 <sup>ae</sup>	1844	209.9	1.1 <sup>dg</sup>	196	244.5	5.6 <sup>cdf</sup>
fy+pa(5)	-	-	-	151	295.8	3.2 <sup>ae</sup>	223	256.2	3.5 <sup>bdf</sup>

<sup>a,b,c,d</sup> Within a column, subclass means followed by different superscripts are significantly different ( $P < .05$ ).

<sup>e,f,g</sup> Within a row, subclass means followed by different superscripts are significantly different ( $P < .05$ ).

The bushveld seemed to be the next best veld type, but the results suggest that greater supplementation may be required to wean heavier calves. The mixed and the sweet velds weaned calves with very low body weights compared to those of other veld types in the extensive system. It seems that the cows, and consequently the calves, were affected by lack of nutrients. This could be during certain periods such as in winter, where the animals require supplements to remedy deficiencies. The weaning weights of calves in the mixed and sweet grassvelds, in the semi-extensive system, suggest that the cows probably benefited from supplements. They weaned calves which were approximately 33 kg heavier than calves in similar veld types in the extensive system.

<sup>3</sup> s.kar = succulent karroo                      bushv = bushveld  
 mx.gv = mixed grassveld                      sw.gv = sweet grassveld  
 sr.v = sourveld  
 fy+pa = fynbos and pasture combination

<sup>4</sup> number of observations

<sup>5</sup> least-square means

<sup>6</sup> standard error

The combination of fynbos and pasture in the semi-extensive areas resulted in the heaviest calves at weaning than all the veld types. This could be because farmers in this ecosystem are aware of its lack of potential for beef production and therefore they attempt to produce good pastures. They may also take precautions for the winter periods.

In general, the results indicate that the intensive type of production system produces heavier weaning calves than any of the systems, in most of the veld types. This is expected because the cows should have sufficient nutrients throughout the year. The difference in weaning weights of calves in different veld types in this system is probably only due to different management skills by breeders e.g. the type of feed supplement provided to their livestock and the type of pastures available.

### 2.3.3 Effect of Season of Birth

#### 2.3.3.1 Introduction

As stated previously, season of birth is an important factor which has been found to have an effect on the weaning weight of calves. The best season of calving is determined by weather, method of winter feeding, labour availability and the markets of the individual beef producers. According to Thomas (1986) milk production is usually higher with cultivated pastures than with dry winter feeding. The nutritive value of the natural pasture is not the same in all seasons, partly because of the different amounts of rainfall and differences in temperature.

The objective of this phase of the study was to reflect on the effect of season of birth on the 205 day weaning weight of Simmental calves under different management systems.

### 2.3.3.2 Results and discussion

The analysis of variance (Table 5, 6 and 7) show that the season of birth had a highly significant effect on the weaning weight of calves ( $P < 0.01$ ) in all the productive systems. The least-squares means and the standard errors for the weaning weight of calves are given on Table 9 for each production system.

Table 9 Least-squares means for weaning weight (kg) for Simmental calves at different seasons of birth in the three management systems.

Season <sup>7</sup>	Extensive			Semi-extensive			Intensive		
	n	lms	se	n	lms	se	n	lms	se
DJF	381	242.9	3.2 <sup>af</sup>	1136	249.1	2.0 <sup>bf</sup>	414	270.9	4.9 <sup>ae</sup>
MAM	558	244.2	3.4 <sup>ae</sup>	1653	236.0	1.7 <sup>cf</sup>	-	-	-
JJA	364	188.6	4.4 <sup>ca</sup>	786	236.9	2.3 <sup>cf</sup>	254	251.9	8.3 <sup>ce</sup>
SON	485	212.2	3.1 <sup>ba</sup>	2708	256.0	1.7 <sup>af</sup>	1059	275.5	3.5 <sup>ae</sup>

<sup>a,b,c</sup> Within a column, subclass means followed by different superscripts are significantly different ( $p < .05$ ).

<sup>e,f,g</sup> Within a row, subclass means followed by different superscripts are significantly different ( $p < .05$ ).

The trend of results in the intensive and the semi-extensive type of management was similar. Cows calving in spring and summer weaned heavier calves than autumn and winter calvers, but intensively reared calves born in spring were 6.9 kg heavier than calves born in summer under the semi-extensive management. These results show that throughout spring calving, the high feed requirements of the lactating cow were met such that these cows produced heavier weaners. The lactating cows and the calves were at an advantage, probably due to the high quality and quantity of the veld and pastures during the summer months. The results also agree with those of Niemann & Heydenrych (1965) who found a

<sup>7</sup> DJF=December-January-February (summer)  
MAM=March-April-May (autumn)  
JJA=June-July-August (winter)  
SON=September-October-November (spring)

decrease in average weaning weight of Afrikaner calves on natural pasture (2.86 kg) for every week of birth after the 1st of October in the Free State.

Calves born in summer weaned heavier than those born in the other two seasons under the semi-extensive production system. This indicates that the dams obtained sufficient nutrients from the summer and the autumn grass in order for them to wean heavier calves.

The calves born in winter and autumn under the semi-extensive management were lighter by approximately 20 kg and 13 kg than calves born in spring and summer, respectively. This suggests that there was a decline in nutritional level in the winter period. The cows calving in autumn probably produced less milk during their lactating period in winter. The cows calving in winter were probably affected during their late period of pregnancy by the poor nutrition from poor grass quality during the winter period and also during their lactation period. This would be especially true during the first four months which was in spring, when the calves depend heavily on milk from their dams for their growth and development. There were no calves born in autumn in the intensive type of management, but calves born in winter were smaller by 23.6 kg and 18.6 kg compared to the calves born in spring and summer, respectively. This indicates that even in the intensive system, where animals are fed on pastures and are usually given supplementary feed, calves born in winter resulted in calves with a lower growth rate. The results in the extensive type of management show that summer and autumn born calves achieved a heavier weaning weight, compared to calves born in winter and spring. The calves born in summer were approximately 55 kg and 31 kg heavier at weaning than calves born in winter and spring, respectively. It seems that the calves born in winter were severely affected by low milk production, which could have been a result of a decline in the quantity and quality of the natural veld

at this time. It was probably a critical period for the calves if they were to achieve heavier weights at weaning. The calves born in spring weaned 23 kg heavier than the calves born in winter. The dams probably benefited from the summer grass, but because they had been severely affected during winter their calves could not realize maximum weaning weights. The growth of the summer and the autumn born calves reflect the good conditions attained by their dams from summer and autumn growth of grass.

#### **2.3.4 Effect of Year of Birth**

##### **2.3.4.1 Introduction**

This part of the study shows the effects of 1992, 1993, and 1994 as the years of birth on weaning weight of Simmental calves. The objective of this section was to show that beef production (performance) fluctuates over the years.

##### **2.3.4.2 Results and discussion**

The results in Tables 5,6 and 7 show that the effect of year of birth was highly significant ( $P < .01$ ) in all the production systems. The least-squares means for weaning weight, according to year of birth (1992, 1993 and 1994), under each production system, are shown in Table 10 and it is apparent that 1994 was the most productive year for the extensive and intensive production systems. One would expect such a trend to occur in the extensive and semi-extensive production systems but not in the intensive system with its higher average annual rainfall. However, because of the higher stocking rates a short period of below expected precipitation can limit weaner growth seriously. This is particularly so if such a drought occurs during the period of high milk production of dams. The effect of year could perhaps have been explained by an interaction between year and season and the interaction of year of birth and veld type, unfortunately, it was not possible to include these interactions in any of the models.

Table 10 Least-squares means for weaning weight (kg) for Simmental calves born during different years of birth

Y.o.b. <sup>a</sup> n	Extensive		semi-extensive			Intensive			
	lsm	se	n	lsm	se	n	lsm	se	
1992	335	209.3	3.3 <sup>bf</sup>	2592	250.1	1.7 <sup>ao</sup>	673	244.8	3.2 <sup>bo</sup>
1993	950	227.0	3.0 <sup>ag</sup>	1785	240.9	1.8 <sup>bf</sup>	738	250.7	2.8 <sup>bo</sup>
1994	503	230.2	3.1 <sup>ag</sup>	1906	242.5	1.7 <sup>bf</sup>	316	273.8	4.6 <sup>ao</sup>

<sup>a,b</sup> Within a column, means followed by different superscripts are significantly different ( $P < .01$ )

<sup>a,g</sup> Within a row, means followed by different superscripts are significantly different ( $P < .01$ )

### 2.3.5 Effect of Sex of calf

#### 2.3.5.1 Introduction

This phase aims to show the significance of sex on weaning weight of calves. The recommended adjustment factors for sex of calf influence are made to a bull or steer, because the male calves have always been found to weigh more than the female calves. The results in this section should indicate if such adjustment values are warranted in these data sets. The difference in weaning weight between heifers and male records used in this study are also indicated.

