Examination of the Effects of Weaning Treatment, Breed of Sire, and Hip Height on Seasonal Fluctuation of Weight and Body Condition Score in Angus, Shorthorn, and Simmental Sired Cows

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Introduction

In the United States, beef production is a major industry supplying protein to the human diet. In order to remain competitive with other animal protein sources, the beef industry is dependent upon continuous improvements in genetics and management. Improvement in any one facet of genetics or management can often result in an interaction with other areas. In order to determine if improvement is being made, measurements must be taken and evaluated. Weight and body condition are among the tools used for evaluation of beef cows. Additionally, hip height can be used to indicate an animal's body size and mass, as well as the animal's resulting energy needs. Cows nursing calves have greater energy needs and therefore need to be assessed regularly to determine if those requirements are being met. Reproductive efficiency can be impacted by not only energy, but also by breed of sire, weight fluctuations, and body condition. The cow's weight, body condition, and reproductive ability are also affected by weaning time or days of lactation. Therefore, early weaning has the potential to have a great effect on these production factors as the energy expenditures of lactation will be decreased by removing the calf at approximately 100 days of age versus the industry standard of almost 200 days. This study will consider the effects of weaning treatment, breed of sire, and hip height on seasonal fluctuations of weight and body condition in Angus, Shorthorn, and Simmental sired cows.

Previous studies have focused on the effects of early weaning on the calves themselves. However, little research has been performed on the effects of early weaning on the dam and measurements such as body condition score, weight, and seasonal changes in body condition and weight. Practical considerations, such as the cost of maintaining a beef cow throughout the year, greatly affect the income of the enterprise and are important factors in this study. Each cow has to reproduce as frequently and consistently as possible throughout a long life, in order to counteract the expense of raising her to reproductive age. In a typical beef cow-calf system, the cows gain and lose significant amounts of weight on an annual basis. Weight fluctuations such as these are wasteful processes because energy is consumed both to put fat on and to take fat off.

Early weaning of spring and fall calves can be used to minimize these extremes, as the nursing calf will drain the cow's energy reserves for a much shorter period of time. However, early weaning may not offset the detrimental effects of starting the winter in poor condition due to failure to meet the cows' nutritional requirements in the summer and fall months. The cows will still end up short on energy during the most critical winter months. Therefore, consistency in body condition is very important to the productivity of the cow and the economic expenses of maintaining her. Factors that can affect the variation in body condition include genetics, skeletal size, and length of the lactation period.

Greater understanding of the factors that contribute to the condition of a cow will allow for better selection and culling practices. Rating the relative importance of the factors will allow a producer to make a more informed decision when maintaining a herd of cattle. This information will help to lower the cost of maintaining a cow year round.

The objectives of this study were to: 1) determine if weaning status, breed of sire, and hip height affects seasonal fluctuation in weight and body condition score; 2) ascertain the degree of weight and body condition change in animals of differing hip height; 3) determine whether Angus and Shorthorn sired females (British breed cattle) or Simmental sired females (Continental breed cattle) maintain a better year-round body condition; and 4) evaluate the relationship between the cow's body weight and condition and the weaning age of her calf.

Literature Review

Maximum production efficiency is the primary goal of cow-calf operators and is partially dependent on the breed or breeds involved. Producers have used selective breeding for several hundred years to develop a variety of breeds; each of which can perform differently under specific circumstances. The Angus, Shorthorn, and Simmental breeds are prevalent in Ohio, as well as throughout the United States. Angus have been bred for their high-quality carcasses, in addition to other desirable traits such as ease of calving, good mothering habits, early maturity, and long productive lives. Shorthorn cattle share many similarities with Angus cattle including high milking ability, in addition to being roughly equivalent in size and frame. Shorthorn carcasses are noted for being high in marbling, another advantage for the breed. In comparison to the Angus and Shorthorn breeds, Simmental cattle bring advantages to a herd such as rapid growth rate, greater muscle mass and frame size, and better carcass cutability.

