Effects of Cow Size and Milk Production on Nutrient Requirements

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INTRODUCTION

The traditional marketing endpoint for most Florida ranches occurs at weaning. Heavier calf weaning weights are preferred because of their direct effect on the output (pounds of calf sold) of the ranch and their positive, though low, relationship to output/input ratios (profit $) (Davis et. al. 1983 a,b). Factors known to affect weaning weight are nutritional plane, age at weaning, genetic makeup and interactions among these factors. The most common methods to increase the genetic potential for weaning weight in a herd are selection within breeds for heavier weaning weights or the utilization of cross breeding systems that capitalize on breed differences such as growth or milk production (Gregory & Cundiff, 1980). As growth rate becomes increasingly more important to the cow/calf industry, producers have continued to select for increased weaning weights, which has often resulted in the production of brood cows that are larger in weight and frame and produce more milk. Breeds and breed combinations have a major influence on the mature size of the cow as well as the milk production potential. Selection within a breed, however, also can have a direct impact on cow size and milk level. Jenkins et. al. (1991) states that the use of breeds or breed crosses of greater genetic potential for performance to improve output will increase the nutrient requirements (input) of the producing herd. Variation in weaning weights, in association with variable nutrient requirements among breeds and their crosses, suggests that differences exist in the conversion of feed energy to pounds of calf sold.

COW SIZE AND MILK PRODUCTION

Many cow/calf producers have emphasized selection for increased growth and milk production over the past two decades in order to develop a more productive cow. Energy and protein requirements as influenced by cow size and level of milk production are shown in Tables 1 and 2. Changes in cow size do not have the same impact on nutrient requirements that significant changes in milk production do. Each change of 100 pounds in cow size increases the maintenance net energy (NE_m) requirement by 6-8%. On the other hand a 5 pound increase in milk production per cow per day increases the energy requirements by 8-10% and the crude protein requirement by 10-14 percent.

Today many Florida cattlemen are asking the question: "Can we select for increased productivity in our cow herds and still maintain reproductive efficiency?" The appropriate question should be: "Will I, the commercial cattle producer, adjust my management program and nutritional philosophy to accommodate the added nutrient demands of a higher producing cow herd?" Sufficient research would indicate that satisfactory reproductive performance can be achieved in more productive cows if the additional nutrients are provided. The real challenge facing the cow/calf producer is that the nutritional needs will be increased and thus, some change in managerial philosophy must occur to accommodate the higher producing cow. In making the decision to have a larger, heavier milking cow, the producer needs to consider his or her available feed resources. If an ample supply of high quality feed exists, a larger, heavier milking cow can often be maintained. However, if the feed supply is marginal or if environmental conditions exists which may limit reproductive rate, then selecting and maintaining a smaller, somewhat lower producing cow may be the most profitable choice.

UNIVERSITY RESEARCH

The relationship of increased cow size and milk production to total nutrient requirement is direct. Increases in cow herd output (weaned calf weight) associated with higher potential for growth rate and/or milk production are offset by equivalent or greater increases in feed requirements for maintenance and lactation (Cundiff et. al, 1983 and Jenkins and Ferrell, 1983).

Conflicting results are noted in the literature with regard to potential differences in the conversion of feed energy to calf weight among breeds or breed crosses. Bowden (1980) concluded that among first-calf heifers of different breed crosses, varying in size and milk production, the conversion of feed energy to weaning weight was not affected by breed cross (Table 3). Brown and Dinkel (1982) concluded that the conversion of feed energy to weaning weight was similar among mature Angus, Charolais and reciprocal cross cows. Davis et al. (1983 a,b) reported results from cumulative studies investigating life cycle production efficiency of various breeds and breed crosses and the relationships between production efficiency and descriptors of cattle phenotype (size and milk level). Information from these studies indicated that significant variation exists among breeds or breed crosses for the efficiency of production of weaned calf weight. Differences among breeds or breed cross groups were most apparent as the quantity of feed energy available for production varied. Jenkins et al. (1991) reported differences in feed energy conversion among breed crosses. They concluded that differences seem to be associated with breed cross differences in genetic potential for milk yield and mature weights; an exception to this trend was the Maine Anjou (Table 4).