#### 2.3.5.2 Results and discussion

The analysis of variance in Table 3 (all Simmental data) indicate that sex is a highly significant factor ( $P < .01$ ) influencing the weaning weight of calves. Similar results were obtained for the extensive, semi-extensive and intensive management systems (Tables 5, 6 and 7). The difference in 205 weaning weight between male and

<sup>a</sup>year of birth

heifer calves, computed from all Simmental data, was found to be 11.9 kg (Table 11).

Table 11 Least-squares means for weaning weight (kg) for sex of calf for all Simmental data

Sex	n	lsm	standard error
heifers	5964	233.0	1.2
males	4724	244.9	1.1

The least-squares means (Table 12) show that males weighed more at weaning in all the different management systems. Thus, the males were 10, 9.6 and 17.9 kg heavier than heifer calves under the extensive, semi-extensive and intensive type of management, respectively.

Table 12 Least-squares means for weaning weight (kg) for sex of calf in three management systems

	Extensive			Semi-extensive			Intensive		
	n	lsm	se	n	lsm	se	n	lsm	se
f <sup>9</sup>	916	217.2	2.4 <sup>c</sup>	3268	239.7	2.2 <sup>b</sup>	890	247.5	1.8 <sup>a</sup>
m <sup>10</sup>	872	227.2	2.2 <sup>c</sup>	3015	249.3	1.8 <sup>b</sup>	837	265.4	1.9 <sup>a</sup>

<sup>a,b,c</sup> Within a row, means followed by different superscript are significantly different ( $P < .01$ )

The magnitude of effect the of sex was almost the same among calves that were raised under the extensive and the semi-extensive management systems. A greater difference in weaning weight between heifers and males was found for the intensive system. The males

<sup>9</sup> heifers

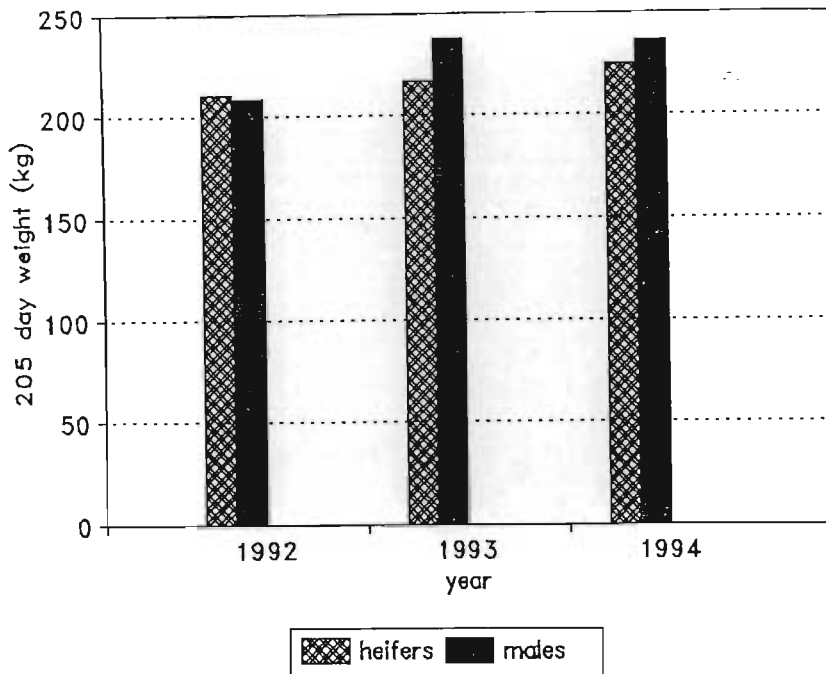
<sup>10</sup> males

and heifers in the intensive system of production weighed 16.1 and 7.8kg and 38.2 and 30.3kg more than the males and heifers in the semi-extensive and extensive types of managements, respectively.

The results support the general contention of higher growth potential for males calves as shown by Cundiff *et al.* (1966a), Anderson & Willham (1978), Nelson & Kress (1981) and Leighton *et al.* (1982). This potential was revealed more for calves that had been raised by dams receiving additional nutrients for milk production. From these results it can be estimated that male calves from the extensive, semi-extensive and intensive production systems grew more rapidly than heifers by 0.049 kg/day, 0.047 kg/day and 0.087 kg/day, respectively.

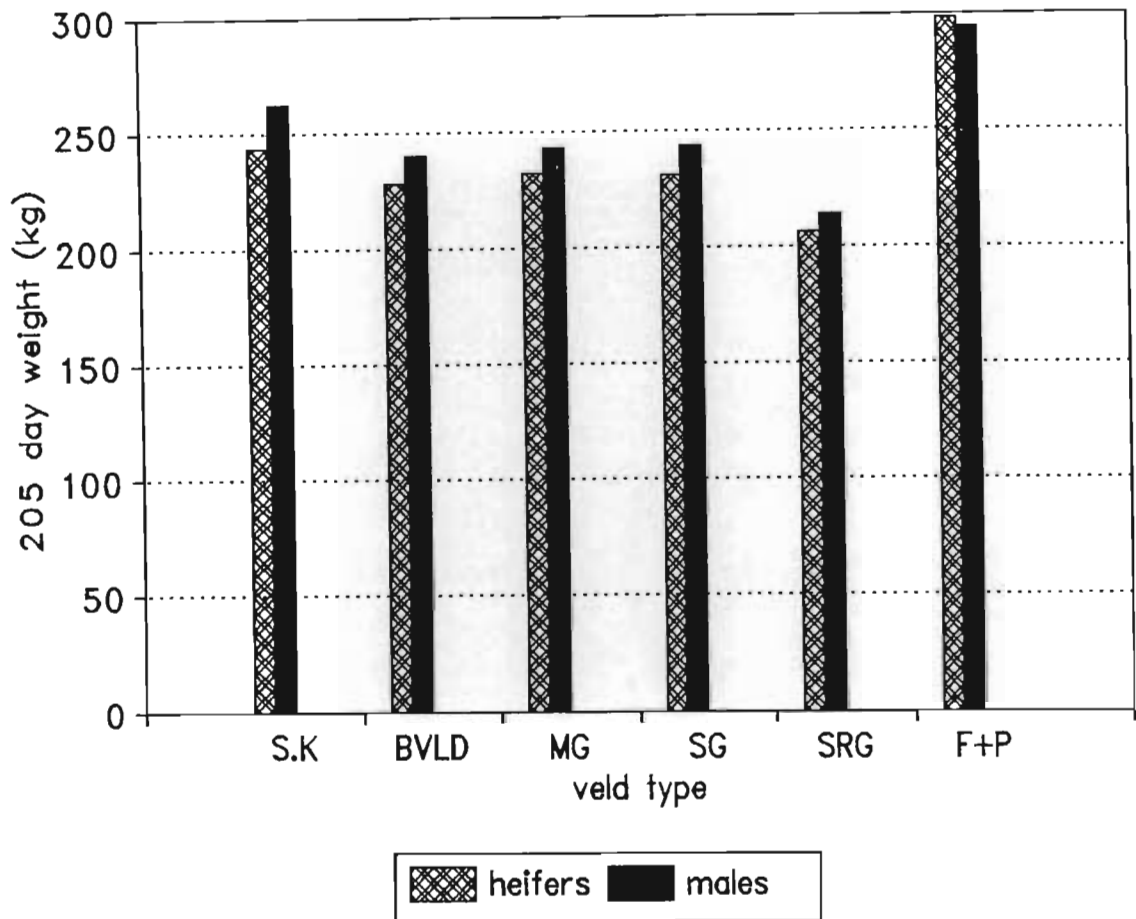
#### 2.3.5.2.1 *Interactions with sex*

Under the **extensive** system, the interaction of "sex of calf" and "vegetation", "sex of calf" and "age of dam", "sex of calf" and "season of birth" were not significant in affecting the weaning weight of calves. However, "sex of calf" and "year of birth" was highly significantly ( $P < .01$ , Table 5). The results indicate that the effect of sex calf is the same regardless of type of vegetation or nutrition, age of dam and season of birth, but is affected by the year of birth. The data in Figure 2, shows the interaction of sex and year in that production system. This interaction implies that growth of male calves was severely inhibited in 1992. This year was the least favourable year in this production system (Table 10).



**Figure 2** *Least-squares means for weaning weight of Simmental male and female calves born in 1992, 1993 and 1994 in the extensive farming areas.*

The results in Table 5, show that under the semi-extensive system of production, the interactions between, "sex" and "age of dam" and "sex" and "year" were not significant. This signifies that the effect of sex was the same irrespective of the age of dam that raised the calf or the year of birth of the calf. The interaction of year of birth and sex was probably eliminated by lick supplements in this production system. The magnitude of significance of the interaction between sex of calf and the veld type was very small ( $P < 0.1$ ). This is probably because the effect of sex was the same in most of the veld types, except in the combination of fynbos and pasture type of vegetation. The data in Figure 3 show this interaction. Since the heaviest calves of all ecosystems were produced here, the results could be indicating that the effect of sex can be reduced if there is high growth rate in heifer and male calves. However, this would be contrary to normal sex differences.



