Effect of weaning and production management strategies on calf growth and carcass traits*

M.M. Thompson[1], C.S. Schauer[1], V.L. Anderson[2], B.R. Ilse[2], J.C. Galbreath[3] and R.J. Maddock[3]

This study investigated the effects of weaning date (early vs. normal) and production system practices (natural vs. conventional) on calf growth and carcass traits in May-born Angus calves during the grow-finish period. Our research suggests that conventionally managed calves gained more weight in the background and finish periods than naturally managed calves, and early weaned calves may gain more slowly than normally weaned calves.

[1] Hettinger Research Extension Center, North Dakota State University, Hettinger, ND 58639

[2] Carrington Research Extension Center, North Dakota State University, Carrington, ND 58421

[3] Department of Animal Sciences, North Dakota State University, Fargo, ND 58105

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Summary

This study investigated the effects of weaning date (early vs. normal) and production system practices (natural vs. conventional) on calf growth and carcass traits in May-born Angus calves during the grow-finish period. One of four production management treatments (TRT) was assigned to 81 Angus steer and heifer calves at the NDSU Hettinger Research Extension Center: early wean-conventional production (EWC; 137 days old), early wean-natural production (EWN; 132 days old), normal wean-conventional production (NWC; 192 days old) and normal wean-natural production (NWN; 199 days old). After the background period (EW = 115 days and NW = 59 days), calves were shipped to the NDSU Carrington Research Extension Center for finishing.

Calves were fed to a common end weight (1,100 pounds) and back fat thickness (0.4 inch) prior to harvest. Calves were harvested and individual carcass measurements collected on two dates. The weaning date impacted weaning weights and background weight gain (P <0.001); however, background end weights were similar across TRT (P = 0.42) after 115 days. At the end of the 133-day finish period, final weight, total gain and average daily gain (ADG) were different across TRT ($P \leq 0.01$). Most carcass traits were similar at harvest (P > 0.05) regardless of TRT, with the exception of hot carcass weights (P = 0.02). Our research suggests that conventionally managed calves gained more weight in the background and finish periods than naturally managed calves, and early weaned calves may gain more slowly than normally weaned calves.

Introduction

Most cow-calf producers in the northern Great Plains calve beef cows in the late winter-early spring months (February and March), guaranteeing ranch resources, time and labor will be readily available in the spring for annual crop planting and fieldwork needs. Conversely, some cattle producers have chosen to calve during the late spring months (May and June) to follow nature's traditional growth patterns for pasture grasses. With a later calving season, higher-quality grazing diets are provided for lactating brood cows and nursing calves, further maximizing milk production and calf growth. However, during drought when forage supplies become limited, the calf-weaning date is moved forward, sparing necessary forage resources for gestating and/or lactating beef cows.

The definition of early weaning varies; generally, calves weaned before 150 days of age are considered early weaned (Loy et al., 1999). Most research on early weaning has focused on late winter-early spring (February and March) calving cowherds (Schoonmaker et al., 2001; Story et al., 2000), with little research evaluating early weaning outcomes on late spring-born (May and June) calves. In recent years, marketing opportunities have grown for "natural" beef, which are cattle raised without antibiotics and growth-promoting technologies such as ionophores and implants. Cattle producers question how "never, ever" natural production practices measure up to mainstream conventional production systems.

Furthermore, few studies have examined the consequences of late spring-born calves raised under natural production system practices. Our study objective was to investigate the effects of weaning date (early vs. normal) and production system practices (natural vs. conventional) on calf growth and carcass traits in May-born Angus calves during the grow-finish period. We hypothesized the early weaned calves raised under natural production practices would have more morbidity, resulting in reduced performance and lower carcass quality as compared with the other three production systems (early weaned-conventional, normal weaning-conventional and normal weaning-natural calves) studied.

Materials and Methods

The NDSU Institute for Animal Care and Use Committee approved all protocols. The experiment was conducted at the NDSU Hettinger Research Extension Center's feedlot in Hettinger, N.D., and the NDSU Carrington Research Extension Center's feedlot in Carrington, N.D. Eighty-one Angus steer and heifer calves (average birth date = May 3 ± 2.12 days) from the NDSU Hettinger Research Extension Center's cowherd were assigned to two weaning dates: early wean = Sept. 13 and Sept. 14, 2007, (EW), or normal wean = Nov. 15 and Nov. 16, 2007, (NW).