Green et al. (1991 a,b) reported differences in the conversion of feed energy to calf weight between *Bos indicus* × *Bos taurus* versus *Bos taurus* × *Bos taurus* cross cows. Total efficiency of calf weight production was 11% greater for cross bred cows of *Bos indicus* × *Bos taurus* breed composition (Table 5).

Approximately 70-75% of the total energy requirements for beef production is used for maintenance (Ferrell and Jenkins, 1985). In addition, the cow herd uses an estimated 65-75% of the total energy required in a beef operation (Klosterman and Parker, 1976). Therefore, about 50% of the total energy required for beef production is used for cow maintenance. Montaño-Bermudez (1990) reported that differences in milk production accounted for 23% of the variation in brood cow maintenance requirements. These results would suggest that maintenance requirements are positively related to milk production. The results presented by Montaño-Bermudez et al. suggest that important differences in maintenance requirements exist beyond those associated with milk production. Differences in thermoregulatory activity or metabolic rate may be part of the breed differences. Because maintenance energy is the ultimate use of roughly half the feed consumed in beef production, evaluation of these energy needs should be part of the criteria when selecting or evaluating breeds and their crosses. Cattle with higher milk production and output have higher maintenance requirements.

Variation among breed crosses for efficiency of conversion of feed energy by the dam and her progeny to weaning weight is apparent in the literature. Variation in efficiency seems to be more dependent on feed energy consumption of the dam than on that of the calf. It is believed that this variation can be attributed to differences in genetic potential, mature size and milk production. Evidence indicating a positive relationship between genetic potential for milk production and feed energy for maintenance has been reported. Jenkins et al. (1991) states that if the assumption of a positive relationship between genetic production and energy requirement/unit metabolic body size is correct, F_1 crosses with greater milk production potential would require more metabolizable energy to maintain body weight over and above that associated with higher milk production. The results from Jenkins et al. (1991) seem to support the conclusion that variation in efficiency among cattle breeds differing in body weight results from the positive relationship between the genetic potential for milk production and maintenance energy requirement.

Another factor that might contribute to differences in efficiencies of feed energy utilization is the choice of sire breed of progeny. Fitzhugh et al. (1975) indicated that the output of a ranch could be improved by mating systems that exploit size differences between paternal and maternal lines. For this concept to be successful, milk production must be sufficient for expression of growth from the sire line and common sense needs to be used when considering birth weights and calving ease of sire line. A complementary effect of sire breed of progeny on the efficiency of feed energy conversion by the dam to weaned calf weight would tend to favor crossbred cows with lower daily feed energy requirement (e.g., small to moderate size).

SUMMARY

Unless feed resources for the cow herd are plentiful and cheap, economic and biological efficiencies would favor cows with moderate size and moderate levels of milk production (Van Oijen et al., 1993). Milk production of the dam should complement the growth potential of the progeny's sire in a mating system. Mature cow weight should complement quantity and quality of available feed energy resources on a beef operation.

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TABLE 1. **Net Energy Requirement of Mature Beef Cows as Influenced by Weight and Milk Production.**[a]

Energy Requirements	Cow Weight, lbs.				
	800	**1000**	**1200**	**1400**	**1600**
NE_m, Mcal/d	6.41	7.57	8.68	9.75	10.83
NE_c, Mcal/d, fetal growth	2.15	2.15	2.15	2.15	2.15
NE_L, Mcal/d, 10 lb. milk	3.40	3.40	3.40	3.40	3.40
NE_L, Mcal/d, 20 lb. milk	6.80	6.80	6.80	6.80	6.80
NE_L, Mcal/d, 25 lb. milk	8.50	8.50	8.50	8.50	8.50

[a]NRC (1984).