While each breed brings advantages to the operation, other factors must be balanced for a particular cattle breed to work in any environment. Management, nutrition, and health can greatly affect the growth and development of the skeleton of an animal. In addition to weight and body condition evaluations to determine growth patterns, height can also be an indicator of continued growth, especially in young cows. In a study by Vargas et al. (1999) on Brahman cows, heifers were assigned to frame size groups based on hip height. They found that small (115 to 126 cm) and medium (127 to 133 cm) frame size heifers attained puberty at younger ages, calved earlier, and had calves with greater weaning weights than the large (134 to 145 cm) frame size heifers. However, the large frame size cows achieved similar levels in their performance traits as the small frame size cows, though only at maturity. The study also found that large frame size heifers had lower Body Conditions Scores (BCS), indicating that their nutritional needs were not met during the course of the experiment. Large mature size and mass is not considered beneficial in a breeding herd, as these animals require more energy for maintenance, thus increasing costs and the difficulty of meeting their nutritional needs (Buttram and Willham,

1989; Fiss and Wilton, 1992). Commercial producers are also challenged to maintain cattle with higher energy demands because sorting larger framed animals and meeting their needs with increased nutrition may be more costly and inefficient than maintaining moderately framed cows. Therefore, depending on the particular environment and needs of the producer, different breeds may be better suited to each individual situation. As noted in a study of Angus and Hereford females by Holloway and Totusek (1973), Angus cattle mature faster, though little difference in height at the hips was noted due to differences in their weaning age or feeding program. For this study, the feed program included pasture, supplemental feed, or creep feeding, and for each group the minimum energy needs were met.

A successful operation is not only affected by the physical traits of the cattle, but also by the management program. Weaning calves earlier than the industry standard of 200 days of age is fostering growing interest within the industry, but the system needs to be thoroughly evaluated to determine if it will be successful for a particular production system. When a calf is early weaned, the beef cow's responsibilities are reduced. She has to produce a good calf and give it a positive start in life for only a brief period of time before she begins a maintenance ration for the rest of the year. Early weaning has the potential to serve as an alternative to traditional methods, with the advantage of minimizing fluctuations in weight and body condition, as found in a study by Peterson et al. (1987). In their study, fall calving Angus × Hereford cows were divided into groups that were early weaned in mid-December or normal weaned in mid-April. The calves varied in age by fifty-nine days. Early weaned calves averaged 110 days and normal weaned calves averaged 222 days at weaning. Lactating cows with normal weaned calves were not able to consume enough feed to meet the nutritional and energy requirements of the body. Stored energy had to be utilized for lactation, thus depleting body reserves, and producing a significant difference in cow weight between the early and normal weaning groups. Early weaned cows gained 2.5 ± 3.3 kg, while normal weaned cows lost 18.2 ± 2.9 kg from the time of early weaning to the time of normal weaning. Neville and McCormick (1981) also found that cows whose

calves were early weaned gained more weight during the months from the time that their calves were early weaned to the time of normal weaning. Cows whose calves were normal weaned did not have the opportunity to gain weight during those two to three months as they were still lactating.

Peterson et al. (1987) also found that early weaning minimized fluctuations in body condition of the early-weaned cows. While no notable difference in condition at time of normal weaning between the early and normal weaned groups of cows was found, it was important to note that the normal weaned cows lost condition from December to April. The lack of change in body condition in early weaned versus normal-weaned cattle was also noted in a study of 395 Shorthorn × Angus × Hereford crossbred cows by Grimes and Turner (1991). They found that the dams of early-weaned calves had body condition scores averaging 3.20, while the body condition scores of normal weaned calves averaged 3.09, not a statistically significant difference.

