Proc 8th Annual Seminar, Society of Sheep & Beef Cattle Veterinarians NZVA, 1978 © VetLearn® Foundation (NZ) 2003

Perinatal Mortality and Deaths to Weaning in Beef Cattle

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Summary

Calf mortality represents a major loss to the New Zealand beef industry. Estimates range from 7-13 calf deaths per 100 cows mated. The majority of calf deaths occur within the first two weeks of life, two thirds occurring in the first 24 hours. In one study, dystocia, enteric diseases and starvation resulted in 64, 13 and 10 percent of deaths respectively.

First calving heifers experienced a higher incidence of dystocia and calf mortality, and factors causing dystocia are more important in this group. The two most important contributing factors are size of the calf and size of the pelvis. However, it is difficult to predict dystocia and calf mortality.

In beef cattle run in extensive conditions, an increased plane of nutrition in late pregnancy is unlikely to increase dystocia. Severe nutrition restriction may delay subsequent conception and increase calf mortality.

Introduction

Calf deaths from around the time of birth through to weaning represent a major loss to the beef breeding industry. This paper considers the extent of the losses occurring in New Zealand and draws on overseas information to discuss the major causes of calf death.

Incidence and Causes of Calf Mortality

Information on the reproductive performance of New Zealand beef cattle is summarised in Table 1. Data from Tara Hills High Country Research Station were taken from 1,200 mating records of Angus, Hereford and Friesian cows collected from 1969-1976 (unpublished results). Cow mortality from mating to calving includes cows culled from the herd at weaning. The main reason for culling was failure to wean a calf in two successive years

Data from Hanly and Mossman (1977) differ because cow mortality is quoted for the entire year. Losses due to barren cows and calf mortality account for the weaning percentage of 81 percent. Cow mortality is additional to this figure.

From Table 1, 20-25 percent of cows mated fail to rear a calf in any one year. The estimate is higher than the average reproductive loss from mating to calf marking of 18.3 percent (New Zealand Meat and Wool Board's Economic Service, 1977). Barren cows and calf mortality are the major causes of reproductive loss with calf mortality accounting for slightly fewer losses than barren cows. If 9 percent of calves die from birth to weaning, the loss to the New Zealand beef herd is of the order of 200,000 calves per year.

Information on calf age at death is summarised in Table 2. Almost two thirds of total calf deaths occur at or within 24 hours of birth. Several studies have further divided the calf deaths from 2 days of age until weaning. The use of differing time periods precludes a simple summary, but the majority of deaths from 2 days until weaning occur in the first one to two weeks of life.

A comprehensive study of cause of death among beef calves was carried out by Young and Blair (1974) in Australia. Data from their autopsy studies on 489 calves are presented in Table 3. The major cause of death was slow or difficult birth, which accounted for 63.5 percent of the total loss and 91.7 percent of calf deaths within 24 hours of birth. The results are supported by New Zealand and overseas studies (Anderson and Bellows, 1967 Abs.; Carter *et al.*, 1975; Haughey, 1975; Laster and Gregory, 1973).

Of the remaining deaths, starvation was the major cause in calves 2 to 7 days old, with enteritis/gastroenteritis the major cause in calves 8 to 90 days old. In total, enteritis/gastroenteritis and starvation accounted for 12.6 percent and 10.2 percent of the calf deaths respectively.

Included in the Remainder category are infections such as black leg, cervical abscess, enterotoxaemia, liver abscess, pericarditis, peritonitis, pleurisy-pneumonia, and miscellaneous causes such as aortic thrombosis, excess cerebrospinal fluid and injury. Individually they accounted for very few deaths, but collectively accounted for 4.4 percent of the total.

Therefore, calf mortality is an important source of reproductive loss. Although specific disease outbreaks may cause large numbers of deaths on individual properties, the main cause of calf death is dystocia. Diarrhoeal diseases of calf were reviewed at the 1977 New Zealand Veterinary Association Conference (Jones *et al.*, 1977) and I will spend the remaining time discussing dystocia and the relationship between nutrition of the dam in late pregnancy and calf mortality.