\*

*S.K =succulent karroo*  
*SG =sweetveld*

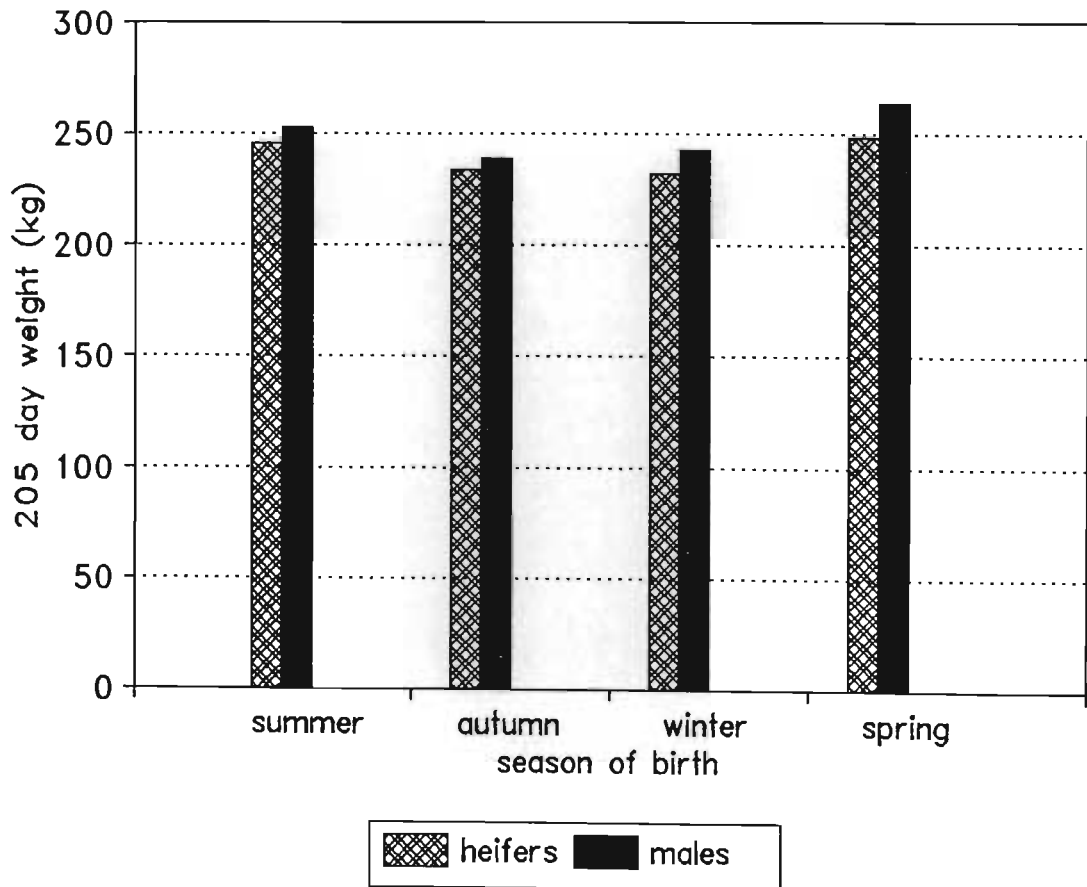
*BVLD =bushveld*  
*SRG =sourveld*

*MG =mixed grassveld*  
*F+P=fynbos and pasture*

**Figure 3. Least-squares means for weaning weight of Simmental male and female calves from different vegetation type in semi-extensive areas**

The interaction of sex and season was significant ( $P < .01$ ) for the Simmental calves from the semi-extensive type of production. The graph of this interaction (Figure 4) shows that the male calves born in spring had a higher growth rate than males born in any other season. The male calves born in autumn reflected a slower growth rate compared to the growth of calves in other seasons. The

least-squares means (Table 8) indicated that calves born in spring under this management system had the highest weaning weights and those born in autumn had the lowest weights. These results imply that if there is adequate nutrition for lactating cows, the suckling male calves grow faster than the heifer calves and if the cows do not obtain enough forage (autumn calving) for their milk production, the male calves are more affected than heifer calves. This could be explained by the difference of 14.8 kg between the heifer calves born in spring and in autumn and 25.1 kg between the males born in the same seasons (Figure 4).



*Figure 4 Least-squares means for weaning weight of Simmental male and female calves from different seasons of birth in the semi-extensive farming areas.*

Under the intensive production system, all interactions with sex were not significant (Table 7). This supports the conclusion that in this system of production, the effect of sex was the same regardless of vegetation type, year of birth or age of dam. This could be expected in this type of production because cows (and probably their calves at a late stage, just before weaning) are usually given extra feed and raised on pastures. They did not depend entirely on climatic conditions and veld type hence less fluctuation in production can be expected due to climatic conditions and veld type.

### **2.3.6 The Effect of Age of Dam on 205 Day Weight of Calves**

#### **2.3.6.1 Introduction**

Age of dam is a very important factor affecting the weaning weight of calves. Thus, differences in weaning weight have been found between calves raised by young dams and those raised by old dams (Leighton *et al.*, 1982). It has been noted that gains made by the calves of the young cows are much smaller than those of the mature and aged dams. It is important for the breeders to know the effect of the different ages of dams on their production, because :

- \* more creep feed may be required for calves from younger dams
- \* correction factors need to be made to adjust for the differences in production caused by different ages of dams. The calves can then be selected for their genetic worth.
- \* comparison between dams can be made, such that cows producing light calves at certain ages can be culled.

The aim of this section of study was to evaluate whether the age of dam had an influence on the weaning weight of calves and to determine the magnitude of the effect.

### 2.3.6.2 Results and discussion

The age-of-dam effect on weaning weight of Simmental calves was highly significant ( $P < .01$ ) (Tables 3,5,6 and 7). Table 3 reflects the analysis of variance for weaning weight of calves for all the Simmental data and Tables 5, 6 and 7 show the analysis of variance for each management system. The least-squares means for the different ages of dam from all Simmental data are shown in Table 13. The mature age of dam was found to lie between the 52 and 57 months. The age-of-dam effect in this data set was influenced by the different management systems, hence the following discussion is based mainly on the results after this effect of management was eliminated. Table 14 shows the "age of dam" least-squares means for weaning weight under each management system.

**Table 13 Least-squares means for weaning weight (kg) at different ages of dam for all Simmental data set**

Age of dam	no.of obs	Least-squares means	standard error
16 to 27mo	802	228.2	2.6 <sup>b</sup>
28 to 33mo	729	230.5	2.4 <sup>b</sup>
34 to 39mo	1150	233.2	2.2 <sup>b</sup>
40 to 45mo	574	240.5	2.2 <sup>a</sup>
46 to 51mo	962	243.9	2.4 <sup>a</sup>
52 to 57mo	508	245.7	2.8 <sup>a</sup>
58 to 117mo	4401	242.6	1.0 <sup>a</sup>
118mo+	672	240.0	2.6 <sup>a</sup>

<sup>a,b</sup> Subclass means followed by different superscripts are significantly different ( $P < .05$ )

*Table 14 Least-squares means (kg), for weaning weight at different ages of dam for each management system.*

Aod <sup>11</sup>	Extensive			Semi-extensive			Intensive		
	n	lsm	se	n	lsm	se	n	lsm	se
16-27mo	89	203.8	5.2 <sup>cda</sup>	472	227.5	2.4 <sup>fr</sup>	241	246.4	3.2 <sup>op</sup>
28-33mo	84	205.8	4.6 <sup>ca</sup>	453	234.0	2.3 <sup>fr</sup>	192	247.2	3.6 <sup>op</sup>
34-39mo	214	214.2	2.9 <sup>bca</sup>	735	241.9	2.1 <sup>dr</sup>	174	250.5	3.3 <sup>cofp</sup>
40-45mo	75	223.3	5.1 <sup>aba</sup>	346	245.1	2.6 <sup>cdr</sup>	153	255.6	3.9 <sup>bofp</sup>
46-51mo	223	228.3	3.2 <sup>ab</sup>	623	250.5	2.1 <sup>acr</sup>	116	262.4	4.3 <sup>abp</sup>
52-57mo	79	230.7	5.5 <sup>ab</sup>	323	252.8	2.7 <sup>abr</sup>	106	266.4	4.3 <sup>ap</sup>
58-117mo	906	226.5	2.7 <sup>ab</sup>	2875	257.5	1.5 <sup>ar</sup>	620	264.1	1.7 <sup>ap</sup>
118+mo	91	218.9	4.2 <sup>aba</sup>	456	246.5	2.4 <sup>bcdx</sup>	125	258.4	3.6 <sup>afp</sup>

<sup>a,b,c,d,e,f</sup>. Within a column, means followed by different superscripts are significantly different ( $P < .05$ ).

<sup>r,x,s</sup> Within a row, means followed by different superscripts are significantly different ( $P < .05$ ).

