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COW SIZE AND COWHERD EFFICIENCY

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Introduction

What is the criteria for the right cow size? Is it calf weaning weight and eventual slaughter weight, marketing endpoint, optimal ranch forage utilization, optimizing net returns for the cow/calf operation, or a lower risk production system? The answer is "yes" to all above as they are all interrelated. Optimizing cow-herd production efficiency is a combination of feed inputs and output. In doing so, ranch efficiency requires an understanding and managing for genetic potential (i.e., cow size, milk production) and how it fits within the given environment and environmental constraints. Mature cow size of the herd has long been debated on what the optimal cow size for a given environment is. Cow size has traditionally been utilized in selecting cows to fit their environmental conditions. Cow size studies; however, are often limited in duration, size of study, simulation studies, or usually end at weaning. In semi-arid and limited resource environments, small to moderate size cows have been suggested to be more efficient than and as productive as larger cows.

A driver of cow size at the ranch is the energetic inefficiency of beef production due to the high cost of body maintenance requirements. With that in mind, of the entire beef production system, the beef cow or cowherd is the most energetically demanding segment. For instance, 71% of the total dietary energy expenditure in beef production is used for maintenance and that 70% of the maintenance energy is required for the cow herd (Johnson, 1984). Therefore, an overwhelming 50% of the total energy expended in producing beef is used for maintenance of the cow. However, with more genetic trends and selection for output traits, maintenance cost for the cowherd may have increased over time.

So why are differences in feed intake so important for the cow herd? Feed requirements amount to 50-75% of the annual maintenance requirement costs for the herd. Grazed forages comprise the largest and most important feedstuff for the cow. Due to increased pasture costs, increasing the utilization of forage with the optimal cow size is important. Thus stocking density of the pastures for the cow herd becomes an increasingly important management control point. As mature cow size increases from 1,000 to 1,400 pounds, intake, energy, and protein requirements increase 23%, 19%, and 13%, respectively for cows 90 days post-calving. Consider that each 100 pounds of additional mature cow weight requires the equivalent of about 600 pounds of additional high-quality grass hay per year to maintain their body weight and condition (NASEM, 2016). Bigger cows simply require more feed inputs, partially due to a larger body mass maintenance.

Calf weaning weight to cow weight ratio has previously been used as a measure of efficiency of cow size. However, there are some fundamentally flawed aspects to using this ratio as a measure of ranch efficiency. First of all, forage intake assumptions may be inaccurate, leading to over or under-estimation for inputs. And, milk production can have a negative or positive impact on the ratio. Across commercial and cow/calf operations in Oklahoma, Bir et al. (2018) reported no strong relationship between cow size and calf weaning weight, indicating there is a large variation in weaning weight. However, these authors do indicated that an additional 100 lb of mature cow body weight only resulted in an increase in 7 lb of calf weaning weight. With that in mind, larger cows have increased input costs and in some instances marginal increases in calf weaning weight, which may not pay for the greater input costs. In herds utilizing maternal genetics, calf weaning weight only influences ranch profitability by 5%. In limited nutrient environments, because of their greater maintenance requirements, the breeds with greater growth and milk potentials may have less energy to commit to reproduction. A fifty pound difference in weaning weight is minimal compared to weaning a four hundred fifty pound calf versus no calf.

Gudmundsen Sandhills Laboratory Cow Size Study

The University of Nebraska-Lincoln Institutional Animal Care and Use Committee approved all procedures used in this experiment. Cow performance data were collected from 2005 to 2017 at the Gudmundsen Sandhills Laboratory (Whitman, NE) from March (n = 3,448) and May (n = 934) calving herds.

Cows utilized in this study were Husker Red (5/8 Red Angus, 3/8 Simmental) and ranged from 2 to 11 yr of age. To correct for differences in BCS at weaning, cow body weight at weaning was adjusted to a common body condition score of 5. Cow size groups were then determine by taking the average adjusted BW within each age and stratifying to groups as small (< 1 standard deviation from mean within age), medium (within 1 standard deviation from mean with age), or moderate (> 1 standard deviation from mean with age). Grouping cow size within age was conducted to normalize data within age of cows so that younger cows would not automatically fall into small cow size and confound results by cow age. Cow size treatment groups were stratified within age to eliminate young cows not yet at mature BW from being miscategorized into the small category. In addition, young cows were left in the dataset to determine if cow age interacts with cow size on productivity. Cow BW at weaning ranged from 642 to 1745 lb with only 3% of cows over 1250 lb at weaning over the years.