Early weaning, in addition to minimizing weight and body condition fluctuations, can also be cost effective as found in a study by Knabel et al. (1989). They found that the cost to maintain non-lactating cows was less than the cost of maintaining lactating cows with calves. The study by Peterson et al. (1987) also considered feed consumption and cost factors and found similar results. On a total digestible nutrient basis, they found that the early-weaned cow-calf pairs consumed 20.4% less than the normal-weaned cow-calf pairs from the time of early weaning to the time of normal weaning. Early weaned cow-calf pairs also excelled in converting kilograms of total digestible nutrients into kilograms of calf gain by being 43.9% more efficient than the normal-weaned cow-calf pairs. Short et al. (1996) similarly found that, though larger cows weaned heavier calves, when the efficiency of the conversion of feed consumed to pounds of calf produced was calculated, the effect of higher weaning weight in the calves were voided. Peterson et al. (1987) noted that this is one of the biggest advantages of early weaning, as approximately 70% of the production costs of raising beef cattle are feed costs. This indicates that the early weaning system can be a useful alternative for producers. Early weaning is

beneficial to the cow and does not cause significant management or feeding difficulties when beef calves are weaned at three to four months of age, according to studies by Green and Buric (1953), Harvey et al. (1975), and Williams et al. (1975).

Early weaning impacts skeletal development, weight, and body condition fluctuations and can also have an impact on reproductive efficiency in cattle. Early weaning has been shown to have a positive effect on productivity in beef cattle. According to a study by Laster et al. (1973), the onset of estrus in beef cows is delayed by the nursing of their calves. Further, the time interval from parturition to estrus is affected by the frequency and intensity of suckling (Wettemann et al., 1978). The correlation between weaning and reproductive efficiency is also supported by a study of first-calf heifers whose progeny were early or late weaned (Lusby et al. 1981). This study found that 90.3% of the heifers whose calves were early weaned showed estrus activity 85 days postpartum, whereas only 34.3% of the heifers whose calves were normal weaned showed ovarian activity by 85 days postpartum.

In order to produce efficiently, a cow must have her nutritional requirements met. The body condition score (BCS) system can be a useful management tool to enhance reproductive performance within the herd, as it is an analysis of the amount of fat that a cow is carrying. Plus, the BCS with weight system was found to be more precise in predicting cow body composition than the more commonly used weight or metabolic weight measurements (Thonney, et al., 1976; Houghton, et al., 1990b). Though the BCS system is subjective, it can be used to make sound management decisions when one person consistently assigns scores to the cows at regular intervals throughout the year.

Evaluations of body condition are particularly essential at calving and at weaning. Studies have shown that visual body condition scoring may be practical as a means of evaluating condition, in order to achieve optimal reproductive performance in a reproductively mature cow (Dunn and Kaltenbach, 1980; Richards et al., 1986; Selk et al., 1988). Low body condition at calving can cause increases in postpartum anestrus, calving interval, percent open cows, and

parasite and disease susceptibility, as well as lower milk production, which results in lower calf weaning weights. In addition to these problems, cows that carry excessive condition are also susceptible to complications at calving time. According to a study by Houghton et al. (1990a), cattle that are maintained at an average body condition from parturition to conception have higher pregnancy rates. Therefore, cattle that are at the extremes of body condition, either excessively thin or fleshy, should be managed to achieve a more moderate body condition before the breeding season begins, in order to maximize breeding performance. Relating body composition and optimal reproductive performance for cows will allow the BCS to be used in identifying which cows need to gain and which ones should lose body weight to achieve a moderate body composition (Houghton et al., 1990a). Greater consistency in body condition requires fewer feed intake adjustments, as well as lower management expenses.

Materials and Methods

Animals

A total of 73 crossbred cows (16 Angus, 15 Shorthorn, and 42 Simmental sired cows) were utilized in the study. All animals were kept on the Jackson branch of the Ohio Agricultural Research and Development Center in Jackson, Ohio from 1994 to 1998. Summer diet consisted of pasturing on a mix of fescue and orchard grass. Pastures were not intensively grazed, as the cattle were rotated from each pasture after a few weeks of grazing. The winter diet, fed from December until March, consisted of fescue and red clover hay. All animals were provided with a free choice salt and mineral supplement year round.

Data Collection

The cow-calf operation had a calving season that was sixty days long, lasting from mid-February to mid-April. The cattle were artificially inseminated at least once and then exposed to a clean-up bull so that they would calve during this time period. The cows were then allotted randomly within age to the two treatment groups. The calves were either weaned at the industry standard of 205 ± 30 days of age or early weaned at 100 ± 30 days of age. Thirty-seven animals were weaned at the normal time with their dams serving as the control group. The experimental group consisted of thirty-six cows that had their calves early weaned. Each weaning group consisted of approximately half Angus or Shorthorn sired females (smaller framed cattle) and half Simmental sired females (larger framed cattle). Other than the difference in weaning age of the calves, the two groups were managed similarly.