Dystocia

Dystocia is usually defined as delayed or difficult birth requiring assistance. Young (1968b) observed calvings in Australian heifers and defined dystocia as births where the calf had not been delivered within four hours of the appearance of the amniotic sac or a foetal extremity. This compares with the mean time from first appearance of the amniotic sac to the calf on the ground of less than one hour for "normal" calvings. (O'Mary and Hillers, 1976).

Much of the following discussion is based on North American studies where the incidence of dystocia was high and the magnitude of the results may not be directly applicable to grazing cattle in New Zealand.

There are two ways dystocia can occur:

(1) When foetal size is larger than the potential size of the birth canal.
(2) When the course of birth is abnormal such as abnormal presentation of the calf or poor relaxation of pelvic structures (Young, 1968b).

Most studies have concentrated on the disproportion between calf size and pelvic opening and the main factors shown to be associated with calf size, pelvic opening and dystocia include:

1. Dam age and parity
2. Calf birth weight
3. Calf sex
4. Pelvic size of the dam
5. Breed of sire
6. Sire within breed
7. Breed of dam

1. Age and parity of the dam

The incidence of dystocia in first calving heifers is 3 to 4 times higher than in cows 5-6 years of age, despite lighter calf birth weights (Brinks *et al.*, 1973; Laster and Gregory, 1973; Laster *et al.*, 1973; Philipsson, 1976b). The relationship between age and dystocia reported by Brinks *et al.* (1973) is shown in Table 4. Levels of dystocia were very high in 2 year old dams and declined to low levels in dams of 5 years of age and older.

Other factors influencing dystocia are expressed more dramatically when the incidence of dystocia is high as in first calving heifers (Laster *et al.*, 1973; Politiek, 1965). The interaction between sire breed and dam age is shown in Figure 1. Hereford and Angus dams were mated to a range of sire breeds including Charolais, Hereford, Angus and Jersey sires. Differences in the incidence of dystocia due to sires were small for dams of 4 and 5 years of age, but very large for 2 year old dams.

Similarly, interactions between dam age and calf birth weight (Smith *et al.*, 1976), and dam age and calf sex (Laster *et al.*, 1973), have been reported. The relationship between dam age, calf birth weight and dystocia is shown in Table 5. Dystocia increased 3.3 percent per kg increase in calf birth weight in 2 year old dams compared with 0.5 percent in dams 5 years and older.

There is little information on the difference in dystocia experienced by dams that calve first at 2 as compared to 3 years of age. Young (1968a) estimated dystocia for dams calving first at 2 or 3 years of age as 16 and 13 percent on the same properties and there were considerable differences between properties within age groups.

Philipsson (1976b, 1976c) concluded that when heifers calved first between 22 and 36 months of age, there was little effect of age on dystocia.

In New Zealand, heifers calving first at 2 as compared to 3 years of age reared fewer calves to marking (Carter and Cox, 1973). Calf mortalities were higher in heifers calving first at 2 years of age.

2. Calf birth weight

Calf birth weight is one measure of calf size. Of factors attributed to the calf, birth weight is the most important variable affecting dystocia (Laster and Gregory, 1973; Philipsson, 1967d; Price and Wiltbank, 1978b; Smith *et al.*, 1976). Calves experiencing dystocia are 2-3 kg heavier than calves from normal births (Smith *et al.*, 1976; Philipsson, 1976b). In North American data where the incidence of dystocia was high, a one kg increase in calf birth weight increased dystocia by 0.5-3.3 percent depending on age of dam (Smith *et al.*, 1976).

Price and Wiltbank (1978b) studied measurements of calf body length, hip width and calf birth weight in calves from first calving heifers. The incidence of dystocia was more closely related to calf birth weight than calf body measurements. The ratio of body measurements to birth weight did not help to explain the incidence of dystocia. Laster (1974) also concluded that differences in dystocia could not be explained by differences in calf body measurements.

