NUTRITION AND REPRODUCTIVE PERFORMANCE OF BEEF COWS

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Reproductive performance (i.e., the ability to wean a calf each year) is the most important production factor in a cow-calf operation (Trenkle and Wilhelm, 1977). Many factors affect reproductive performance of females, for example: fertility of bulls, diseases, length of time from calving to first heat, age of cow and others. One of the factors that the cowman can control is nutrition. In the following discussion, I will present some ideas on ways nutrition both before and after calving affects reproductive performance in the current year and in the following year.

I believe that nutrition before calving is more important since it affects two aspects of production: (1) weight and survival of calves born this year and (2) age, and thereby weaning weight, of calves born next year. Nutrition after calving affects embryo survival and thus affects the size of next year's calf crop.

We are often asked to make recommendations concerning what to feed and how much to feed. This is a difficult task because forage quality varies from field to field, ranch to ranch and year to year. In addition, some operators depend upon grazing for most of their forage supply while others utilize harvested forages. If one knows the nutrient composition of his forage plus the quantity of forage consumed by grazing animals, then it is possible to make accurate feeding recommendations. I believe that a more useful approach is to feed for a given weight gain. Because undernutrition before calving affects production both this year and next year, weight changes which reflect the level of nutrition before calving are of critical importance.

NUTRITION BEFORE CALVING

Remember, when you feed a pregnant cow, especially during the last 3 months of gestation, that you are really feeding two individuals: the cow and her fetal calf. During the last 3 months of gestation, the fetal calf increases its weight about five times, going from about 15-16 lb to 80 lb or more (Figure 1). Clearly the nutrient demands of the fetal calf are sizeable during this time. If a cow does not consume adequate feed, she will mobilize her own body tissue stores to provide nutrients for the developing fetus. A cow that must utilize her body tissue

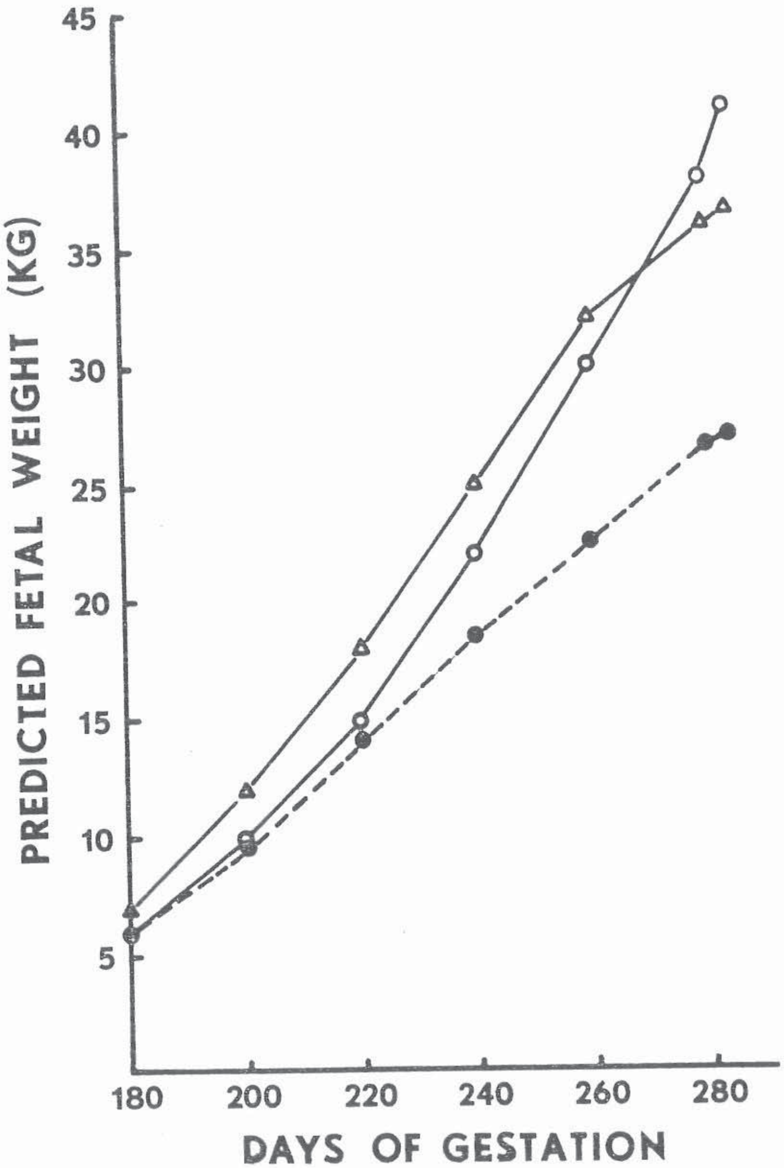

Figure 1. Predicted bovine fetal weights from three different studies (△———△ crossbred beef calves, Prior and Laster, 1979; o———o Hereford calves, Ferrell et al., 1976; ●———● mostly Jersey calves, Eley et al., 1978). To convert kilograms to pounds, multiply by 2.2.