On a quarterly basis, in January to March, April to June, July to September, and October to December, the cattle were weighed and body condition scores assigned. The same person used the standard 1 through 9 Body Condition Scoring (BCS) System for beef cattle each quarter. Successful use of the BCS system required evaluation of six critical areas: the brisket, back, ribs, hooks, pins, and tail head. The numerical range of 1 to 9 identified varying degrees of fatness, with 1 being very thin and 9 being excessively fat. It was important to account for pregnancy

status, gut fill, hair coat, and age when scoring cows for body condition. A body condition score of 5 was considered optimal. During one of the quarters, in 1995 and 1997, hip height measurements were taken. These data were added to farm records, which included the age and genetic history of the animal.

Statistical Analysis

All data were evaluated using the General Linear Model procedures of SAS (SAS Inst. Inc., Cary, NC). The model for the analysis of quarterly weight, average weight, quarterly BCS, and average BCS included the fixed effects of weaning treatment, breed of sire, and year of birth, as well as the covariate hip height.

Results and Discussion

The breed and treatment distribution of all animals included in the study are displayed in Table 1. Analysis of the average weight during each quarter demonstrated the impact of early and normal weaning on the dams' weight fluctuations (Table 2). Cows were early weaned at the end of June allowing for variation of ± 30 days from the 100-day base age. Thus, they did not have a calf on them during the third quarter of the year. The early-weaned cows were significantly ($P = 0.003$) heavier than the normal-weaned cows whose calves continued to nurse until their weaning time in late September. Weaning status continued to play a significant role ($P = 0.01$) in the amount of weight the cows carried into the winter months of the fourth quarter, October through December. By the end of the fourth quarter, normal-weaned cows had begun to regain some of the weight that they had lost supplying the energy needs of their calves for a more extensive period of time than early-weaned cows. Therefore, during the first quarter of the following year, weaning treatment did not have a significant effect ($P = 0.08$) on weight. The second quarter of the following year also revealed no significant effect due to weaning treatment, as many of the cows were pregnant or had just freshened.

The yearlong average weight of the dam was significantly associated with weaning treatment (Table 2, $P = 0.03$). Females that were early weaned maintained a greater yearlong average weight with less fluctuation than females that were weaned at the industry standard of 205 ± 30 days. The yearlong average BCS was also significantly affected by weaning treatment ($P = 0.002$), as expected. By decreasing the fluctuations in weight and body condition of the dam with early weaning, less of the nutritional value of the winter feed is put toward replacing the weight and energy stores of the cow that had been depleted during nursing.

Additionally, the cows that were early weaned maintained a slightly higher average BCS throughout each quarter of the year (Table 2). During the third quarter of the year when the early-weaned cows were no longer nursing their calves, they showed a significantly higher ($P < 0.0001$) BCS of 5.71 ± 0.17, versus the normal-weaned cows' (that were still nursing calves) BCS of 4.70 ± 0.17. This trend continued into the fourth quarter when weaning treatment again significantly ($P = 0.001$) affected the amount of condition the cows had at the start of fall and winter.

The direct effect of early versus normal weaning was significant for both body weight and body condition during the third and fourth quarters of the year. Therefore, it appears that weaning treatment affects the seasonal fluctuation in weight of a cow. Implementation of early weaning may then provide additional benefits by increasing cow reproductive performance and lowering the costs of maintaining the non-lactating cow (Knabel et al., 1989).

The analysis of the affect of the breed of sire (Table 3) included cows in both the early and normal weaned groups thus examining the spectrum of weights and body condition scores. Sire breed also had a small impact on quarterly body weights. During the first quarter of the year, breed of sire had a significant effect on the dams' weight ($P = 0.04$). Being similar in frame size, the Angus and Shorthorn crossbred cows weighed approximately 100 pounds less than the larger framed Simmental crossbred cows. Breed of sire was not a significant factor for the second through fourth quarters. Breed of sire also did not have a significant effect on the yearlong average weight ($P = 0.15$).