Calf birth weight is the result of genetic and environmental factors including gestation length, calf sex, breed of sire, breed of dam, nutrition, heterosis, age and parity of the dam. The influence of these factors on still-birth and dystocia are partly due to their effects on calf birth weight.

3. Calf Sex

Dams giving birth to male calves experience 2-3 times more dystocia than those giving birth to female calves (Philipsson, 1976c; Price and Wiltbank, 1978a). Male calves are consistently heavier at birth than female calves (Andersen and Plum, 1965) and much of the difference in dystocia is due to calf birth weight. However, at the same birth weight there remain significant differences in the incidence of dystocia between male and female calves (Philipsson, 1976c). The differences may be due to calf conformation or hormonal activity.

4. Pelvic size of the dam

Dams with small pelvic openings are more likely to experience dystocia (Bellows *et al.*, 1971a; Bellows *et al*, 1971b; Laster, 1974; Price and Wiltbank, 1978b). Within age groups, pelvic size is the most important variable attributable to the dam (Price and Wiltbank, 1978a).

Price and Wiltbank (1978b) studied the relationship between pelvic size and dystocia in Angus, Hereford x Angus, and Charolais heifers mated to Angus, Hereford, and Charolais bulls. The relationship between pelvic size and dystocia in heifers when the pelvic area was less than 200 cm^2. Above 200 cm^2 the relationship is less clear. Statistical analysis of the results of both experiments demonstrated that only a small part of the variation in dystocia would be accounted for by measurements of pelvic size. Both studies concluded that calf birth weight was more important than pelvic size in explaining variation in dystocia, and that by itself pelvic opening was of little help in predicting dystocia.

5. Breed of Sire

Breed of sire can alter calf birth weight, dystocia and calf mortality. In Hereford and Angus dams, calves by large sire breeds such as Charolais, Simmental, Limousin and South Devon, experienced more dystocia than those sired by Hereford, Angus and Jersey bulls, particularly in young dams (Laster, 1973).

Part of the difference in dystocia between sire breeds is due to differences in calf birth weights. In Hereford and Angus dams mated to Charolais, Simmental, Limousin, South Devon, Angus and Jersey sires there were significant differences between breeds in average calf birth weight (Laster *et al.*, 1973). Only two thirds of the differences in dystocia for calves of Jersey sires and those of the large sire breeds could be accounted for on the basis of calf birth weight.

6. Sires within breeds

Within breeds there are significant differences between sires in the proportion of their progeny experiencing dystocia (Brinks *et al.*, 1973; Rice and Wiltbank, 1972; Politiek, 1965; Price and Wiltbank, 1978b). Price and Wiltbank (1978b) studied the incidence of dystocia in first calving Angus, Charolais, and Hereford x Angus heifers. Variation between Angus sires in shown in Table 7.

The differences between most sires were small and a large number of progeny are required to accurately predict dystocia. For example, sire 10 had the highest incidence of dystocia, but was not significantly different from any of the other sires.

It has been claimed that when sires whose progeny have lower calf mortalities were mated to first calving heifers the incidence of dystocia and still-birth was reduced by more than half in a 9 year period (Politiek, 1965).

Careful selection of sires for heifer mating based on dystocia and mortality at the birth of their progeny, may be effective in reducing the incidence of dystocia and calf mortality.

7. Breed of Dam

Dam breed significantly affects the incidence of dystocia. Friesian dams experienced more dystocia than Jersey dams when mated to either Friesian or Jersey sires (Monterio, 1969). In crossbred cows, South Devon, Simmental, Charolais and Limousin crosses experienced more dystocia than Jersey crosses (Laster, 1974).

Laster (1974) studied the relationship between calf birth weight, pelvic size and dam liveweight in 14 breed groups. The regressions of deviations from mean pelvic size and mean calf birth weight are shown in Fig. 2. On average, heavier dams had larger pelvic openings, but proportionately even larger calves.