Cow performance results

Cow BW at pre-calving, breeding, and weaning were greater as cow size increased ($P < 0.01$; Table 1), which was expected due to the experimental design. Moderate cows maintained BW from calving to weaning; whereas, small and medium sized cows lost BW ($P < 0.01$). In addition, BCS was lower ($P < 0.01$, Table 2) for small-sized cows at pre-calving, pre-breeding, and weaning. Pregnancy rates increased with increasing cow size ($P < 0.01$) with the lowest pregnancy rates in small cows. The increase in BW loss and decrease in pregnancy rate in small-sized beef cows may be due to an imbalance of genetic potential for milk production and ability to consume enough forage to support that milk production level. Although milk production level will increase forage intake, cow size will have larger impact on forage intake. Therefore, milk production in the small-sized cows may have been too great for the nutritional environment of the Sandhills, resulting in greater BW loss and decreased reproductive performance.

Calf BW at birth, breeding, weaning, and 205-d weight increased ($P < 0.01$, Table 1) as cow size increased. Calf ADG from birth to breeding was lower ($P < 0.01$) in calves from small-sized dams, where offspring from medium- and moderate-sized cows having similar ADG to breeding. Overall ADG from birth to weaning was greater ($P < 0.01$) in calves from moderate-sized cows. Although, as a percent of cow size, small-sized beef cows did wean a greater ($P < 0.01$)

percentage of their BW compared with their larger counterparts, which is expected. In general, small cows tend to be more efficient at weaning a larger percentage of their BW than larger cows.

Post-weaning steer performance

Steer feedlot entry BW increased ($P < 0.02$, Table 2) as dam size increased. Steer BW at reimplant tended ($P = 0.07$) to increase with increased dam size. In addition, final BW was greater ($P < 0.01$) for steer from moderate cows with no difference in finishing BW between steers from small and medium cows. Although finishing steer BW were lighter from smaller cows, small cows did have steers with a finishing feedlot BW approximately 1.5 times their mature BW. Feedlot ADG, DMI, and G:F were not different ($P \geq 0.52$) among steers from dams with increasing cow size. Similar to final BW, HCW increased ($P < 0.01$) in steers from moderate dams with no difference between steers from small and medium cows. Marbling score and yield grade were not different ($P > 0.39$) regardless of dam size. However, LM area and back fat thickness were different ($P < 0.05$) in steers from differing sized dams. Steers from small cows had decreased LM area compared to their counterparts with no difference between steers from moderate- or medium-sized cows. On the other hand, back fat thickness was greater for steers from small cows compared with steers from moderate- and medium-sized cows.

Conclusion

As beef cattle production costs increase, particularly those associated with feeding the cow herd, the size and nutritional requirements of the cow herd have to be addressed. The challenge for every beef cattle enterprise is to produce calves that meet market requirements as efficiently as possible. When analyzing optimal cow size, producers have to take into account the market endpoint they will be selling into. Cow mature weight has important implications for many of the production parameters associated with the overall cow herd. Heifer development, cow reproduction, and calf performance can be affected by cow weight. If bigger cows wean a heavier calf, does that difference in pounds weaned pay for the difference in forage that the larger dam will consume? In many instances, the level of inputs may be greater for larger cows than the offsetting increase in calf weaning weight.

In the UNL dataset, small cows resulted in decreased reproductive performance, smaller weaning weight of calves, and smaller carcass weights. Increasing cow size above cows managed at Gudmundsen does have a point of diminishing returns. Overall, each individual operation must analyze his own situation within their environment and management goals and fit the cow to that situation, however, at the same time projecting future demands with enough flexibility to make subtle alterations as conditions change. Intuitively, the goal would be modest size cows with high reproductive rates and low input costs which produce high-value calves.

Literature Cited

Bir, C., E. A. DeVuyst, M. Rolf, D. L. Lalman. 2018. Optimal beef cow weights in the U.S. Southern Plains. J. Ag. Res. Econ. 43:102-116.