stores for the developing fetus will lose weight.

We use <u>net weight change</u> to describe the effects of precalving nutrition. Net weight change is a measure of how prepartum nutrition affects the cow independent of her calf. I have presented three examples in Table 1. At 100 days before calving each cow weighed 1000 lb. Cow A may appear to be holding her own, i.e. neither gaining nor losing; however, she will lose about 150 lb at calving (this loss is accounted for by the calf, membranes and fluids). Therefore, instead of having 0 weight change, she will have a net weight loss of 150 lb. In order to prevent a net weight loss, a cow must gain about 150 lb (i.e. about 1.5 lb/day) during the last 100 days of gestation as shown in Table 1 for Cow B. Any gain in excess of 150 lb will show as a net weight gain (Cow C in Table 1).

Net Weight Loss Reduces Calf Weights

Calves born to dams that have a large net weight loss during the last one-third of gestation are lighter at birth and at weaning and gain less weight between birth and weaning (Table 2). Calves born to undernourished dams grew at a slower rate than did calves born to adequately nourished dams. There are at least two possible explanations for the slower growth rate. First, and most likely, cows that are undernourished during the last one-third of gestation produce less milk during lactation. In the Nebraska study (Dunn, 1964) this was true. Cows with a net weight gain prior to calving produced 4.1, 3.7 and 2.2 lb more milk at 53, 81 and 109 days of lactation than did cows with a net weight loss. In Corah's study (Corah et al., 1975), however, the opposite was true with cows having a net weight loss producing more milk than those with a gain (11.0 vs 10.6 lb/day). A second explanation is that maternal malnutrition decreases the ability of the calf to grow. In all four studies shown in Table 2, calves born to undernourished dams had lower weight gains from birth to weaning than did calves born to adequately nourished dams. To support this idea, we have induced cows to calve 14 days early. Early-born calves were 15 lb lighter at birth (69 <u>vs</u>. 84 lb) but only 5 lb lighter at weaning (456 vs 461 lb). Although these calves were lighter at birth, their ability to gain was not impaired.

In another experiment, Corah et al. (1975) demonstrated that many of the adverse effects of maternal malnutrition could be reversed by feeding a high energy ration during the last 30 days of gestation. One of the interesting results of this experiment was the finding that more calves from underfed dams were afflicted by calf scours than from dams that received the high energy ration during the last 30 days of gestation (52 vs 33 percent incidence of scours). Not only were more calves affected by scours, but the mortality

Table 1. Calculation of net weight changes in cows.

Cow	Net weight change	Weight (lb) at: 100 days before	1 day before	1 day after	Net weight change (lb)
A	Loss	1000	1000	850	-150
B	No change	1000	1150	1000	0
C	Gain	1000	1175	1025	25

Table 2. Effect of net weight change on calf birth weight, weaning weight and gains.

Type of cows and location	Net weight change of dam (lb)	Calf weight (lb) Birth	Weaning	Calf gain (lb)
Mature cows,	- 15	58	263	205
New Zealand[a]	-139	45	236	191
Difference		13	27	14
First-calf heifers,	+ 26	70	289	219
Nebraska[b]	- 86	63	269	206
Difference		7	20	13
First calf heifers,	+ 51	63	363	300
Montana[c]	- 46	59	339	280
Difference		4	24	20
First calf heifers,	- 35	67	354	286
Wyoming[d]	-119	63	329	262
Difference		4	25	24

[a] Hight, 1968.

[b] Dunn, 1964.

[c] Bellows and Short, 1978.

[d] Corah et al., 1975.

(from all causes) was greater in calves born to malnourished mothers (19 vs 0 percent).

Cows with a net weight loss prior to calving will have calves that are lighter at birth and at weaning. These calves will also be more likely to die between birth and weaning. The result is that cows that lose weight prior to calving will wean fewer and lighter calves in the fall.