Heritability and Repeatability of Dystocia and Still-Births

Differences between sires in dystocia and still-birth rate in their progeny have been demonstrated and selection of sires for heifer mating may result in decreases in still-birth rate However, estimates of the heritability and repeatability of dystocia and still-birth rate are low. Heritabilities for dystocia range from 0 03-0.19 and for still-birth rate they are generally less than 0.05 (Philipsson, 1976a; Philipsson, 1976b). The repeatability of dystocia has been reported as 0.045 (Brinks *et al.*, 1973). Selection against dystocia would have little effect on the average rate of dystocia in future generations and subsequent years.

Nutrition of the Dam in Late Pregnancy

It has been argued that in heifers, the plane of nutrition in late pregnancy should be severely restricted to prevent dystocia (Young, 1970). However, evidence on the relationship between plane of nutrition and calf mortality does not support this view.

Severe dietary restriction in late pregnancy reduces calf birth weights and increases calf mortality. At Whatawhata Hill Country Research Station, Hight (1966) fed mixed age Angus dams two planes of nutrition for the last 120 days of pregnancy. The results are shown in Table 8. Calf mortality was higher in the low plane group.

Weather conditions during calving may have exaggerated calf mortality, but in the low plane group birth weights of the dead calves were lighter than those of the calves that survived.

When Hereford cows lost 65 kg in the last 100 days of pregnancy, mean calf birth weight was 27 kg and 29 percent of calves died from birth to weaning. (Corah *et al.*, 1975) Ten percent of these calves died close to birth and 19 percent died between birth and weaning due to calf scours. There were no losses in calves born to dams losing 10 kg. The calves weighed 35 kg at birth.

Severe underfeeding can also increase calf mortality due to dystocia caused by failure of pelvic structures to relax or general weakness of the dam (Hodge *et al.*, 1976; Marsh *et al.*, 1968; Young, 1968b).

At moderate planes of nutrition, calf birth weights increase with increased level of feeding. However, there is little change in dystocia or calf mortality (Price and Wiltbank, 1978a); Rice and Wiltbank, 1972). For example, Hereford and Angus heifers were fed at three levels of nutrition for 90 days prior to calving (Laster, 1974). Results are shown in Table 3.

With increasing level of nutrition, average daily gain and calf birth weight increased. There was no significant effect on dystocia, with a trend to more dystocia in heifers fed at the low level. Levels of energy had no effect on calf dimensions and it was suggested that increases in calf birth weight were due to increases in soft tissue rather than skeletal size.

When heifers are stall fed to the point of obesity, higher calf mortality can result from increased dystocia and abnormal presentations (Arnett *et al.*, 1971; Bond and Wiltbank, 1970). At such high planes of nutrition the increased dystocia was not caused by higher calf birth weights, but may have been due to obstruction of the pelvic opening by fat. There was no effect of obesity in cows 8 years or older. However, these results may not apply to grazing cattle in New Zealand.

Although most nutritional experiments have involved limited animal numbers, there is little evidence that restricted planes of nutrition in late pregnancy will reduce the incidence of dystocia. Severe restrictions will increase calf mortality and reduce subsequent reproductive performance (Dunn *et al.*, 1969; Hodge *et al.*, 1976; Philipsson, 1976a). Restricted planes of nutrition should not be used as a method of controlling dystocia.

Discussion

Many factors have been related to the incidence of calf mortality and dystocia, yet our ability to predict and reduce the incidence is limited. Factors studied often account for only a minor part of the variation and in a recent review of dystocia Price and Wiltbank (1978a) concluded that "size of the calf and size of the pelvis are the major factors determining the level of dystocia. While statistical analysis indicates that these two variables account for only a small proportion of the variation in the incidence of dystocia, other sources account for little or no variation."

