Matching Cow Type to the Nutritional Environment

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The goal in planning a management program for a commercial cow-calf operation is to maximize profits. Income sources are weaned calves and culled cows and bulls. Income from calves is the product of:

$$\text{number of breeding females} \times \left[\frac{\text{weaning}}{\text{rate}} - \frac{\text{replacement}}{\text{rate}}\right] \times \frac{\text{weaning}}{\text{weight}} \times \frac{\text{price per}}{\text{pound}}$$

All of these variables, with the possible exception of replacement rate, are directly affected by two major type characteristics; 1) *mature cow size* and 2) *level of milk production*. Both of these characteristics have a great impact on nutrient requirements of the herd, and thus, on production costs. The following discussion will concentrate on matching cow size and level of milk production to the nutritional environment or resources.

Cow Size

Prichard and Marshall in a preceding paper presented at this short course reviewed the effects of cow size on nutrient requirements. They indicated that each increase of 100 lb in mature cow weight increased the net energy for maintenance by 6 to 8%. For example, a 1200 lb cow requires 14.7% more net energy for maintenance than does a cow weighing 1000 lb at maturity (8.68 vs 7.57 Mcal/day). Since maintenance accounts for 70 to 75% of the total annual metabolizable energy requirements of a beef cow (Ferrell and Jenkins, 1982), increasing mature size will increase annual feed requirements, and thus, production costs. Likewise, increasing mature size will decrease carrying capacity (number of cow-calf units) of a given farm or ranch.

The managerial decision on cow size for a give cow-calf operation is, "What is the optimum cow size for the nutritional environment of this operation?" The optimum size cow must not only be one that can maintain a satisfactory reproductive rate, but also wean calves that produce a profit when sold as stocker-feeder calves and heifers that are desirable herd replacements. Her calves sold as stocker-feeder should have the potential for efficient and profitable growth in backgrounding and feedlot operations, and finish within the desired market weight range.

Larger mature size within a breed is positively correlated, genetically and phenotypically, with heavier birth, weaning, and yearling weights; with later maturity, thus, with a longer growing period and older age at which mature size is reached; and with later puberty and heavier weight at puberty.

Larger frame (relates to larger mature size) heifers will require more weight gain from weaning to the beginning of the breeding season if they are to reach puberty and breed as yearlings to calve as 2-year-olds. If postweaning nutritional level is only moderate to low, smaller frame (smaller mature size) heifers are more likely to reach puberty and breed as yearlings than are larger frame heifers. Buttram and Willham (1989) reported that there was little difference in cycling rate during a 45-day breeding season as yearlings and in calving rate as 2-yr-olds among small, medium and large size heifers when all were raised on adequate levels of nutrition (Table 1). Cycling rates were 98.5, 98.3, and 97.9%, respectively for small, medium, and large size heifers; and respective calving rates as 2-yr-olds were 84.9, 84.5, and 81.8%. Large size heifers, however, had lower cycling and calving rates than small size heifers when the nutritional level was marginal. Calving rate as 2-yr-olds was about 74% for the small size heifers versus 53% for the large. This difference in calving rate was due primarily to delayed puberty in the large size heifers, since only 62.1% of the large heifers were cycling during the 45-day breeding season versus 81.5 and 83.8% of the medium and small size heifers, respectively (Table 1). The calving rate as 3-yr-olds under marginal nutrition was also lower in the large size cows than in the small cows, even though as 2-yr-olds their calves were weaned at 45 days of age. This indicates that the level of nutrition available was not adequate to meet the higher nutritional needs of the large heifers for maintenance and growth.

If the breeding and calving seasons are matched with the forage production calendar, a cow of the correct size should be able to reach a body condition score (BCS) of 5 (1 to 9 scoring system) by calving data on the forage available, or with minimal supplementation of protein and(or) energy. Most data reported have shown that a BCS of at least 5 is needed if a high pregnancy rate is to be achieved in a limited breeding season (Kunkle and Sand, 1990).

What is the optimum size in beef cattle? We need medium to small cows to lower maintenance requirements and reduce production costs, and growthy, muscular calves that will weigh 1100 to 1200 pounds when they reach .3 to .5 inch outside fat. A similar problem has been resolved, to a large extent, by the poultry and swine industries. It has been possible in these industries, because of high reproductive rates, to produce female lines selected for reproductive and maternal traits and male lines selected for traits important in the slaughter animals. Due to the low reproductive capacity of the beef cow, the same cows and bulls that produce steers and heifers for slaughter must also produce heifer and bull replacements for the breeding herd.

Average slaughter weights of steers and heifers have continued to increase, indicating an increase in the average size of cattle in the U.S. This increase in average size has probably occurred in Florida also, at least to some extent. Increased size in breeding cattle equates to higher feed requirements for maintenance, growth, and gestation. If the increased nutritional requirements of the replacement heifers and brood cows are not met, the results will be delayed puberty and unsatisfactory reproduction performance, with the possibility of reducing total production and efficiency.