The means given in the Tables 13 and 14 for the eight age-of-dam classes follow the same pattern published in literature (Niemann & Heydenrich, 1965, Cundiff *et al.*, 1966a, Sellers *et al.*, 1970, Nelson & Kress, 1981). However, the results of this study show differences for mature age of dams within different beef production systems. The mature age of dam obtained from records for all the Simmental data was realised for cows between 52 and 57 months of age.

Dams in the extensive and the intensive systems of production reached a mature age earlier (between 52 and 57) months than the cows under the semi-extensive type of production system which reached their peak at 58 to 117 months of age (Table 14). According to Brown (1960) and Paterson *et al.* (1980) the age at

<sup>11</sup> Aod = Age of dam

which cows first calve and their breed, influence the age at mature production. Paterson *et al.* (1980) reported a peak production at 6 and 8 years for the Simmental cows managed under intensive production systems in South Africa, for cows had that started calving at 28 months of age. The cows used for analysis in this study started calving at 16 months. Nevertheless, the results from the semi-extensive management system agreed with those of Paterson *et al.* (1980), Nelson & Kress (1981) and Leighton *et al.* (1982).

Pell and Thayne (1978) suggested another possibility which could affect the age of maturity on cows. It was speculated that the effect of culling of less productive animals had the effect that most productive cows had an opportunity to have records in each ensuing age group. This could mean that cows that mature early are not due to age alone but to their inherent genetic make-up as well.

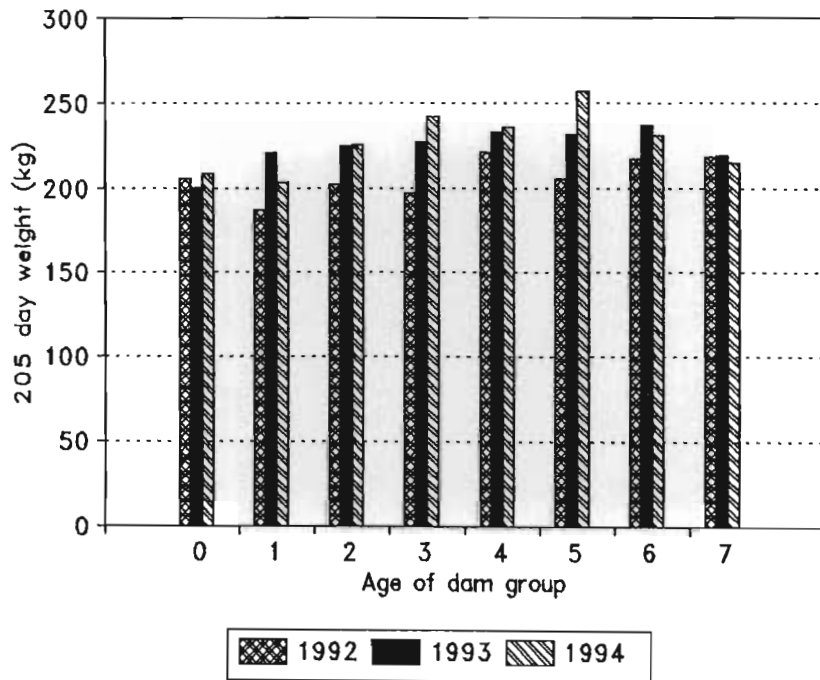
#### *2.3.6.2.1 Age-of-dam effect under the extensive management system*

The weaning weight of calves increased until the dams reached 52 to 57 month of age and thereafter a decline in production or growth rate occurred. Weaning weight of calves increased by 26.9 kg as the age of dam increased from 16 to 57 months. There was no apparent difference in weaning weight of calves from 16 to 27 months up to the 34 to 39 months old dams until the dams reached 40 months.

##### *2.3.6.2.1.1 Interactions with age-of-dam*

There was a significant interaction between the age of dam and year of birth ( $P < .05$ ), and between age of dam and season of birth ( $P < .01$ ). This indicates that the effect of age of dam on weaning weight of calves in the extensive management system can be influenced by the year of birth and season of birth. This is expected in this type of management because the climatic conditions are important for the growth of natural veld as well as the seasons determining the quantity and quality of grass of the veld. Figures 5 and 6 show the interaction between the age of dam and year and

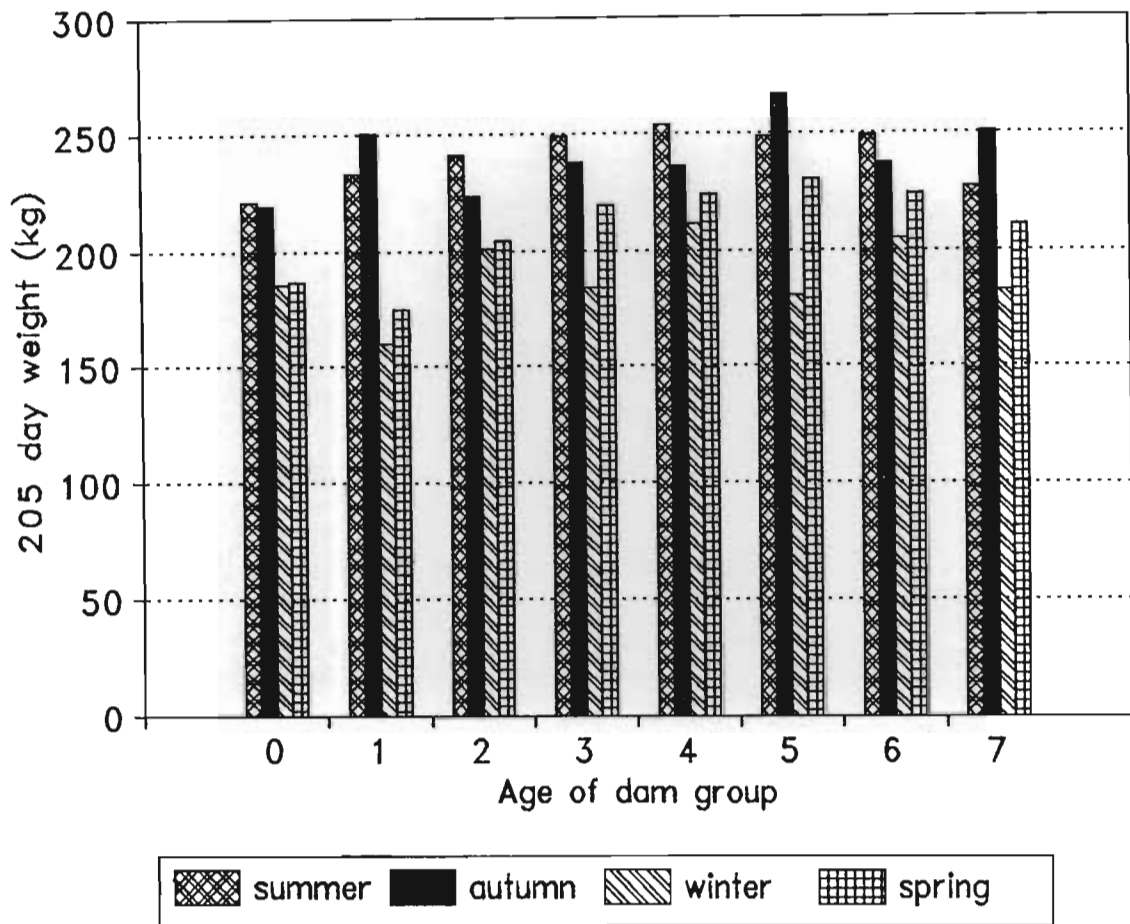
age of dam and season of birth, respectively. The results demonstrate that the same age group produced differently in different seasons. Even the highest producing age group of 52 to 57 months (group 5) had a low growth rate in the year 1992 (Figure 5) and in autumn (Figure 6)



\*

0=16-27months    1=28-33months    2=34-39months    3=40-45months  
 4=46-51month    5=52-57months    6=58-117months    7=118+months

Figure 5. Least-squares means for weaning weight of calves born in 1992, 1993 and 1994 from dams of each age



\*  
 0=16-27months    1=28-33months    2=34-39months    3=40-45months  
 4=46-51months    5=52-57months    6=58-117months    7=118+months

Figure 6. Least-squares means for weaning weight of calves born in at different seasons from dams at each age

The interaction between sex and age of dam was not significant. Thus, the effect of age of dam was the same regardless of the sex of calf. The result of this interaction is similar to that found by Minyard & Dinkel (1960), Swiger *et al.* (1962), Cunningham & Henderson (1965), Cundiff *et al.* (1966a), Cardellino & Fraun (1971), Kress & Webb (1972) and Leighton *et al.* (1982) who failed to record the interactions between age of dam and sex of the calf.