Greater weight fluctuations between quarters were found in the larger Simmental crossbred cows. Between the first and second quarters of the year, the Simmental cows' average weights decreased by approximately 150 pounds, while the Angus and Shorthorn cows' average weights changed by only about 100 pounds. The dramatic change in the Simmental cows' weights can be attributed in part to parturition, where the 75 to 100 pound calf each cow was carrying was no longer included in their weight. Some of the weight loss may also have been due

to other factors such as inadequate nutrient and energy intake during initiation of lactation and failure of the diet to meet the greater needs of the cow during the first weeks of greatest milk production. The Simmental cows regained much of the lost weight during the summer months, from a low of 1262.93 ± 30.19 pounds during the second quarter to 1315.02 ± 29.03 pounds during the third quarter. Yet this was a very wasteful process, as larger framed cattle naturally have greater nutritional needs. Instead of benefiting from extra energy reserves added for the fall and winter months, these animals were only able to replace the reserves they had lost during the raising of their calves.

Breed of sire had a significant (P = 0.01) effect on the yearlong average body condition of the dam. However, during the individual quarters of the year, no significant effect was noted (Table 3). The Simmental crossbred cows had higher condition scores than the Angus and Shorthorn cow groups, which was unexpected especially after noting their weight fluctuations. These larger framed cattle maintained a more stable condition during lactation. This may be due to the greater resources these cattle had available while providing for their calves in comparison to the Angus and Shorthorn cattle. It was interesting to note that during the third quarter, the Shorthorn cattle that had either weaned their calves or were still nursing had an average BCS of 4.76 ± 0.45, the lowest of the year.

The BCS system can be advantageous when used consistently. More accurate knowledge of the energy requirements of the cow would allow for improved utilization of feedstuffs through the postpartum period before weaning (Houghton et al., 1990a). Use of the BCS system offers further advantages according to Houghton et al. (1990b), in that the cows do not have to be restrained for evaluation, which can be made frequently, and no special equipment is required. In this study, BCS was most useful during the third and fourth quarters, when weaning treatment had a significant effect.

According to Houghton et al. (1990b) height and weight can be used to evaluate mature cow body composition. They are the most reliable for comparison of cows of the same breed that

have a common nutritional background (Klosterman et al., 1968; Nelsen et al., 1985). Hip height was evaluated in both 1995 and 1997 (Table 4), where it had a significant impact ($P = 0.04$, $P = 0.0001$) on the yearlong average weight. Hip height was not significantly associated with body condition for the larger framed Simmental crossbred cows. However, the greater seasonal weight fluctuations of these cattle may be due to the significant effect that hip height had during the second and fourth quarters of both years (Table 4).

Conclusion

This study found that weaning treatment, breed of sire, and cow size significantly impact seasonal weight fluctuations and the corresponding body condition of beef cows. Early weaning had a positive effect on the weight and body condition of the cow. Average weight and average BCS fluctuated less in the early-weaned cows versus normal-weaned cows. The Simmental cows had greater fluctuations in weight, while maintaining the most steady body condition score. The Angus and Shorthorn cows weighed the least during the second quarter of lactation, though body condition score did not change significantly with the change in weight.

Further research would be beneficial in determining the effect of early weaning on the cows' number of productive years in a herd. Also, simultaneous research that would follow the calves into feedlots or back into the breeding herd and evaluate their productivity measurements would also be an important factor in the analysis of the impact of early weaning.