On respective weaning dates, EW and NW calves were hauled (five miles) to the feedlot after morning gathering and weighing in the pasture. Calves assigned to the EW group averaged 422 pounds at weaning, while NW calves averaged 553 pounds at weaning. All calves were fed a receiving ration (total mixed ration) containing 27.6 percent barley silage, 7.4 percent protein supplement, 29.5 percent ground mixed hay, 29.8 percent whole barley, 2.7 percent deccox crumbles, 2.4 percent sodium bicarbonate and 0.6 percent calcium carbonate (dry-matter basis; 14.8 percent crude protein; 0.52 megacalories/pound of net energy for gain) for the first 17 days (EW) and 10 days (NW) after weaning.

On Oct. 2, 2007, (EW) and Nov. 27, 2007, (NW) calves were weighed following an overnight shrink, stratified by weight and sex, and allotted to one of 12 pens (six or seven calves/pen) for backgrounding (EW = 115 days; NW = 59 days). Pens were assigned to one of four production management treatments (TRT; n = 3): early wean-conventional production (EWC), early wean-natural production (EWN), normal wean-conventional production (NWC) and normal wean-natural production (NWN). Calves receiving "natural" treatments (EWN and NWN) did not receive growth-promoting implants and were not fed ionophores. When natural fed calves were treated with antibiotics for illness, they were removed from their respective treatments. Calves were fed a 58:42 forage:concentrate diet during the growing period (14 percent crude protein; 0.52 megacalories/pound of net energy for gain growing diet; dry-matter basis; Table 1). The conventional protein supplement for the growing diet provided 225 milligrams/hd/d of Rumensin (Elanco Animal Health, Indianapolis, Ind.) and 0.5 mg/lb MGA (melengestrol acetate,

Table 1. Dietary ingredient and nutrient concentration of calf growing and finishing diets.

Item	Growing Diet	Finishing Diet
Ingredient, % DM		
Barley silage	27.8	-
Calcium carbonate	0.60	-
Corn silage	-	13.3
Deccox crumbles	2.7	-
Growing supplement[a,b]	7.5	-
Finishing supplement[c,d]	-	1.4
Mixed hay, ground[e]	29.8	-
Rolled corn	-	45.0
Sodium bicarbonate	1.60	-
Wet distillers grain	-	35.0
Wheat straw, chopped	-	5.30
Whole barley	30.0	-
Nutrient concentration[f]		
% DM	57.8	67.0
CP, % DM	14.0	14.0
NEg, Mcal/lb. DM	0.52	0.62
Ca: P	2.55	2.0

[a]Natural calf growing supplement contained min 26% CP, 3.4% Ca, 0.7% P, 1.38% K, no animal byproducts, and no medications.
[b]Conventional calf growing supplement contained min 26% CP, 3.4% Ca, 0.7% P, 1.38% K, no animal byproducts, 225 mg/lb Rumensin® and 0.5 mg/lb. MGA (melengestrol acetate).
[c]Natural calf finishing supplement contained Rumatec® Finisher at 0.5 ounces/day (as fed).
[d]Conventional calf finishing supplement provided Rumensin® at 300 mg and MGA (melengestrol acetate) at 0.50 mg (as fed).
[e]Mixed hay composed of equal parts barley and alfalfa-grass hays.
[f]Analytical results for growing diet are from composited samples; analytical results for finishing diet are from balanced feeding rations.

Pfizer Animal Health, N,Y,), while the natural supplement was unmedicated.

Diets were formulated for 2.20 pounds of daily gain; diets were isonitrogenous and isocaloric at the study start. Diets were fed once daily (9 a.m.) and slick bunk management was used to determine individual pen daily feed allotment. Calves had free access to water in ice-free automatic fence line water fountains. All calves were dewormed and vaccinated for respiratory and clostridial diseases, and conventional calves were implanted with a Ralgro implant (36 mg zeranol; Schering-Plough Animal Health Corp., Kenilworth, N.J.) at the start of their respective background periods.

Calves were checked daily for signs of bloat and respiratory illness. Calf weights were recorded on day 0, 28, 56, 59, 85 and 114. Initial and final weights were determined by weighing each animal following an overnight shrink before feeding, while interim body weights were measured as unshrunk weights recorded prior to feeding. Background diet samples were collected (day 1, 7, 36, 55, 74, 92 and 100), composited by treatment and analyzed by a commercial laboratory (Midwest Laboratories, Omaha, Neb.) for nutrient analysis.

