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## The effect of pre-calving and post-calving nutritional regimes on calf birth weight and pre-weaning growth

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### ABSTRACT

Numerous studies with New Zealand beef cattle have been carried out to determine responses of live weights or reproductive/survival traits to changes in the level of nutrition, at various stages during the annual production cycle. Various studies have also been carried out to describe how much of the variation for these traits of the cow or calf is genetic. This brief summary explores the possibility that some of these cattle data could be re-evaluated because of their possible relevance and analogies to current medical questions of interest.

**Keywords:** growth; nutrition; cow; calf; genetics; medical analogy.

### INTRODUCTION

Large experiments have been carried out with beef cattle by AgResearch and its predecessors to investigate responses of cows or calves to differing nutritional regimes, and to determine what genetic components of the same response traits may be changed when applying traditional selection techniques. Over the years, large data banks have been built up as a result of these studies, and most of the results have been published in peer-review and/or farmer articles. The focus for these 'animal production' research has been in providing short-term managerial and nutritional advice to the farmer, and in providing longer-term advice and information to the seedstock industry on animal breeding and genetics. However, in recent discussions with the medical research community, it has become clear that some of these large databases may also provide information of relevance to current medical research areas, if different questions were to be asked of existing data sets. We have reviewed examples of some of our animal production findings which may be relevant to medicine today, comprising nutritional and genetic effects, and these are described below.

### RESULTS

#### Nutritional effects

The life of a beef breeding cow is governed by the seasonal nature of the pasture feed supply. The gestation length of a cow is about 282 days, leaving only 83 days for her to conceive if the annual production cycle is to be maintained. Conception and milk production are energy demanding processes and it is usual for the farmer to time calving for the spring, when pasture is abundant and of good quality. This means that late gestation coincides with the winter when pasture production is low and therefore feed costs are high.

For this reason research into beef cow nutrition has examined varying the plane of nutrition over the last trimester of pregnancy. The focus has been on defining

the most nutritional strategy that will ensure good production from the cow and the calf while making the most efficient use of scarce pasture feed resources. There have been a large number of trials conducted (e.g., Hight, 1968; Nicoll, 1979; Pleasants and Barton, 1985). The conclusions are that in mature cows it requires severe nutritional restriction over the last trimester of pregnancy to affect calf birth weight. If nutrition after calving is good (as it should be in spring when there is a rapidly increasing feed supply) there do not appear to be any adverse effects to the cow or calf of restriction over the last trimester. Current recommendations to farmers are that mature beef cows in good condition in the autumn can lose 10% of their live weight up to 3 weeks before calving without adverse effect. When the plane of nutrition of cows on restricted feeding is increased over the last trimester of pregnancy, this appears to increase the weight of the foetal membranes, but does not affect the weight of the calf (Pleasants and Barton, 1992).

While *nutritional* effects over the first and second trimester of pregnancy have not been investigated as fully, there is a great deal of data collected on the live weights and cow condition scores over this period. This might be analysed with medical implications in mind. Similarly, the results of early pregnancy nutrition on calf survivability have not been a subject of investigation, since the issue is less important economically in animal production. Some general points are known, as described below.

Calf survivability is affected by maternal over-nutrition (Pleasants and Barton, 1992), particularly in young cows (Anderson *et al.*, 1981), or by severe under-nutrition before calving (Hight, 1968). Cows that are very well fed until about 3 weeks before calving, followed by pre-calving under-nutrition, appear to be particularly vulnerable. Morris *et al.* (1986) reported U-shaped graphs showing that mortality was high in calves born with either low or high birth weights.

There is evidence that beef cows adapt over time to periods of winter under-nutrition, becoming more resistant to liveweight loss (Hughes *et al.*, 1978).

Whether this effect has any metabolic basis or is due to cows becoming more efficient foragers willing to eat a wider variety of plants (rushes, manuka etc.) is still open to debate. However, it has been observed that cows undergoing winter under-nutrition and liveweight loss have increased longevity (Pope, 1967). Avoiding having cows in fat condition appears to result in lower losses due to 'metabolic diseases' (hypomagnesaemia, milk fever) (e.g., Baker and Gould, 1976).