Factors that contol the length of gestation and the onset of parturition may be important since gestation length, calf birth weight, calving difficulty and still-birth rate are all related (Philipsson, 1976d). Differences in hormonal relationships have been demonstrated for cows with different gestation lengths (Hunter *et al.*, 1970). Therefore, more detailed studies of the relationships involved in the initiation of parturition may increase our understanding of calving difficulty and calf mortality.

Conclusion

1. Calf mortality represents a major loss to the New Zealand beef industry.
2. The major cause of calf loss is delayed or difficult birth.
3. First calving heifers have a higher incidence of dystocia and factors affecting dystocia are more important in this group.
4. Of factors related to dystocia so far identified, size of calf and size of pelvis are the most important.
5. Severe nutritional restriction in later pregnancy should not be used as a method of controlling the incidence of dystocia.

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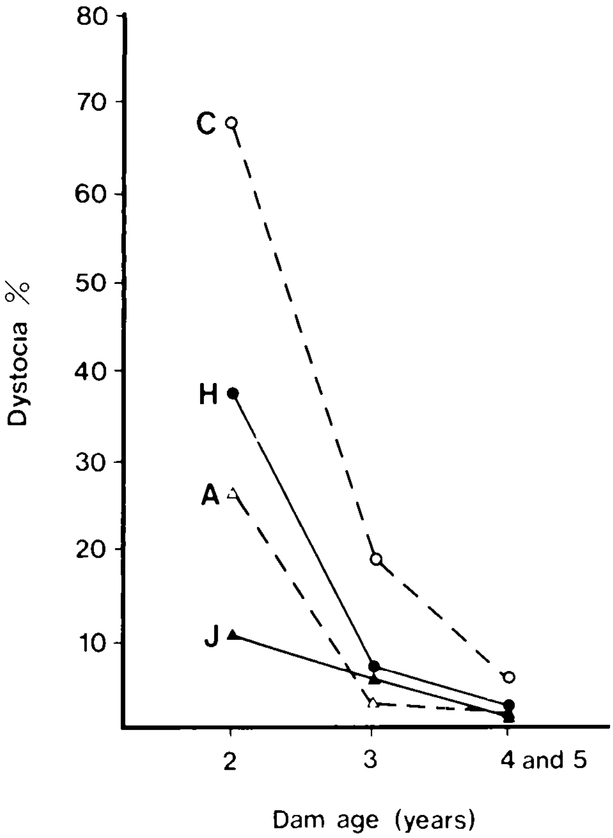

Figure 1. *Interaction between dystocia, dam age and sire breed (Laster, 1973).*
C — Charolais *A — Angus*
H — Hereford *J — Jersey*

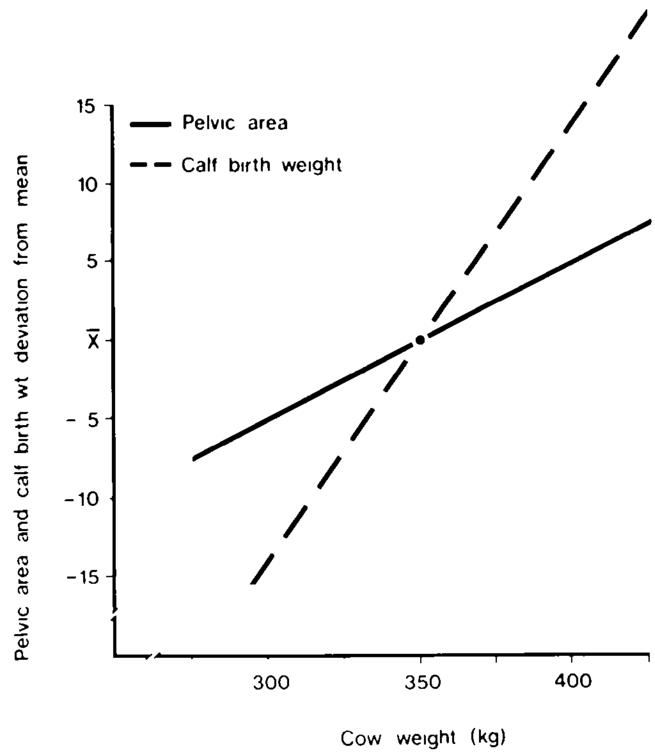

Figure 2. *Relationship between cow weight and pelvic area and cow weight and calf birthweight averaged over 14 breed groups of 2-year-old cows. Mean pelvic area = 232 cm² and mean calf birth weight = 31.1 kg (Laster, 1974).*