<u>Net Weight Loss Increases Postpartum Interval</u>

Not only does maternal undernutrition affect this year's calf crop, but it also affects the size and weight of next year's calf crop because it affects the length of the interval from calving to first heat (<u>postpartum interval</u>). The length of this interval is important in operations that use a limited breeding season. The difference between 365 (number of days in a year) and 285 (average gestation length for cows) is 80 days. During this period of time a cow must recover from calving, return to heat and conceive if she is to calve on or before the same time next year. If the interval from calving to first heat is longer than 80 days, then it is impossible for the cow to maintain an annual calving interval. In fact, one would like cows to have a postpartum interval of 60 days or less. If she has an interval of 60 days or less, she will have more than one opportunity to be bred prior to the 80-day deadline. For example, if she shows her first heat 59 days after calving, she will have one opportunity to be bred at that time plus another opportunity 21 days later and still be within the 80-day deadline.

We (Dunn and Kaltenbach, 1980) used the data on prepartum weight changes from eight different studies to estimate both the percentage of cows that had shown estrus by 60 days postpartum (i.e. had a postpartum interval of 60 days or less) and the length of the postpartum interval. Separate analyses were conducted for mature cows and 2-year-old heifers nursing their first calves. For mature cows, 91 percent can be expected to show estrus by 60 days postpartum if their postpartum weight change is 0 (Figure 2). However, for each 10 lb (4.54 kg) of prepartum net weight loss, the percentage of cows showing heat by 60 days postpartum is decreased by 2.3 percentage points. Thus, for cows with a prepartum weight loss of 200 lb, one would expect only 45.6 percent to show heat by 60 days after calving. For 2-year-old heifers (Figure 3) 64 percent would be expected to be in heat by 60 days after calving if their prepartum net weight change was 0. This value would decrease by 1.1 percentage points for each 10 lb (4.54 kg) net weight loss. Therefore, for 2-year-old heifers with a 100-lb net weight loss, one would expect only 53 percent to be in heat by 60 days after calving.