For cows run in the same herd over a lifetime, the degree of liveweight loss from cow to cow is repeatable (e.g., an average  $r$  value = 0.57; Pleasants *et al.*, 1994), and larger cow liveweight losses are positively correlated with subsequent calf production measured as weaning weight (average  $r$  value = 0.35). There is evidence that cows with higher milk production have higher maintenance requirements due to a higher metabolic rate (Ferrell and Jenkins, 1985). These observations support the hypothesis of different metabolic rates between cows being reflected in the performance of the progeny.

Long-term nutritional effects were investigated in a trial run over 4 years by Smeaton *et al.* (2000). This showed that Hereford x Friesian cows placed on different planes of nutrition as heifers attained different mature live weights, and this affected calf birth weight and calf weaning weight. Anderson *et al.* (1985) showed that in first-calving 3-year-old heifers the environment over the first 2 years of life, resulting in heavier cows at calving, had an effect on calf birth weight and calf weaning weight. However this effect did not occur in the second calving when the live weights of the cows were the same. But Anderson *et al.* (1981) noted a nutritional effect over the last trimester of pregnancy for calf birth weight in first calving Angus heifers, and this effect on birth weight was measurable in the second calving, a year later.

The data used by Pleasants and Barton (1992) to establish that there was little effect of nutrition in the last trimester of pregnancy was re-examined to test for an effect of first-trimester pregnancy weight change on subsequent calf birth weight (fitting cubic spline polynomials to the series of live weights for each cow, with 2 knot points placed between the first two trimesters and between the last two trimesters of pregnancy, and from these spline polynomials the liveweight change could be calculated for a cow at any time). When correlated with subsequent calf birth weight, a significant ( $P < 0.05$ ) relationship existed between cow liveweight change around one month after conception and calf birth weight. Cows which gained more liveweight at this time gave birth to lighter calves ( $b = -0.29 \pm 0.12$  kg birth weight/kg cow liveweight change). Male calves were more strongly affected than female calves. Possibly cows gaining liveweight diverted nutrient and energy resources away from the foetus at this critical time.

#### Genetic effects also influencing growth

Brinks *et al.* (1964) showed in an early American study that differences in the mature weight of animals

were associated with differences in their birth weight. Similarly in New Zealand, Baker *et al.* (1986) were able to use birth weight to predict differences in yearling live weight, a weight which may be of interest to the medical profession because in cattle it is close to when puberty is reached. Yearling weight increased by 2.56 kg for each kg heavier at birth (after adjustment for gender differences and known dam effects); alternatively, yearling weight increased by 0.38 % of its mean for each % increase in birth weight. Just over a third (36%) of this covariance between birth and yearling weight was genetic in nature.

Morris *et al.* (2000) estimated the genetic variation in age and weight of heifers at puberty and showed that almost one third of the differences among heifers in age at puberty are genetic. Morris *et al.* (2000) also calculated genetic correlations between birth weight and puberty traits. The genetic correlation between birth weight and age at puberty was 0.21 for direct effects and -0.46 for maternal effects.

Baker *et al.* (1990) have reported on genetic variation in gestation length, in a comparison of 11 breeds for many traits of the calf or the cow, with 4500 calving records. Gestation length was highly heritable (value 0.48); there were genetic correlations between gestation length and other traits as follows: calf survival to 48h after birth (-0.46), calf survival to weaning at 4 months (-0.23), and birth weight (0.41), indicating that half of the differences in gestation lengths (single births) are heritable and some of these differences are associated with critical traits of the calf.

Morris *et al.* (1992) published the results of a trial to examine the long-term effects of selection for yearling weight or 18-month weight using 2294 calves born between 1975 and 1988. The average live weight of the selected lines increased, as did food intake. However seasonally the differences between the selection and control groups was considerably reduced in the spring, and this was thought to be associated with differences in body composition. Weight-selected cows were buffered in a different way from controls, losing relatively more weight in spring and gaining it back in autumn.

## CONCLUSIONS

These beef cattle results show only just a sample of the data available and the purposes for which they have been analysed. Firstly, there may be other types of analyses possible on the same data, in order to follow-up medical questions. Secondly, with large herds of beef cows still being maintained on AgResearch farms, and it is also possible that small increases in the number/type/frequency of traits recorded in future may help provide answers to current medical questions.

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