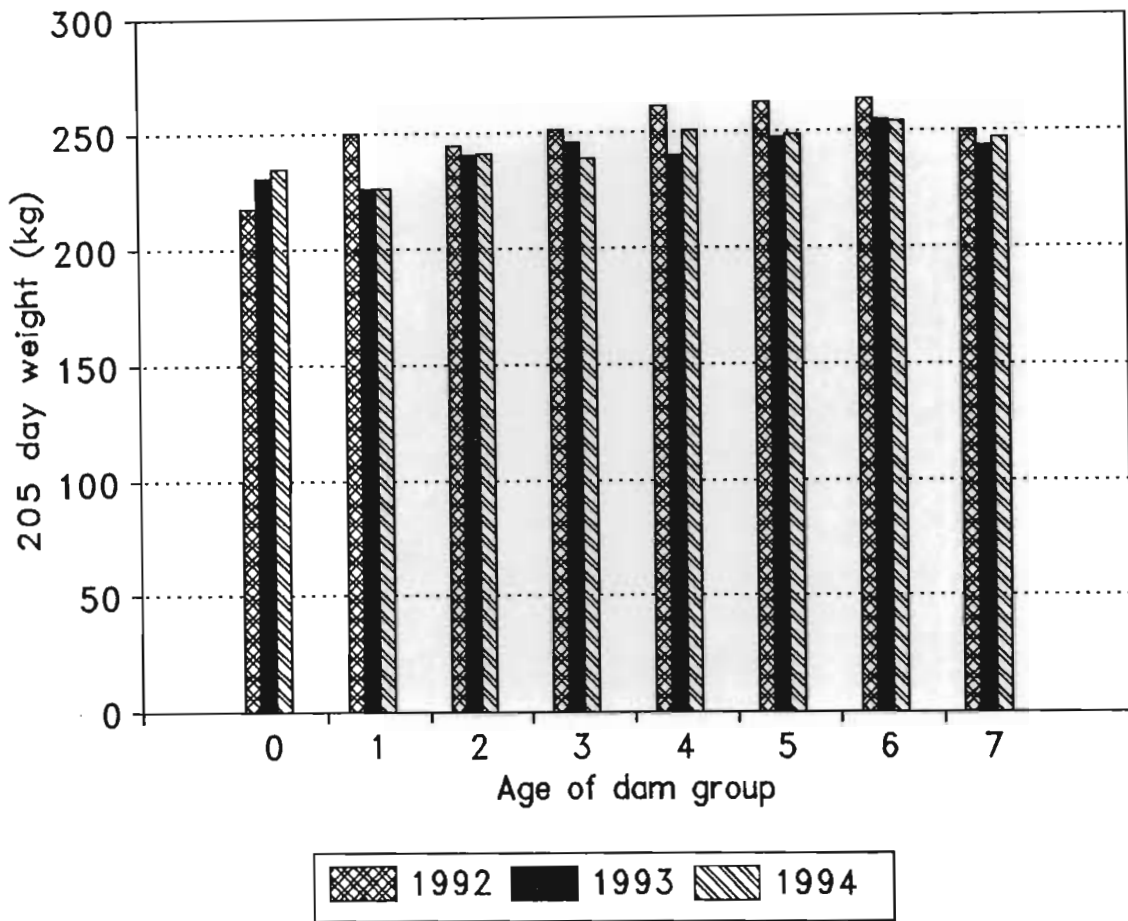
#### 2.3.6.2.2 Age of dam effect under semi-extensive management

Results in Table 14 show that weaning weight of calves increased with the increasing age-of-dam and reached a peak at the 52 to 57 month age-of-dam group and thereafter showed a decline. The weaning weight of calves increased at an increasing rate from cows of 16 months of age to 39 months. Thereafter, a decline in increase rate occurred until the highest production group. The highest significant difference in increase of 7.9 kg was observed between cows in the 28 to 33 month age group and the 34 to 39 month age group. The magnitude of decline in production between the highest producing group and the following group (118 month and above) was significantly large (11 kg).

##### 2.3.6.2.2.1 Interactions with age-of-dam.

The interactions that were found to be highly significant ( $P < .01$ ) were the age-of-dam and year and age-of-dam and season. The sex and age of dam interaction was not significant. The data in Figures 7 and 8 show the least-squares means for the age-of-dam and year and age of dam and season interactions.

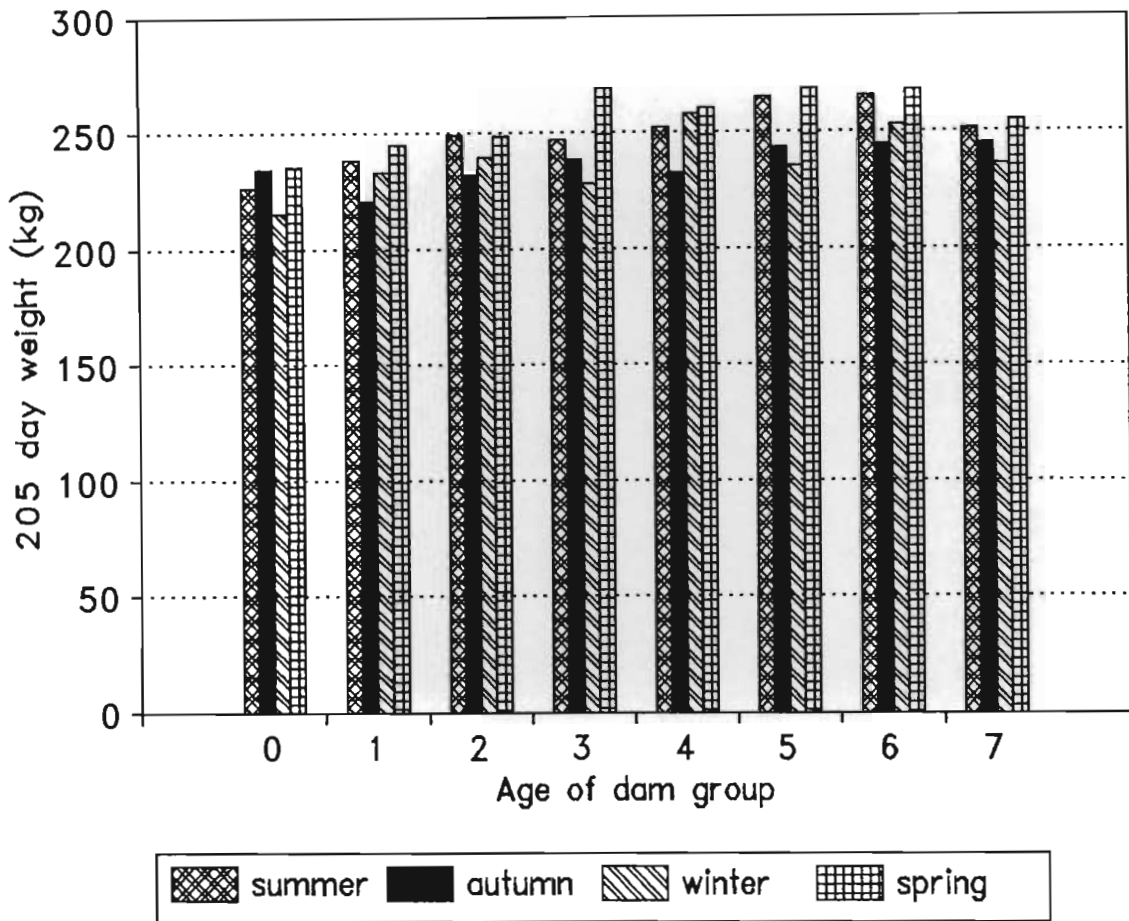
Clearly 1992, was the most productive year for most of the dams. However, the calves raised by the dams aged 28 to 33 months were severely affected in 1993 and 1994 (Figure 7). The dams aged 46 to 51 months produced heavier calves in winter, but thereafter a decline occurred for older cows (Figure 8). A different picture was obtained for dams aged 40 to 45 months. When these cows calved in spring heavy calves were produced whereas when they calved in winter, the calves had relatively light weights at weaning. A similar trend occurred for the dams of 28 to 33 months which calved in spring and those which calved in autumn.



\*

0=16-27months    1=28-33months    2=34-39months    3=40-45months  
 4=46-51months    5=52-57months    6=58-117months    7=118+months

Figure 7. Least-squares means for weaning weight of calves born in 1992, 1993, 1994 from dams of each age group



\*  
 0=16-27months    1=28-33months    2=34-39months    3=40-45months  
 4=46-51months    5=52-57months    6=58-117months    7=118+months

**Figure 8. Least-squares means of calves born in different seasons from dams of each age group**

#### 2.3.6.2.3 Age-of-dam effect under intensive management

The pattern of effect of age of dam was almost similar to that observed in the extensive management system. There was an increase in production until the peak was reached at 52 to 57 months of age (Table 14).

There was an increase of 20 kg in weaning weight of calves between the first calvers and the mature dams. This increase is 9.6kg less than the one for the dams from the extensive system of production. The smaller difference is probably because of the difference in quality of nutrients received by the dams in the two management systems. It would appear that if the dam receives more nutrients the age-of-dam effect is reduced compared to that seen in literature.