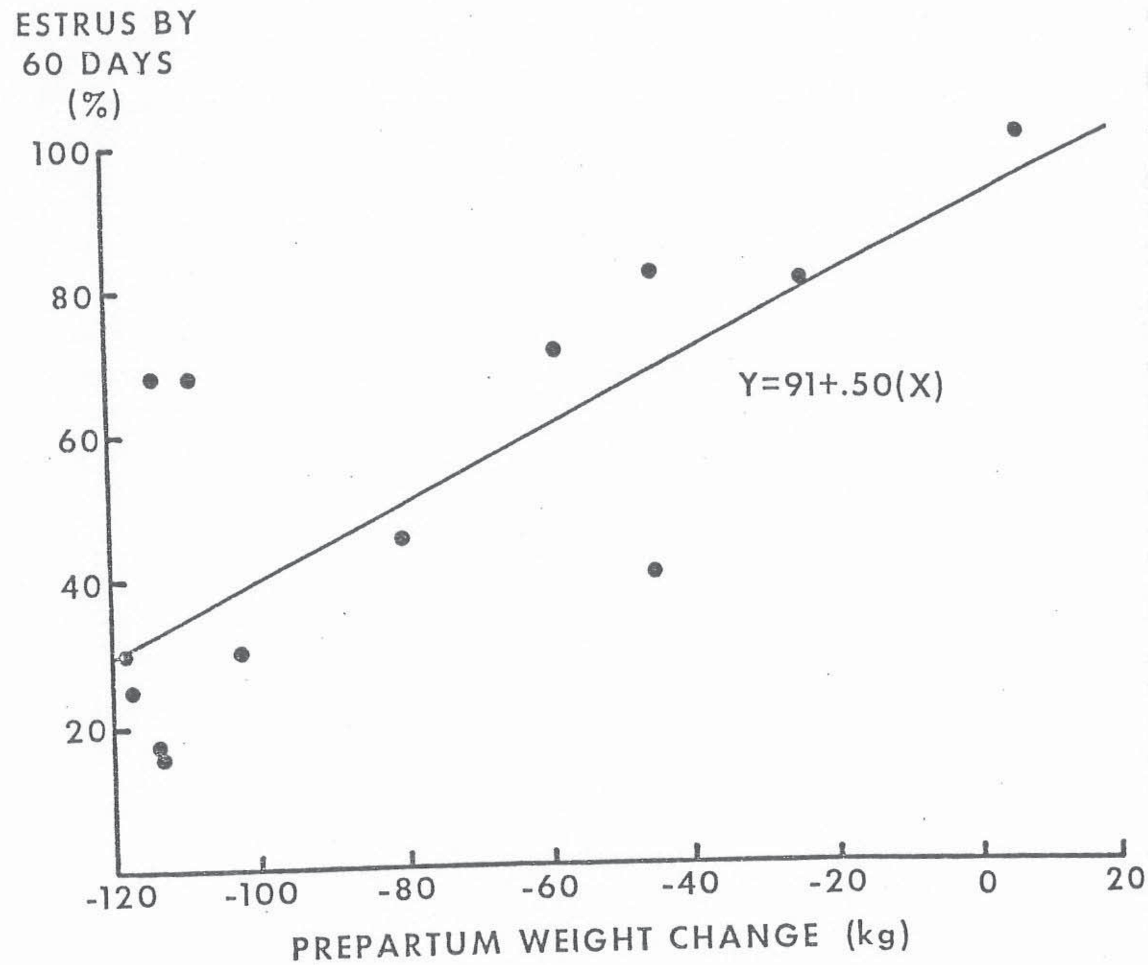

Figure 2. The relationship between percentage of mature cows that had shown heat by 60 days after calving and their prepartum weight change. To convert kilograms to pounds, multiply by 2.2. (From Dunn and Kaltenbach, 1980).

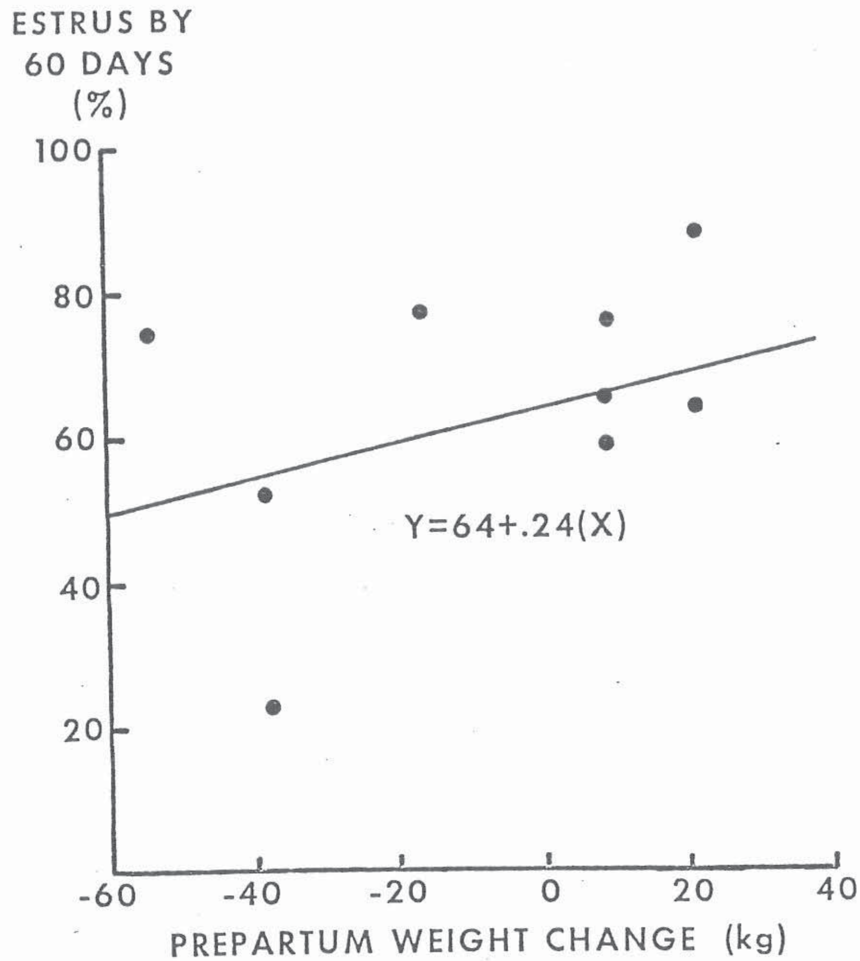

Figure 3. The relationship between percentage of 2-year-old heifers that had shown heat by 60 days after calving and their prepartum weight change. To convert kilograms to pounds, multiply by 2.2. (From Dunn and Kaltenbach, 1980).