It is possible that a cow with the genetic potential to reach a given mature size will be smaller at maturity in Florida than she would be if she were raised in a more temperate region of the U.S. Butts et al. (1971) reported that, at five years of age, cows were heavier, larger, and taller when raised in Montana than were cows of similar or equal genotypes that were raised in Florida (Table 2).

As a general rule, a steer will reach .4 to .5 inch of outside fat (about 30 to 32% carcass fat) at about the mature weight of his dam, if he is placed in the feedlot at weaning and fed a high energy diet to slaughter and if his sire was of comparable frame size as his dam. The weight at which he will reach the slaughter and point of .4 to .5 inch outside fat can be increased by 50 to 100 pounds by placing him in a stocker-backgrounding program for three to six months prior to being placed in the feedlot (Huffman et al., 1990).

Based on the data of Butts et al. (1971) and on the fact that a high percentage of Florida produced calves are stockered prior to being placed on a high energy diet in the feedlot, it is possible that desired-weight slaughter steers may be produced from smaller mature weight cows in Florida than in the more temperate regions of the U.S. where better nutritional resources are available to the cow herd.

Milk Production

Most data show that the nutrition requirements of a cow for lactation and fetal development are directly proportional to the quantity of milk produced and the birth weight of her calf. Cows of higher milk production potential do, however, have higher maintenance requirements per unit of metabolic body size ($kg^{.75}$) than do cows having lower milk production potential (Ferrell and Jenkins, 1982; Montaño-Bermudez et al., 1990).

Deutscher and Whiteman (1971) reported that the rebreeding performance was extremely low in lactating, high milk producing 2-yr-old heifers under range conditions (Table 3). The 2-yr-old Angus-Holstein crossbred cows weaned heavier calves (431 and 420 lb for steers and heifers) than did the Angus cows (386 and 344 lb for steers and heifers). The Angus-Holstein cows lost more weight and body condition from before calving to after calving than did the Angus cows (Table 4). All nonlactating 2-yr-olds, those that did not breed as yearlings and those that lost calve, of both breed groups became pregnant in the 90-day breeding season. Montaño-Bermudez and Nielsen (1990) reported that there were no significant differences in date of first postpartum estrus and first and last breeding among high, medium and low milk production groups of cows in Nebraska. Breed composition and average milk production for the three milk groups are shown in Table 5. They did, however, report a significant age of cow × milk group interaction for calving rate (Table 6). In yearling heifers, the calving rate was lowest in the Low-milk group (73.6%) and highest in the Medium-milk group (92.5%) but in 2-yr-old and older cows there were no differences among milk groups. Under the conditions in which the cows were maintained in southeastern Nebraska, cows in all milk production groups were able to consume sufficient energy and gain or lose body reserves to achieve similar reproductive performance.

***Bos indicus* vs *Bos taurus* Crossbreds**

A large number of research reports have shown that there is two to three times as much heterosis expressed by *Bos indicus* × *Bos taurus* crossbreds than by *Bos taurus* × *Bos taurus* crossbreds (Cundiff, 1970; Franke, 1980; Koger, 1980; Long, 1980). Green et al. (1991a) reported that the total efficiency of calf gain in weight in a 126-day lactation period was 11% greater for *Bos indicus* × *Bos taurus* F_1 crossbred cows than for *Bos taurus* × *Bos taurus* F_1 crossbreds (Table 7). Green et al. (1991b) reported that *Bos indicus* × *Bos taurus* F_1 cows were over 4% more efficient that *Bos taurus* × *Bos taurus* crossbreds in a life-cycle biological efficiency study of cow-calf production to weaning (Table 8).

Summary and Recommendations

Large differences exist among and within breeds and(or) biological types for most production traits. This is certainly true for mature size, growth rate, and level of milk production. There is no one size or milk level that is right for all beef cattle ranches or farms. Different sizes and levels of milk production will rank differently for both biological and economic efficiency under different production environments, where different levels of feed resources exist.

The most profitable producers are those with the lowest production costs, but who maintain high levels of reproduction (Odde and Gutierrez, 1993). These authors also stated that forage and feed are the largest components of annual cow costs, and that the most profitable producers usually were those with low forage and feed costs -- those who got as much as possible of the nutrient requirements for the herd from pasture.

Pregnancy rate and weaning rate have been shown to be positively related to biological and economic efficiency. Cows that are unable to reproduce at a satisfactory rate (probably unable to maintain a body condition score near 5 or higher) because they are too big and(or) milk too much for the nutritional resources of the ranch or farm should be eliminated.

Selection programs should be planned for balanced trait selection, considering production efficiency and marketability. Extremes or maximums for any trait or combination of traits will nearly always be detrimental. Maximum profit is generally reached before maximum production.