After backgrounding, calves were shipped to the NDSU Carrington Research Extension Center for finishing on Jan. 28, 2008. Calves were dewormed, revaccinated for respiratory and clostridial diseases, and commingled into one of two finishing pens based on production practices (natural or conventional) at arrival. Calves were fed a 19:81 forage:concentrate diet (14 percent crude protein; 0.62 megacalories/pound of net energy for gain; finishing diet; dry-matter basis; Table 1) to a common end weight (1,100 pounds) and back fat thickness (0.4 inch) prior to harvest. The finishing supplement for the natural calves contained Rumatec Finisher (Ralco Nutrition Inc., Marshall, Minn.), a natural feed additive (as previously described by Anderson et al., 2008) fed at 0.5 ounce/head/day. The conventional finishing supplement provided 300 mg Rumensin (Elanco Animal Health, Indianapolis, Ind.) and 0.5 mg MGA (melengestrol acetate, Pfizer Animal Health, N.Y.) per head per day.

Unshrunk calf weights were recorded (day 44, 86, 99, 119 and 133). Final weights were measured on all calves prior to shipping for harvest. Conventional calves were reimplanted (day 86; Synovex Choice, 100 mg trenbolone acetate and 14 mg estradiol benzoate; Wyeth Animal Health, Madison, N.J.) and all calves were given an ultrasound test to measure fat thickness for determining marketing date (day 99).

Calves (n = 77) were harvested and individual carcass measurements collected on two dates (May 28 and June 11, 2008) at Tyson Foods (Dakota City, Neb.). On the first harvest date, 20 calves were harvested (10 from each pen), while the remaining calves were fed for 14 more days. Following a 24-hour chill, qualified university personnel, in concert with USDA graders, collected carcass data on the individual carcasses. Carcass traits measured included hot carcass weight; marbling scores; 12th rib fat thickness; longissimus area; kidney, pelvic and heart fat; and USDA yield grade. Calf growth and carcass traits were analyzed as a completely randomized design with the backgrounding pen serving as the experimental unit. Treatment means were separated by least square means following a protected F-test ($P < 0.05$).

Results and Discussion

Growing Performance. The effects of weaning and management strategies on calf performance and health are shown in Table 2. One calf (EWN) died because of bloat during the background period. All performance data from the removed calf was deleted from subsequent performance analyses.

Additionally, three more calves were treated for ruminal bloat (EWC = one and EWN = two) and five calves were treated for respiratory illness (EWC = one, NWC = one, NWN = one and EWN = two). Of the calves treated for respiratory symptoms, three of the five calves required additional treatment with a second antibiotic (one calf each for EWN, EWC and NWN, respectively) during the background period. Natural calves treated with antibiotics remained with their respective pens during the background period. Because of treatment, these natural calves no longer were considered natural and were marketed as conventional calves at harvest, resulting in lost premiums for natural production. Calves were revaccinated for respiratory diseases on day 85 because of intermittent nasal discharges during backgrounding. Final veterinary medicine costs, bloat events, respiratory illness treatments and calf mortality were unaffected by TRT during backgrounding ($P > 0.05$; Table 1).

By design, weaning date impacted weaning weights; early weaned calves were lighter and younger at weaning (422 pounds; 135 days of age) compared with normally weaned calves (553 pounds; 196 days of age; $P < 0.001$). Weight gain, ADG and feed efficiencies (gain:feed) were greater for EWC compared with EWN during the first 28 days on feed ($P \leq 0.01$), although feed cost/pound of gain did not differ across TRT ($P = 0.05$). Similarly, in period two, weight gain, ADG and gain:feed were greater for EWC calves than EWN calves ($P \leq 0.02$), while feed cost/pound of gain and veterinary medicine costs were similar across TRT ($P \geq 0.05$). Dry-matter intakes (DMI) also were similar in this period, averaging 12.75 pounds ($P = 0.85$). No significant differences

Table 2. Effect of weaning and management strategies on calf performance and health.