Table 1. *A summary of reproductive performance in New Zealand beef cattle.*

Reference	Calves weaned per 100 cows mated	Barren cows	Calf mortality birth to weaning	Cow mortality mating to calving
Tara Hills Cattle	77	10	7	6
Hanly and Mossman (1977)	81	10	9	6*
Wareham (1975)	76	8	13	3
Packard (1973)	79	11	8	2

* Cow deaths for the entire year

Table 2. *The proportions of calf deaths occurring at different ages.*

	Calf deaths (%)	
	0-1 day of age	2 days - weaning
Koger *et al*, (1967)	54	46
Tara Hills Friesian comparison herd	63	37
Wiltbank *et al*, (1961)	70	30
Young and Blair (1974)	67	33*

* Deaths from 2 days until 3 months of age

Table 3. Proportions of calf deaths attributed to various causes. Adapted from Young and Blair (1974).

Cause of death	Calf age at death (days) 0-1	2-7	8-90	Total
Slow or difficult birth	62.7	0 8		63 5
Enteritis/gastroenteritis		1 7	10 9	12 6
Starvation		9 8	0 4	10 2
Dead prior to birth	3 8			3 8
Navel infection		1 7	0 4	2 1
Congenital abnormality	1 9	1 3	0 2	3 4
Remainder		1 3	3 1	4 4

Table 4. The relationship between age of dam and the incidence of dystocia. (Brinks **et al.**, *1973)*

Age of Dam	Number of Calvings	Dystocia (%)
2	437	29 7
3	475	10 5
4	427	7 2
5	387	2 8
6	366	2 7
7	279	3 2
8	205	2 4
9	141	1 4
10	100	4 0
11	66	4 5
12	42	2 4
13	26	3 8

Table 5.

The effects of age of dam and calf birth weight on the incidence of dystocia (Smith **et al.**, *1976).*

Age of dam	Percentage of increase in dystocia per kg increase in calf birth weight
2	3 3
3	1 5
4	0 9
5+	0 5

Table 6. Relationship between pelvic area and the incidence of dystocia (Price and Wiltbank, 1978b)

Pelvic area (cm^2)	Number of Heifers	Dystocia (%)
140 — 150	6	100
151 — 160	32	65
161 — 170	77	66
171 — 180	160	47
181 — 190	194	37
191 — 200	188	21
201 — 210	101	15
211 — 220	45	20
221 — 230	26	7
231 — 240	17	0

Table 7. Variation between Angus sires in the incidence of dystocia (Price and Wiltbank, 1978b).

Sire number	Number of Calves	Dystocia (%)	Confidence interval (95%)
10	17	47	23-72
3	43	47	32-62
6	43	46	30-61
7	46	45	30-60
9	41	43	28-60
2	44	43	28-59
4	85	34	24-45
12	31	34	19-54
8	49	24	13-38
11	31	22	9-41
1	42	20	10-36
5	39	9	2-24

Table 8. The effect of nutrition in late pregnancy on liveweight change, birth weight and calf mortality (Hight, 1966).

	Plane of Nutrition High	Low
Net cow liveweight change (kg)	- 11	- 82
Calf birth weight (kg)	27 7	22 2
Calf mortality (%)	5	20

Table 9. Effect of pre-calving nutrition on calf birth weight and dystocia (Laster, 1974).

Level of Nutrition	Cow liveweight Gain (kg/day)	Calf birthweight (kg)	Dystocia (%)
Low	0 25	26 3	26
Medium	0 65	27 9	17
High	0 90	29.0	18