I suggest that moderate size and moderate levels of milk production will be suitable for most Florida ranches. The breeding and calving seasons should be set to match the forage quality and quantity with the nutrient requirements of the herd. Nutrient requirements in the breeding herd are highest in the first 120 days post-calving, since this is the period of highest milk production and also the period in which rebreeding must occur in a 365-day calving interval is to be maintained.

Utilize breed complementarity and heterosis obtained from crossbreeding by planning and following a well-designed, systematic crossbreeding program. If you are not knowledgeable about Expected Progeny Differences (EPD's) published in the sire Summaries of the different breed associations, then learn. Research has shown that up to eight times as much progress can be made by selecting on the EPD's as can be made by selecting on the basis of individual performance.

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TABLE 1. Effects of Nutritional Level on Cycling Rate in Yearling Heifers and Calving Rate as 2-Year-Olds.

	Adequate Nutrition			Marginal Nutrition		
Heifer Size	**Small**	**Medium**	**Large**	**Small**	**Medium**	**Large**
Cycling rate, %	98.5	98.3	97.9	83.8	81.5	62.1
Calving rate, %	84.9	84.5	81.8	73.8	67.5	53.0

Adapted from Buttram and Willham (1989).
There was an interaction ($P < .05$) between cow size and nutritional level for both cycling rate and calving rate.

TABLE 2. Size Traits of 5-Year-Old Hereford Cows

	Origin of Cattle					
	Montana	**Florida**	**Montana**	**Florida**	**Montana**	**Florida**
Location	**Fall wt., lb.**		**Body length, in.**		**Wither height, in.**	
Montana	1,128	1,030	55.0	54.0	47.6	46.3
Florida	1,099	973	52.6	52.2	46.5	45.0

Butts et al. (1971)

TABLE 3. Calf 205-d Weight and Rebreeding Percentage of Lactating 2-Year-Old Cows.

Cow breed group	205-d calf wt., lb		Pregnancy rate (%) lactating 2-yr-old
	Male	Female	
Angus-Holstein	431	420	13
Angus	386	344	63
Difference	45	76	50

Adapted from Deutscher and Whiteman (1971).

TABLE 4. Body Weight and Condition Changes in 2-Yr- Old Cows.

Cow Breed Group	Before Calving		After Calving		Difference	
	Wt., lb	Condition	Wt., lb	Condition	Wt., lb	Condition
Angus-Holstein	869	3.26	813	2.43	−56	−.83
Angus	759	4.30	752	4.04	−7	−.26

Adapted from Deutscher and Whiteman (1971).

TABLE 5. Milk Production and Breed-Group Composition of Crossbred Cows with Different Genetic Potential for Milk.

Milk Group	Breed Composition	Daily Milk Production, lb
Low	Hereford × Angus	18.7
Medium	Red Poll × Angus	21.1
High	Milk Shorthorn × Angus	23.1

Adapted from Montaño-Bermudez et al. (1990).

TABLE 6. Calving Rate (%) for Cows of Three Milk Groups and Three Ages.

Age of cow at breeding, yr	Milk Group		
	Low	Medium	High
1	73.6	92.5	81.3
2	78.7	80.6	83.8
3+	93.2	90.4	87.1
Average	83.2	88.2	84.1

Adapted from Montaño-Bermudez and Nielsen (1990).

TABLE 7. Production Efficiencies of *Bos Indicus* × *Bos Taurus* and *Bos Taurus* × *Bos Taurus* F_1 Crossbred Cows, 126-d Drylot Period.

<table>
<tr><th>Cow Breed Group[a]</th><th>Average daily milk production, lb</th><th colspan="2">Efficiency of calf gain, g/Mcal[b]</th></tr>
<tr><td>Brahman × Angus (A) or Hereford (H)</td><td>16.3</td><td>34.6</td><td rowspan="2">35</td></tr>
<tr><td>Sahiwal × A or H</td><td>15.7</td><td>35.2</td></tr>
<tr><td>Pinzgauer × A or H</td><td>16.0</td><td>31.5</td><td rowspan="2">32</td></tr>
<tr><td>H or A × A or H</td><td>14.0</td><td>31.6</td></tr>
</table>

Adapted from Green et al. (1991a).
[a]All calves were sired by Charolais bulls.

TABLE 8. Efficiency to Weaning of *Bos Indicus* × *Bos Taurus* and *Bos Taurus* × *Bos Taurus* F_1 Crossbred Cows.

Cow Breed Group Sire × Dam	Efficiency per unit weaned calf	Efficiency per unit weaned calf plus .55 × cull cow wt.
	Mcal/kg	Mcal/kg
Brahman × Angus (A) or Hereford (H)	57.33	47.52
Sahiwal × A or H	55.97	46.11
Pinzgauer × A or H	60.71	49.69
H or A × A or H	60.32	49.76

Adapted from Green et al. (1991b).
[a]cows mated to Red Poll bulls for first calf and Simmental bulls thereafter.