#### *2.3.6.2.3.1 Interactions with age-of-dam*

The effect of year of birth and age of dam, sex and age of dam was not significant in this production system. The results reflect that the effect of age of dam was the same, regardless of year of birth of calf and sex of calf. However, the effect of vegetation and age of dam was significant ( $P < .01$ ). This interaction probably reflects the effect of different management skills by farmers or perhaps different types of pastures grown. The results signify that the age-of-dam effect differs due to different levels of nutrition.

### **2.3.7 Correction Factors**

#### *2.3.7.1 Introduction*

Correction factors are the tool which is used by breeders and performance testing schemes to eliminate environmental variations which affect the identification of real genetic differences between animals. This section depicts the correction factors which appear to be appropriate from the data analysed.

#### *2.3.7.2 Results*

From this analysis, the magnitude of "sex of calf" and "age of dam" main effects on 205 day weaning weight of calves was large enough for adjustments to be needed in order to eliminate these environmental sources of variation under each management system. The interactions of age-of-dam and sex of calf were not significant under all the management systems. This shows that the adjustment

of weaning weight records for the Simmental breed are needed only for the overall effects of sex of calf and age of dam.

Correction factors in each management system, based on the least-squares means given in Tables 12 and 14, are presented in Table 15. After the application of adjustments, (age-of-dam followed by sex adjustment) weaning weight records will be corrected to a " male calf raised by a mature cow" basis.

The adjustment of weaning weight records for sex of calf differences are multiplicative, whereas the adjustment to remove age of dam differences is additive.

*Table 15 Sex of calf and age of dam weaning weight adjustment factors for the Simmental calves within each management system*

Effect	Adjustment factors		
	Extensive	Semi-extensive	Intensive
<b>Sex of calf (multiplicative)</b>			
Males	1.00	1.00	1.00
Heifers	1.05	1.04	1.07
<b>Age of dam (additive), kilograms</b>			
16 to 27 months	+26.9	+30.0	+20.0
28 to 33 months	+24.9	+23.5	+19.2
34 to 39 months	+16.5	+15.6	+15.9
40 to 45 months	+7.4	+12.4	+10.8
46 to 51 months	+2.4	+7.0	+4.0
52 to 57 months	0	+4.7	0
58 to 117 months	+4.2	0	+2.3
118 and up	+11.8	+11.0	+2.8

## 2.4 Environmental Factors and their Effects on the Hereford Breed

### 2.4.1 Productive system

#### 2.4.1.1 Results and discussion

The analysis of variance shown in Table 16 reflect that the type of management was not a significant factor influencing the variation in 205 day weight of calves.

**Table 16 Analysis of variance for 205 day weight of Hereford calves**

Source	DF	Seq SS	Adj SS	Adj MS	F	P
yr	1	186789	41380	41380	38.21	0.000
se	3	209694	100698	33566	31.00	0.000
sx	1	65510	16287	16287	15.04	0.000
mgt	2	209040	77	38	0.04	0.965
aod	7	57754	33142	4735	4.37	0.000
re	5	188440	156593	31319	28.92	0.000
yr*se	3	44849	24152	8051	7.43	0.000
yr*sx	1	1618	773	773	0.71	0.398
yr*mgt	2	18903	14118	7059	6.52	0.002
yr*aod	7	17264	12408	1773	1.64	0.121
yr*re	5	12957	25779	5156	4.76	0.000
se*sx	3	3686	5727	1909	1.76	0.153
se*mgt	6	159785	140415	23402	21.61	0.000
se*aod	21	38942	38866	1851	1.71	0.024
sx*mgt	2	3474	3184	1592	1.47	0.230
sx*aod	7	8433	7977	1140	1.05	0.393
sx*re	5	2661	2661	532	0.49	0.783
Error	1643	1779269	1779269	1083		
Total	1724	3009068				
R <sup>2</sup>	-	-	-	40.87		

The least-squares means for the weaning weight of calves under each management system are presented in Table 17. The performance of the calves was almost the same in the three systems.

**Table 17 Least-squares means for weaning weight in three management systems**

Management	Least-squares means (kg)	standard error	no. of obs.
Extensive	195.8	2.3 <sup>a</sup>	887
semi-extensive	196.9	3.3 <sup>a</sup>	502
Intensive	197.0	4.4 <sup>a</sup>	336

<sup>a,a,a</sup> Means followed by similar superscripts are not significantly different.

The results probably indicate that breeders whose livestock depend on natural veld, to satisfy the nutrient requirements of their livestock throughout the year, are adopting systems of veld management.

## 2.4.2 Veld type

### 2.4.2.1 Results and discussion

Veld type was a highly significant ( $P < .01$ ) factor (Table 16). The results indicate that the mixed and sweet grassveld areas have a good nutritional basis for raising Hereford calves (Table 18). The mean difference in production between these veld types and the lowest producing pasture and sourveld combination was approximately 47kg. This agrees with the observation made by Tainton (1988) that the mixedveld and the sweetveld are primarily suited to the breeding and fattening of cattle. Calves raised on pastures were smaller on average by 25.1 and 18 kg than calves in the sweet and mixed grassveld, respectively. Calves raised on both pastures and sourveld combined had the lowest production. These results could imply that an improvement may be necessary on the pastures. A higher production would be expected on calves raised on pastures than on veld.

**Table 18** *Least-squares means for weaning weight (kg) of Hereford calves from different veld types*

Veld type	least-square means	standard error	no. of obs.
suc.karroo	188.1	5.2 <sup>c</sup>	85
mixed grassveld	211.5	3.2 <sup>a</sup>	289
sweet grassveld	218.6	3.7 <sup>a</sup>	317
sourveld	199.3	3.9 <sup>bc</sup>	263
pasture	193.5	2.5 <sup>bc</sup>	606
pasture+sourveld	168.5	4.2 <sup>d</sup>	165

<sup>a,b,c,d</sup> Means followed by different superscripts are significantly different ( $P < .01$ ).

### 2.4.3 Season of birth

#### 2.4.3.1 Results and discussion

The season of birth effect was highly significant ( $P < .01$ ), on weaning weight of calves. Calves born in **autumn** and **winter** weaned heavier than those born in **summer** and **spring** (Table 19).

**Table 19** *Least-squares means for weaning weight (kg) of Hereford calves born in different seasons*

season	least-squares means	standard error	no. of obs
summer	180.2	4.5 <sup>c</sup>	196
autumn	215.1	2.9 <sup>a</sup>	352
winter	202.9	3.1 <sup>b</sup>	373
spring	188.2	2.4 <sup>c</sup>	804

<sup>a,b,c</sup> Means followed by different superscripts are significantly different ( $P < .01$ )

These results (Table 19) might indicate that Hereford calves can withstand cold weather. Sellers *et al.* (1970) found that Hereford calves born in late fall and early winter grew faster than Angus calves born in the same seasons. They observed that the Angus calves born in spring and summer grew better than Hereford calves born within this period. They maintained that the Hereford calves have the ability to withstand severely cold weather whereas the Angus calves are better able to withstand heat and humidity.

#### 2.4.3.1.1 Interaction between season of birth and management system

The results shown on Table 16 reflect that the interaction between season of birth and the type of production system was highly significant ( $P < .01$ ). The effect of season on weaning weight of calves was affected by the different management systems. The least-squares means (Table 20) show that the calves born in summer, under the semi-extensive and intensive systems, were affected more by season of birth than all the other calves. However, calves born in autumn in the semi-extensive system showed higher weights than in any other system of production.

**Table 20** Least-squares means for weaning weight (kg) of Hereford calves born at different seasons from different management systems

season	n	Extensive		Semi-extensive			Intensive		
		lsm	se	n	lsm	se	n	lsm	se
summer	84	186.6	4.6 <sup>be</sup>	98	169.0	5.8 <sup>cf</sup>	14	184.9	10.1 <sup>ceg</sup>
autumn	213	189.9	3.2 <sup>bg</sup>	48	246.6	6.5 <sup>ae</sup>	91	208.4	5.1 <sup>af</sup>
winter	108	212.9	4.1 <sup>ae</sup>	143	189.1	4.4 <sup>bf</sup>	122	206.7	4.9 <sup>ae</sup>
spring	482	193.6	2.3 <sup>bf</sup>	213	182.8	3.6 <sup>be</sup>	109	188.3	4.8 <sup>bef</sup>

<sup>a,b,c</sup> Within a column, means followed by different superscripts are significant ( $P < .05$ ).

<sup>e,f,g</sup> Within a row, means followed by different superscripts are significant ( $P < .05$ ).

The conclusions made on this observation would not be reliable because of the limited numbers of observations. For instance, the highest producing season of birth (autumn in the semi-extensive production system) had only 48 observations and the standard deviation was quite large. Similarly, the number of calves born in summer that occurred in the intensive management system subclass was only 14 and a large deviation (+ or -10.13 kg) from the mean. The number of observations in spring (under the extensive management) was 482, which was very large when compared to the remaining observations in this system. More data would be needed to evaluate this interaction as most of the results could be affected by a single good or bad herd.