Item	Treatments					
	EWC[a]	EWN[b]	NWC[c]	NWN[d]	SEM[e]	*P*-value[f]
No. head	20	21	19	21	-	-
Wean weight, lb.	423^{g}	420^{g}	546^{h}	560^{h}	6.41	< 0.001
Age at weaning, days	137^{g}	132^{g}	192^{h}	199^{h}	2.04	< 0.001
Initial weight, lb.	426^{g}	456^{g}	574^{h}	572^{h}	6.39	< 0.001
Period 1, day 0-27						
DMI, lb./d	10.3^{g}	12.7^{h}	-	-	0.36	0.01
28-day gain, lb.	72^{h}	37^{g}	-	-	5.93	0.01
ADG, lb./d	2.56^{h}	1.32^{g}	-	-	0.21	0.01
Gain:feed	0.25^{h}	0.10^{g}	-	-	0.02	0.01
Feed cost/lb gain, $/lb.	0.37	0.78	-	-	0.11	0.05
Veterinary medicine costs, $/hd	9.97	10.02	-	-	1.77	0.98
Period 2, day 28-58						
DMI, lb./d	12.7	12.8	-	-	0.30	0.85
31-day gain, lb.	49^{h}	30^{g}	-	-	2.66	0.007
ADG, lb./d	1.52^{h}	0.92^{g}	-	-	0.08	0.006
Gain:feed	0.12^{h}	0.07^{g}	-	-	0.009	0.02
Feed cost/lb. gain, $/lb.	0.75^{g}	1.16^{h}	-	-	0.07	0.01
Veterinary medicine costs, $/hd	0.93^{g}	1.11^{g}	8.15^{h}	7.79^{h}	0.75	< 0.001
Period 3, day 59-84						
DMI, lb./d	15.9	16.4	16.1	14.9	0.44	0.16
26-day gain, lb.	104	99	109	98	6.0	0.59
ADG, lb./d	4.01	3.80	3.74	3.44	0.20	0.33
Gain:feed	0.25	0.23	0.23	0.23	0.01	0.58
Feed cost/lb. gain, $/lb.	0.36	0.37	0.35	0.37	0.02	0.85
Veterinary medicine costs, $/hd	0.06	0.16	0.47	0.41	0.32	0.77
Period 4, day 85-114						
DMI, lb./d	17.9	18.6	18.4	18	0.55	0.77
30-day gain, lb.	43	70	44	39	10.9	0.25
ADG, lb./d	1.50	2.41	1.51	1.35	0.37	0.24
Gain:feed	0.08	0.13	0.08	0.08	0.02	0.25
Feed cost/lb. gain, $/lb.	1.37	0.68	1.61	1.20	0.42	0.49
Veterinary medicine costs, $/hd	2.14	2.03	2.14	3.43	0.65	0.42
Overall, day 0-114						
Background period end weight, lb.	694	700	726	711	13.6	0.42
DMI, lb./d	14.2^{g}	14.8^{g}	16.4^{h}	16.5^{h}	0.41	0.009
115-day gain, lb.	268^{h}	235^{h}	153^{g}	138^{g}	12.81	< 0.001
ADG, lb./d	2.33	2.04	2.58	2.35	0.195	0.34
Gain:feed	0.164	0.137	0.157	0.142	0.011	0.31
Feed cost/lb gain, $/lb.	0.551	0.615	0.591	0.593	0.041	0.74
Veterinary medicine costs, $/hd	12.34	13.73	10.75	11.63	2.02	0.77
Incidence of bloat, % of calves	5.0	19.0	0	0	9.82	0.34
Treatment for respiratory illness, % of calves						
Once	5.56	9.52	5.56	4.76	6.62	0.95
Twice	5.56	4.76	0	4.76	4.37	0.80
Mortality, % of calves	0	4.76	0	0	2.38	0.44

[a]EWC: Early wean, conventional calves; wean date = Sept. 13 and 14, 2007.
[b]EWN: Early wean, natural calves; wean date = Sept. 13 and 14, 2007.
[c]NWC: Normal wean, conventional calves; wean date = Nov. 16 and 17, 2007.
[d]NWN: Normal wean, natural calves; wean date = Nov. 16 and 17, 2007.
[e]Standard error of mean; n = 3 observations per treatment.
[f]*P*-value for F-test of treatment.
[g,h]Means with different subscripts differ ($P < 0.05$).

were observed among TRT for DMI, gain, ADG, feed efficiencies, veterinary medicine costs and feed cost/pound of gain for the remaining background periods (periods three and four; P ≥0.16).