In this same study, we (Dunn and Kaltenbach, 1980) also examined the effect of net weight change for mature cows and for 2-year-old heifers nursing their first calves. The length of the postpartum interval for mature cows with 0 net weight change was 47 days. This interval increased by .8 days for each 10 lb of prepartum net weight loss. Thus, if a cow had a 200-lb net weight loss, she would be expected to show heat 62 days after calving. For 2-year-old heifers, the interval was 54 days and it increased by .9 days for each 10 lb of net weight loss.

At least two investigators (Whitman, 1975 and Clemente, 1978) have shown that body condition of cows at calving has an effect on the length of time from calving to first heat, with thin cows having a longer interval than cows in good body condition. We (Dunn and Kaltenbach, 1980) further examined Whitman's (1975) data and found that the effect of prepartum weight change was negated in cows in good body condition (Figure 4). In other words, a high percentage of cows in good body condition at calving had shown heat by 60 days after calving regardless of weight changes either before or after calving. For cows in moderate body condition, however, net weight change became more important with about 72 percent of these cows showing estrus by 60 days after calving if they gained weight prior to parturition. In contrast, only 49 percent that lost weight before calving had postpartum intervals of 60 days or less. In cows that were thin at calving, weight change became crucial. In spite of thin body condition at calving 67 percent of the thin cows that gained weight prior to calving had postpartum intervals of 60 days or less compared with 25 percent of thin cows that lost weight both before and after calving.

It appears therefore, that both body condition at calving and prepartum weight changes influence the length of the interval from calving to first heat. Clearly, the effect of prepartum weight change is more important in cows that are in moderate or thin body condition at calving. If these cows are to show heat by 60 days after calving, they must have a positive net weight change. For cows in good body condition at calving, prepartum weight change seems to be less critical; and they can probably afford to lose weight during the last one-third of gestation. It is not known how such weight loss would affect their calf, however.

If a cow is forced to utilize their own body tissue stores to provide nutrients for the developing fetus, they will have a net weight loss during the last one-third of gestation. Cows that suffer a net weight loss will have calves that are lighter at weaning and less likely to survive until weaning. Thus, this year's calf crop will be lower than for cows that had a net weight gain. Unless the cow is in good body condition at calving, her next year's