Table 1. Distribution of cows by breed and weaning treatment group

Breed of Sire	**Weaning Treatment**		**Total**
	Early[a]	**Normal**[b]	
Angus	5	11	16
Shorthorn	9	6	15
Simmental	22	20	42
Total	36	37	73

[a] Calves weaned at 100 ± 30 days of age

[b] Calves weaned at the industry standard of 205 ± 30 days of age

Table 2. Least-squares means and standard errors for production measurements based on weaning treatment

Production Measurement	Weaning Treatment		P-value[c]
	Early[a]	Normal[b]	
Average Weight[d]			
Quarter 1	1371.09 ± 20.89	1330.68 ± 21.15	0.08
Quarter 2	1239.53 ± 15.58	1225.93 ± 15.78	0.43
Quarter 3	1315.96 ± 14.98	1265.44 ± 15.17	0.003
Quarter 4	1386.77 ± 16.17	1339.66 ± 16.37	0.01
Yearlong Average Weight[e]	1315.26 ± 14.81	1279.92 ± 14.99	0.03
Average BCS[d]			
Quarter 1	5.77 ± 0.15	5.58 ± 0.15	0.25
Quarter 2	5.63 ± 0.15	5.40 ± 0.15	0.17
Quarter 3	5.71 ± 0.17	4.70 ± 0.17	<0.0001
Quarter 4	5.85 ± 0.12	5.39 ± 0.12	0.001
Yearlong Average BCS[f]	5.73 ± 0.12	5.29 ± 0.13	0.002

[a] Calves weaned at 100 ± 30 days of age

[b] Calves weaned at the industry standard of 205 ± 30 days of age

[c] Significance level of effect of weaning treatment on the production measurement

[d] Average of all weights or BCS from each individual quarter throughout the study

[e] Average weight of each cow's yearly average weight for the duration of the study

[f] Average BCS of each cow's yearly average BCS for the duration of the study

Table 3. Least-squares means and standard errors for production measurements based on breed of sire

Production Measurement	Breed of Sire			
	Angus	**Shorthorn**	**Simmental**	**P-value[a]**
Average Weight[b]				
Quarter 1	1311.45 ± 51.92^{y}	1325.31 ± 54.62^{yz}	1415.89 ± 40.48^{z}	0.04
Quarter 2	1219.05 ± 38.721	1216.22 ± 40.74	1262.93 ± 30.19	0.31
Quarter 3	1286.08 ± 37.23	1270.98 ± 39.17	1315.02 ± 29.03	0.51
Quarter 4	1343.24 ± 40.18	1349.97 ± 42.28	1396.66 ± 31.33	0.22
Yearlong Average Weight[c]	1278.79 ± 36.79^{y}	1280.81 ± 38.71^{yz}	1333.17 ± 28.69^{z}	0.15
Average BCS[b]				
Quarter 1	5.35 ± 0.38^{y}	5.72 ± 0.40^{yz}	5.96 ± 0.29^{z}	0.14
Quarter 2	5.51 ± 0.38	5.13 ± 0.40	5.91 ± 0.29	0.23
Quarter 3	5.47 ± 0.42	4.76 ± 0.45	5.40 ± 0.33	0.66
Quarter 4	5.79 ± 0.31	5.22 ± 0.32	5.85 ± 0.24	0.49
Yearlong Average BCS[d]	5.56 ± 0.31	5.16 ± 0.32	5.80 ± 0.24	0.01

[a] Significance level of effect of breed of sire on the production measurement

[b] Average of all weights or BCS from each individual quarter throughout the study

[c] Average weight of each cow's yearly average weight for the duration of the study

[d] Average BCS of each cow's yearly average BCS for the duration of the study

[y-z] Within a row, means without a common superscript letter are different ($P < 0.1$)

Table 4. P-values for the effect of hip height on production measurements

Production Measurement	Hip Height P-Values[a]	
	1995	1997
Average Weight[b]		
Quarter 1	0.08	0.11
Quarter 2	0.05	0.0001
Quarter 3	0.10	<0.0001
Quarter 4	0.01	0.004
Yearlong Average Weight[c]	0.04	0.0001
Average BCS[b]		
Quarter 1	0.69	0.50
Quarter 2	0.55	0.33
Quarter 3	0.50	0.78
Quarter 4	0.59	0.60
Yearlong Average BCS[d]	0.72	0.50

[a] Significance level of effect of hip height on the production measurement

[b] Average of all weights or BCS from each individual quarter throughout the study

[c] Average weight of each cow's yearly average weight for the duration of the study

[d] Average BCS of each cow's yearly average BCS for the duration of the study

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