TABLE 2. **Relationship Between Cow Size and Milk Production.**[a]

Cow wt., lb.	Lb. milk/d	TDN lb./d	NE_m Mcal/d	C.P. lb./d
	10	10.1	9.8	1.8
800	20	12.1	13.2	2.2
	25	13.0	14.9	2.4
	10	11.5	11.0	2.0
1000	20	13.8	14.4	2.5
	25	14.9	16.1	2.7
	10	12.8	12.1	2.1
1200	20	15.2	15.5	2.7
	25	16.4	17.2	3.0
	10	14.0	13.2	2.3
1400	20	16.5	16.6	2.9
	25	17.8	18.3	3.2
	10	15.1	14.3	2.4
1600	20	17.7	17.7	3.0
	25	19.0	19.4	3.3

[a]NRC (1984).

TABLE 3. **Means of Intake of Nutrients by Dams and Conversion of Energy to Calf Weaning Weight.**

Item	Breed of dam			
	SA	CA	HA	JA
Total nutrients consumed by dams during lactation (200 days)				
Dry matter, kg	1,475[a]	1,470[a]	1,330[b]	1,368[b]
Digestible energy, Mcal	4,820[a]	4,803[a]	4,344[b]	4,470[b]
Digestible protein, kg	177[a]	177[a]	160[b]	164[b]
Calcium, kg	8.86[a]	8.86[a]	7.96[b]	8.27[b]
Phosphorus, kg	5.18[a]	5.18[a]	4.67[b]	4.81[b]
Daily DM intake as % BW[d]	1.74[b]	1.65[c]	1.69[bc]	1.85[a]
DE intake of dam/kg calf WW[e], Mcal	20.7[a]	20.8[a]	20.2[a]	20.5[a]
DE intake of dam & calf/kg calf WW[e], Mcal	23.9[a]	24.8[a]	24.1[a]	23.6[a]

[a,b,c] Means on lines within breed of dam bearing different superscripts differ (P<.05)
[d] Body weight
[e] Weaning weight.
Note: Red Poll sired calves.

TABLE 4. **Means for Components of Efficiency Ratio for Crossbred Cows.**

Trait	Sire breed of cow[a]					
	Angus/ Hereford	Brown Swiss	Chianina	Gelbvieh	Main Anjou	Red Poll
Input cumulative ME intake, Mcal						
Progeny[e]	792	734	739	711	730	761
Cows[f]	3,444[b]	3,966[d]	3,923[d]	3,965[d]	3,793[c]	3,629[bc]
Output, kg[e]						
Weight gain	152[b]	161[c]	154[bc]	157[bc]	161[c]	156[bc]
Efficiency ratio, g/Mcal	35.8[b]	34.3[bc]	33.1[c]	33.7[c]	35.6[b]	35.7[b]
Efficiency ratio relative to mean, × 100	103	98	95	97	102	103

[a] Mated to Angus and Hereford cows.
[b,c,d] Means within row with different superscripts differ (P<.05).
[e] Means for weight gain and ME consumed for the 138.5-d test.
[f] Means adjusted ME consumed to maintain BW.
Note: Simental sired calves.

TABLE 5. **Mean Efficiency Values by Breed Cross.**

Variable	**Breed cross**			
	Hereford/Angus-×	**Brahman-×**	**Sahiwal-×**	Pinzgauer-×
Calf efficiency[a] ratio	100[c]	104[c]	107[c]	96[c]
Total efficiency[b] ratio	100[c]	110[d]	111[d]	100[c]

[a] Calf efficiency = calf gain ÷ total ME (kg/Mcal) consumed by cow.
[b] Total efficiency = calf gain ÷ total ME (kg/Mcal) consumed by cow and calf.
[c,d] Means within a row with different superscripts differ ($P < .05$).
Note: Charolais sired calves.