Johnson, D.E., 1984. Maintenance requirements for beef cattle: Importance and physiological and environmental causes of variation. IN: Proc. Beef Cow Efficiency Forum. Michigan State Univ., E. Lansing, MI and Colorado State Univ., Fort Collins, CO. p. 6.

National Academies of Sciences, Engineering, and Medicine. (2016). *Nutrient requirements of beef cattle* (8th rev. ed.). Washington, DC: National Academies Press. doi:10.17226/19014

Notter, D. R. 2002. Defining biological efficiency of beef production. Proceedings Beef Improvement Federation. Omaha, NE.

Table 1. Effect of cow size on cow-calf performance in the Sandhills.

	Cow Size[1]				
Measurement	Small	Medium	Moderate	SEM	*P*-value
Cow BW, lb					
Pre-calving	961[a]	1,080[b]	1,187[c]	6	< 0.01
Breeding	947[a]	1,065[b]	1,178[c]	6	< 0.01
Weaning	882[a]	1,025[b]	1,187[c]	5	< 0.01
Cow BW change, lb					
Pre-calving to weaning	-72[a]	-54[b]	0[c]	5	< 0.01
Cow BCS[2]					
Pre-calving	4.8[a]	5.1[b]	5.3[c]	0.06	< 0.01
Breeding	5.2[a]	5.4[b]	5.6[c]	0.02	< 0.01
Weaning	4.9[a]	5.1[b]	5.2[c]	0.03	< 0.01
Pregnancy rate, %	86[a]	92[b]	97[c]	3	< 0.01
Calf BW, lb					
Birth	72[a]	76[b]	79[c]	0.6	< 0.01
Breeding	226[a]	235[b]	240[c]	2	< 0.01
Weaning	460[a]	483[b]	498[c]	3	< 0.01
205-d	425[a]	452[b]	474[c]	3	< 0.01
Percent of Cow Size Weaned[3], %	52.5[a]	47.7[b]	42.9[c]	0.4	< 0.01
Calf ADG, lb/d					
Birth to breeding	2.03[a]	2.12[b]	2.13[b]	0.02	< 0.01
Birth to weaning	1.78[a]	1.87[b]	1.94[c]	0.01	< 0.01

[abc]Within a row, means with differing superscript letter differ ($P < 0.05$).

[1]Cow size determined by adjusting cow weaning BW to a BCS 5.

[2]Scale of 1 (emaciated) to 9 (extremely obese).

[3]Calculated by dividing calf weaning weight by dam weaning weight.

Table 2. Effect of cow size on progeny steer feedlot performance.

	Cow Size[1]				
Measurement	Small	Medium	Moderate	SEM	*P*-value
Feedlot Performance, lb					
Entry BW	656[a]	667[b]	693[c]	15	0.02
Reimplant[2] BW	1,027	1,042	1,068	22	0.07
Final BW	1,399[a]	1,413[a]	1,469[b]	22	< 0.01
ADG, lb/d					
Entry to Reimplant	4.07	4.04	3.91	0.30	0.71
Reimplant to Final	3.75	3.81	3.83	0.18	0.74
Overall	3.91	3.95	3.88	0.13	0.66
Dry Matter Intake, lb					
Entry to Reimplant	27.52	27.33	27.87	0.98	0.79
Reimplant to Final	27.51	27.50	27.97	0.94	0.88
Overall	27.45	27.42	27.83	0.88	0.89
Gain:Feed					
Entry to Reimplant	0.1485	0.1486	0.1366	0.0107	0.52
Reimplant to Final	0.1377	0.1398	0.1354	0.0050	0.54
Overall	0.1463	0.1476	0.1421	0.0067	0.66
Carcass Characteristics					
HCW, lb	881[a]	890[a]	925[b]	14	< 0.01
Marbling[3]	506	506	505	16	0.99
LM area, in^2	14.07[a]	14.22[b]	14.41[b]	0.12	0.05
Back fat, in	0.60[a]	0.55[b]	0.53[b]	0.03	0.01
USDA Yield Grade	3.06	2.95	2.98	0.14	0.39

[abc]Within a row, means with differing superscript letter differ ($P < 0.05$).

[1]Cow size determined by adjusting cow weaning BW to a BCS 5.

[2]Approximately, 100 d prior to slaughter.

[3]Marbling: $Small^{00}$ = 400, $Small^{50}$ = 450, $Modest^{00}$ = 500.

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