#### 2.4.4 Year of birth.

##### 2.4.4.1 Results and discussions

The weaning weight of Hereford calves was highly affected by the year of birth ( $P < .01$ ). Calves born in 1993 weighed 22.4 kg heavier at weaning than the calves born in 1992 (Table 21). This could be due to fluctuations of average annual rainfall between these 3 years of birth of calves.

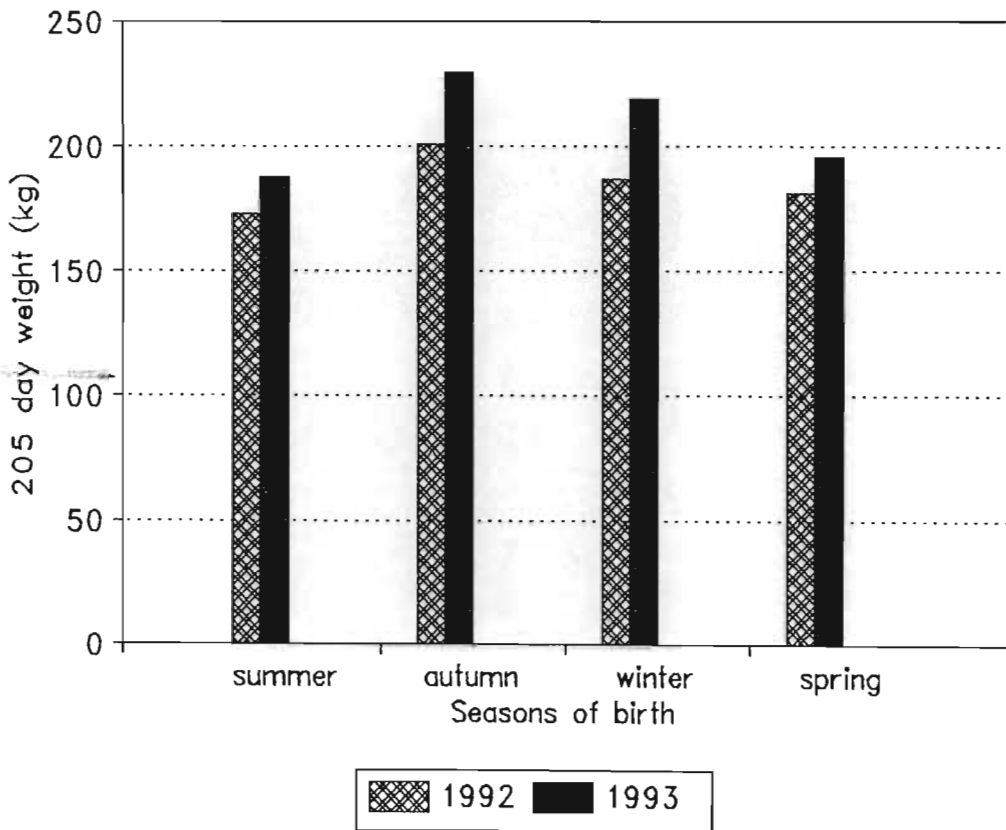
Table 21 Least-square means for weaning weight (kg) of Hereford calves born in 1992 and 1993

Year of birth	least-squares means	standard error	no. of obs
1992	185.4	2.9	823
1993	207.8	2.6	902

##### 2.4.4.1.1 Interactions with year of birth

The year-of-birth and season-of-birth interaction was highly significant ( $P < .01$ ) on weaning weight of Hereford calves. The means shown in Figure 9, reveal that all calves born in 1993

weighed heavier than calves born in 1992 for all seasons. However, the results indicate that even though calves born in 1992 were lighter than calves born in 1993, the effect of season of birth was an important factor in Hereford calves. This was because there was a similar trend of production among the seasons of birth in both years. Even though calves born in 1993 generally weaned heavier than those born in 1992, those born in autumn and in winter weaned heavier than the calves born in spring and summer in both years.

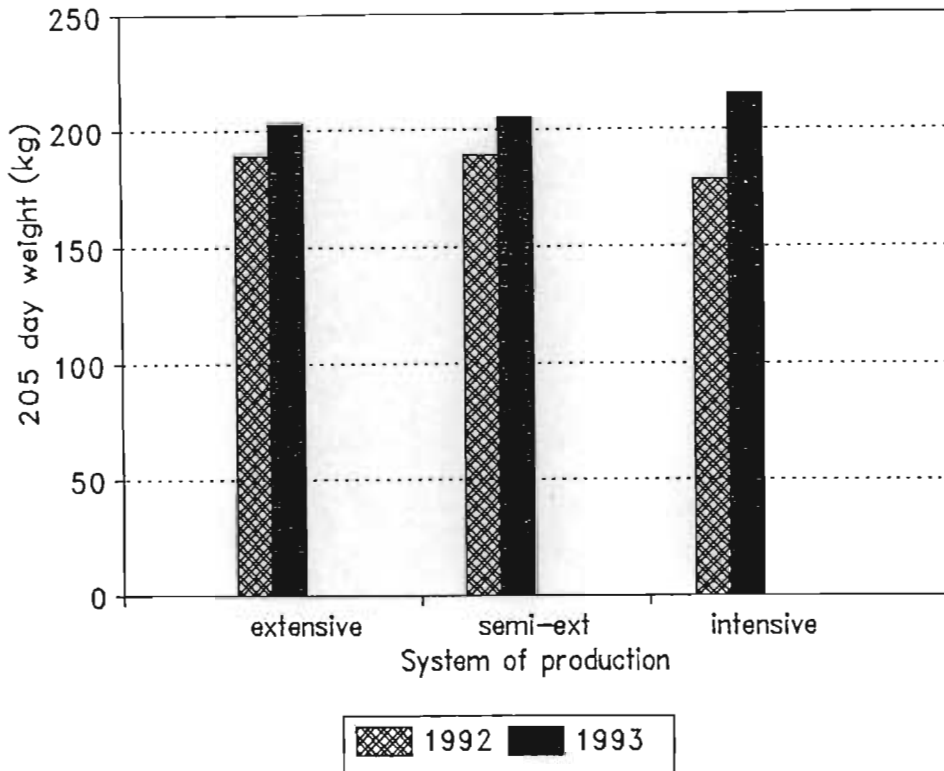


**Figure 9** *Least-squares means for weaning weight of calves born in 1992 and 1993 at different seasons*

The magnitude of the difference in weaning weight was 14.2 kg between the weight of calves born in the summer of 1993 and those born in the summer of 1992. A similar difference was found in weight of calves between the two years but, born in spring. These

results suggest that the larger differences between the years in weight of calves born in autumn and winter was mainly due to the decrease in growth rate that was experienced by the calves in 1992. In a good year calves born in autumn and winter grew even faster. The smaller difference in weight of calves born in summer and in spring between the two years may have been due to a decreased growth as a result of both unfavourable seasons of birth and year-of-birth effects.

The interaction between **year-of-birth** and **type of management system** was highly significant ( $P < .01$ ). The weaning weight of calves born in 1992 was less than for the calves born in 1993 in all the production systems (Figure 10). Calves born in 1992 and raised under the **intensive** system weaned a mean of 37 kg less than the calves born in 1993 and raised under the same system. This difference was 2.3 and 2.7 times larger than the difference in weaning weight of calves born in 1992 and 1993 under the extensive and semi-extensive systems, respectively. The results indicate that calves raised under the intensive system were affected more by the year (1992) than the calves from other systems of production.



**Figure 10** Least-squares means for weaning weight (kg) of calves born in 1992 and 1993 under different systems of management

The interaction between veld type and year of birth was highly significant ( $P < .01$ ). Calves born in 1993 weighed more than those born in 1992 in most the veld types, except in the combination of pasture and sourveld. The highest mean differences in weaning weight of calves between the two years of birth was seen in calves born on the mixed, succulent karroo and sour veld grassveld with the difference of 37.9, 33.4 and 29.3kg, respectively (Table 22). The results reflect the ability of the sweetveld and the mixedveld to sustain breeding cattle. Even though 1992 was not a good year the calves weaned in the sweetveld were heavier than those from most veld types.

**Table 22** Least-squares means for weaning weight (kg) of Hereford calves born in 1992 and in 1993 at different veld types

Veld type	Year of Birth					
	1992			1993		
	n	lsm	se	n	lsm	se
succulent karroo	59	171.4	6.7 <sup>cdg</sup>	26	204.8	7.8 <sup>bct</sup>
mixed grassveld	63	192.6	5.0 <sup>abg</sup>	226	230.5	3.7 <sup>af</sup>
sweet grassveld	177	207.1	5.6 <sup>ag</sup>	140	230.1	4.6 <sup>af</sup>
sour grassveld	157	184.7	5.8 <sup>bdg</sup>	106	214.0	5.2 <sup>bf</sup>
pasture	286	185.9	3.6 <sup>bcg</sup>	320	201.1	3.2 <sup>cf</sup>
pasture + sourveld	81	170.7	5.4 <sup>df</sup>	84	166.2	5.5 <sup>df</sup>

<sup>a,b,c,d</sup> Within a column, means followed by different superscripts are significantly different ( $P < .05$ ).