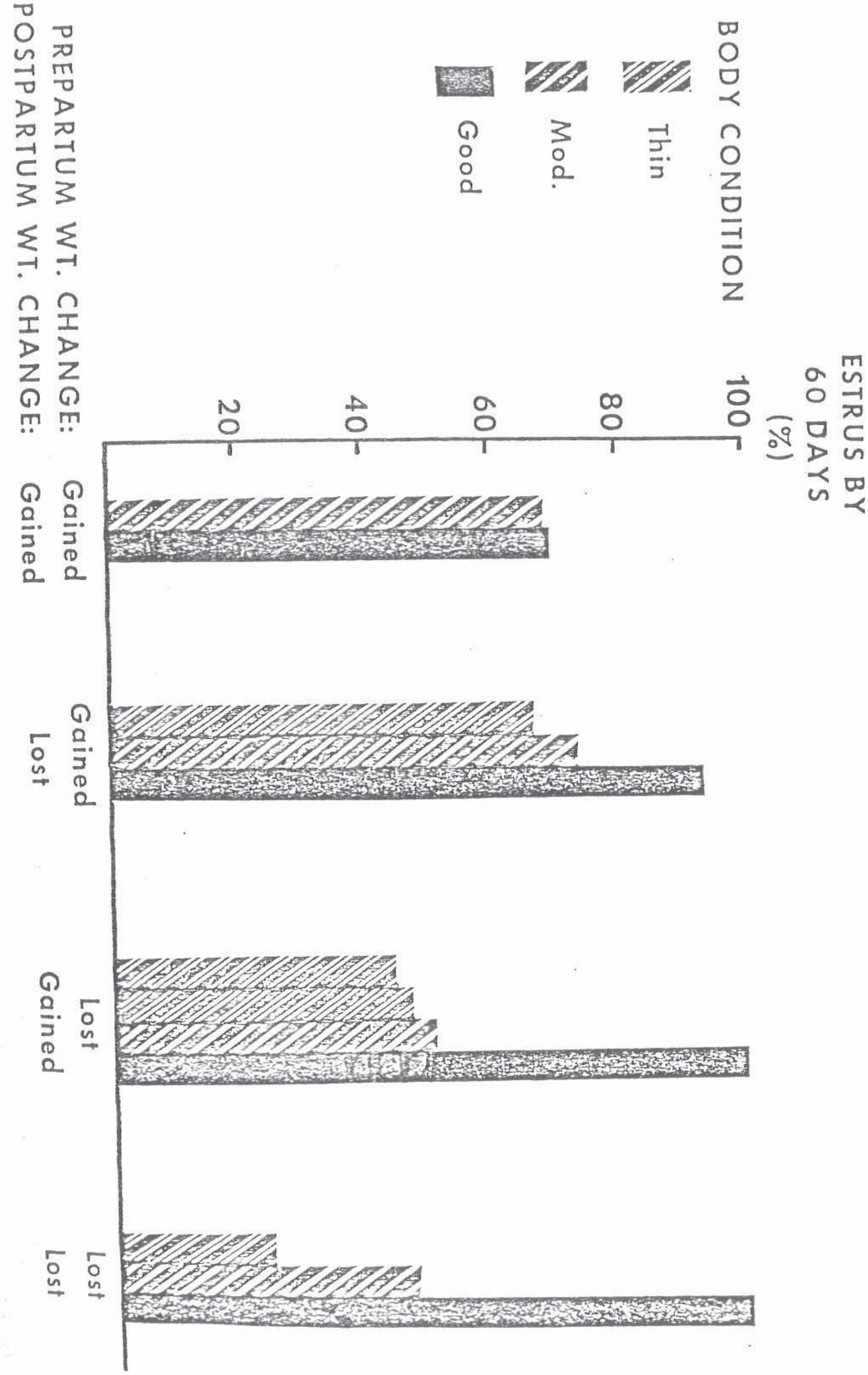

Figure 4. The effect of body condition at calving, prepartum weight change and postpartum weight change on percentage of cows that had shown heat by 60 days after calving. (From Dunn and Kaltenbach, 1980).

calf will be younger and hence lighter at weaning. It will be younger because it will be conceived later in the breeding season due to a long postpartum interval caused by prepartum weight loss. Indeed, there is a possibility that the cow may not conceive for next year because of failure to show estrus during the breeding season or showing heat so late in the breeding season that she must conceive at a single service.

NUTRITION AFTER CALVING

Cows that lost weight after calving had lower pregnancy rates than those that gained weight (Wiltbank et al., 1962; Dunn et al., 1969). In these studies, thin cows failed to show estrus during the breeding season; however, this did not account for all of the pregnancy failures.

Fertilization failure may account for failure of some of the cows to become pregnant. This possibility was examined in a recent study (Dunn, 1980). As shown in Table 3, the fertilization rate for cows that lost weight after calving was similar to that for cows that gained weight (83 and 77 percent). This information must be viewed with considerable caution, however, because of the small number of ova that was examined.

Decreased embryo survival may also account for some of the pregnancy failures. Over 30 years ago, Tanabe and Casida (1949) reported that 65 percent of the fertilized ova of repeat breeder dairy cows failed to develop into normal embryos by 34 days after breeding. The effects of undernutrition on embryo survival have not been studied extensively. The results of an experiment involving embryo survival in suckled cows that were gaining or losing weight is shown in Table 4. Although the differences in embryo survival were not significant and the numbers are small, there is a suggestion that cows that lose weight after calving have a higher incidence of embryo mortality than cows that are gaining weight.

SUMMARY

Both pre-calving and post-calving nutrition affect reproductive performance of beef cows. Nutrition before calving is more important since cows that lose weight before calving will wean fewer and smaller calves this year and their next year's calf will be younger and hence lighter at weaning. Body condition seems to modulate the effect of prepartum weight changes on the postpartum interval since cows that are in good body condition have short postpartum intervals. Cows that lose weight after calving have a higher embryo mortality rate than cows that gain weight.

Table 3. Fertilization rate in cows that gained or lost weight[a].

Item	Weight change	
	Gaining	Losing
Range in A. D. G. (lb)	.04 to 2.89	-.33 to -1.08
Ova examined	65	53
Ova fertilized	50	44
Fertilization rate (%)	77	83

[a] Dunn, 1980.

Table 4. Embryo mortality in cows that gained or lost weight after calving[a].

Group	Average daily weight change (lb)	Number of potential embryos	Number pregnant 35 days after breeding	Embryo number	Mortality percent
Gaining	2.40	45	34	11	24
Losing	-.69	17	10	7	41

[a] Dunn, 1980.

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