<sup>1,2</sup> Within a row, means followed by different superscripts are significantly different ( $P < .05$ ).

#### 2.4.5 Sex of calf

##### 2.4.5.1 Results and discussion

The sex of the calf was highly significant ( $P < .01$ ) on the weaning weight of the Hereford calves. The means in Table 23 show that males were on average 13.2kg heavier than heifers. This difference is within the range of 10 to 21 kg between Hereford males and heifers found by Evans et al. (1955), Knifer (1959), Pell & Thayne (1978), Nelson & Kress (1981) and Leighton et al. (1982).

**Table 23** Least-squares means for weaning weight of Hereford males and heifers

Sex of calf	least-squares means	standard error	no. of obs
heifers	190.0	2.6	844
males	203.2	2.7	881

#### 2.4.5.1.1 Interactions with sex of calf

The interactions between the sex of calf and year of birth, sex of calf and season of birth, sex of calf and type of production system, sex of calf and age-of-dam and sex of calf and the type of veld all had no significant effect on the weaning weight of calves (Table 16). This implies that the effect of sex of calf was the same regardless of the these environmental influences.

#### 2.4.6 Age of dam

##### 2.4.6.1 Results and discussions

The age of dam effect on weaning weight was significant ( $P < .01$ ). Examination of the least-squares means (Table 24) indicate that weaning weight of calves increased by 20.4kg as the cows aged from 22 months to a mature age, (between 72 and 95 months). Pell & Thayne (1978) and Leighton *et al.* (1982) found this difference to be 24 and 28 kg, respectively between Hereford cows, which is in line with this study.

*Table 24 Least-squares means for weaning weight of calves at different ages of dams*

Age-of-dam	least-squares means	standard error	no. of obs
22-27 months	184.8	5.1 <sup>e</sup>	101
28-35 months	190.6	3.7 <sup>d,f,c,e</sup>	165
36-47 months	196.3	2.6 <sup>bc</sup>	326
48-59 months	197.6	2.6 <sup>bd</sup>	317
60-71 months	202.0	2.8 <sup>ab</sup>	259
72-95 months	205.2	2.6 <sup>a</sup>	327
96-119 months	201.3	3.7 <sup>ab</sup>	165
120-185 months	197.5	6.6 <sup>abr</sup>	65

<sup>a,b,c,d,e,f</sup> Means followed by different superscripts are significantly different ( $P < .05$ ).

#### 2.4.6.1.1 Interactions with age of dam

Table 16 shows that the interactions between **age-of-dam** and **year of birth and sex and age of dam** did not significantly affect the weaning weight of calves. This indicates that the effect of age of dam was the same irrespective of the sex of calf or the year of birth. However, the interaction between **season of birth and age of dam** was significant ( $P < .05$ ) which could imply that the effect of age of dam on weaning weights of calves was affected by the season of birth.

The results in Table 25 suggest that there was no significant difference in weaning weight of calves born in summer by dams of different ages. However dams of 60 to 71 months and 72 to 95 months showed significant weaning weight differences of calves born between the four seasons. In these dam age groups, calves born in autumn weaned the heaviest weights (215.1kg) followed by those born in winter (202.9kg), spring (188.2kg) and those in summer (180.2kg). Even though the effect of age of dam was not the same in all the seasons, the means indicate that in most cases, cows that calved in summer and in spring did not produce as well as those that calved in autumn and winter. However, conclusion made on this effect can be biased because of the number of observations, especially in the summer and winter peak production age groups. It seems that this interaction was affected by the small number of observations found in each subclass. It is thus not a good representation of how season of birth and age of dam interact to affect weaning weight of Hereford calves.

Table 25 least-squares means for weaning weight of calves born in different seasons under different veld types

	Season of birth											
	summer			autumn			winter			spring		
Aod	n	lsm	se	n	lsm	se	n	lsm	se	n	lsm	se
22-27mo	15	175.9	9.6 <sup>ap</sup>	17	193.3	8.6 <sup>dep</sup>	6	192.9	13.8 <sup>adp</sup>	63	177.1	5.1 <sup>ep</sup>
28-35mo	13	162.7	10.1 <sup>ar</sup>	29	223.5	6.9 <sup>acp</sup>	62	188.8	4.7 <sup>bdq</sup>	61	187.3	4.7 <sup>abeq</sup>
36-47mo	44	181.9	5.9 <sup>ar</sup>	50	216.6	5.1 <sup>bcp</sup>	87	202.9	4.1 <sup>aq</sup>	145	183.9	3.4 <sup>bcer</sup>
48-59mo	44	176.9	5.8 <sup>ar</sup>	62	213.9	4.5 <sup>cp</sup>	62	199.7	4.6 <sup>bcdq</sup>	149	189.0	3.3 <sup>bcqr</sup>
60-71mo	31	174.9	6.6 <sup>as</sup>	57	232.3	4.8 <sup>ep</sup>	59	206.7	4.8 <sup>acq</sup>	112	194.2	3.6 <sup>abr</sup>
72-95mo	34	183.5	6.2 <sup>as</sup>	78	226.0	4.2 <sup>abp</sup>	56	213.1	4.8 <sup>aq</sup>	159	198.3	3.3 <sup>ar</sup>
96-119mo	12	187.6	10.2 <sup>apq</sup>	40	222.8	5.9 <sup>acp</sup>	29	200.7	6.6 <sup>adq</sup>	84	194.2	4.3 <sup>acdq</sup>
120-185mo	3	197.9	20.3 <sup>apq</sup>	19	192.1	8.3 <sup>ep</sup>	12	218.4	10.0 <sup>apq</sup>	31	181.8	6.6 <sup>bdq</sup>

<sup>a,b,c,d,e</sup> Within a column, means followed by different superscripts are significant ( $P < .05$ )

<sup>p,q,r,s</sup> Within a row, means followed by different superscripts are significant ( $P < .05$ )

## 2.5 Correction Factors

### 2.5.1 Results

The analysis of variance in Table 16, indicates that only sex of calf and age-of-dam significantly influenced the variation in weaning weight of calves for the Hereford breed. The interaction of sex of calf with age of dam was of minor importance, hence the correction factors were made for the overall sex of calf and age of dam. The correction factors developed for the Hereford breed in this study, based on the least-squares means in Tables 22 and 23 are given in Table 26. Table 27 shows the adjustment factors proposed by Leighton et al. (1982) for the Hereford calves in the United States.

**Table 26** Sex of calf and age-of-dam weaning weight (kg) adjustment factors for the Hereford calves

Effect	Correction factors		
	This study	Leighton et al. (1982)	
<b>Sex of calf (multiplicative)</b>			
males	1.00	males	1.00
heifers	1.07	heifers	1.10
<b>Age of dam (additive), kg</b>			
22 to 27 months	+20.4	22 to 27mo	+24
28 to 35 months	+14.6	28 to 35mo	+18
36 to 47 months	+8.9	36 to 47mo	+11
48 to 59 months	+7.6	48 to 59mo	+5
60 to 71 months	+3.2	60 to 71mo	+2
72 to 95 months	0	72 to 95mo	0
96 to 119 months	+3.9	96 to 119mo	+2
120 to 185 months	+7.7	120 to 143mo	+6
		144mo and up	+12

### GENERAL CONCLUSIONS

The following conclusions were drawn from this study

1. Simmental cows raised in the extensive production system appear to need to supplements in order to increase their growth performance.

2. The sourveld does not seem to be a good veld type for Simmental beef production. Breeders on this veld should rather grow pastures, as the results indicate that even where licks are normally given they do not provide enough for the imbalances realised by cows and consequently the performance of their calves is affected as seen by 205 day weaning weight.

3. Spring and summer are the best seasons for calving Simmental cows. Perhaps all the breeders should attempt to schedule their breeding season such that their cows can calve at these times. This can also decrease the costs of supplements which seem to be required especially if calves are to be born in winter.

4. The mixed and sweet grassveld are best for raising Hereford calves on natural veld.

5. Autumn and winter are the best calving seasons in terms of weaning weight for Hereford calves, regardless of system of production.

6. Correction factors for the Simmental breed should be developed within management systems.

7. The correction factors developed for the Simmental and Hereford show a similar trend to those that have been developed by other investigators.

8. Correction factors that have been developed in this study may not properly correct records when used by individual producers because they are obtained from records collected across South Africa. Producers with large herds may have to develop "within herd" adjustments based on their own data.

9. The models derived for the Simmental breed accounted for 22.65% of variation in weaning weight before the data were split into the different management systems. It accounted for 30.8%, 22% and 18.4% in the extensive, semi-extensive and intensive management systems, respectively. The model for the Hereford breed accounted for 40.87% of variation in weaning weight of the calves. The percentage not accounted for would include other unmeasured and unknown sources.

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