Although background ending weights were similar across TRT (708 ± 13.6 pounds; $P = 0.42$) after 115 days, background weight gain was impacted by TRT (268, 235,153 and 138 pounds for EWC, EWN, NWC and NWN, respectively; $P < 0.001$). Calf weight gain was influenced directly by the number of days on feed. Early weaned calves spent 56 days more on higher energy rations (based on weaning date) as compared with the NW calves (EW = 115 days vs. NW = 59 days). Although EWC and EWN calves had higher feed costs at the end of 115 days than NWC and NWN calves (data not shown), feed cost/pound of gain was comparable, averaging $0.588/pound for 115 days ($P = 0.74$). Overall, EW calves had 11.9 percent lower DMI intakes as compared with NW calves ($P = 0.009$). This may be attributed to their weaning date and weight, incidences of bloat and respiratory illness events that affected the calves, resulting in lower DMI during periods one and two of the background phase.

Finishing Performance. The effects of weaning and management strategies on calf finishing performance are reported in Table 3. During the finish period, one NWN calf was removed from the study because of chronic infection and one EWC calf died due to complications from a broken shoulder. All performance data from the two removed calves was deleted from subsequent performance analyses. Additionally, feed intake data was not analyzed during finishing, since treatment pens were commingled into two pens during the finish period. Body weights were greatest for NWC calves during periods one and two, with no differences for gain and ADG among TRT ($P = 0.02$). This difference in weight gain can be attributed to ionophore (Rumensin) feeding in the conventional diet and implant efficacy. Ionophores can increase ADG by 1 percent to 6 percent and improve feed efficiency by 6 percent to 8 percent (Preston, 1987). When ionophores and implants are used together at the same time, they have a synergistic effect (additive) on an animal's weight gain and feed efficiency. This additive effect can increase daily gains by 0.15 to 0.20 pound/day.

The Ralgro implants still were working (potent) to improve feed efficiency in NWC calves during finish periods one and two. However, the Ralgro implants for the EWC calves had expired (run out) by this time (Ralgro implant potency period is approximately 90 days post-implanting). At the start period three of the finishing phase, all conventional calves (EWC and NWC) were implanted with Synovex Choice. During period three, NWC had the greatest weight gain and ADG, followed by EWC, EWN and NWN calves ($P = 0.002$).

Performance data for the 20 early harvested calves (May 28, 2008; EWC = two, EWN = three, NWC = eight and NWN = seven) is shown as period four (Table 3). Of the few head harvested, EWC, NWC and NWN calves had similar ending weights, which were greater than EWN calves ($P = 0.03$). The performance data for the remaining 58 calves is reported in period five. For these calves, conventionally managed calves (EWC and NWC) weighed the heaviest, gained the most and had the greatest ADG when compared with naturally managed calves within their respective weaning group (EWN and NWN; $P \leq 0.03$). Overall, the NWC and EWC calves had the greatest gains (total gain and ADG) compared with EWN and NWN calves for the 133-day finish period.

When the remaining calves (n = 58) were weighed before shipping for harvest (June 10, 2007), the decision was made to send one EWC calf to a local abattoir (Barton Meats, Carrington, N.D.) for harvest because this calf would be discounted as a small carcass at the commercial plant and required more days on feed to reach market weight. In this study, most carcass traits were similar at harvest ($P > 0.05$) regardless of TRT, with the exception of hot carcass weights ($P = 0.02$, Table 3) which followed the trend of final weight. Harvest weights were 6 percent heavier for conventional calves (EWC and NWC) as compared with natural calves (EWN and NWN).

Implications

In the present study, calves that were managed as "natural," with no growth-promoting implants, ionophores, or antibiotics, gained less weight during backgrounding and finishing as compared with their contemporaries that were managed conventionally (implanted with a growth-promoting implant, fed an ionophore, and treated with antibiotics during periods of morbidity). Harvest weights were 6 percent heavier for conventional calves as compared with natural calves. Additional research on breakeven costs for naturally raised versus conventionally raised calves is needed. In this trial, early weaned (135-day-old) May-born calves tended to gain less weight during the background and finish phases when compared with normally weaned (195-day-old) calves. While early weaning is a viable option for managing grazing lands during drought, the result may be lighter calves at harvest.

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Table 3. Effect of weaning and management strategies on calf finishing performance and carcass traits.

	Treatments					
Item	**EWC[a]**	**EWN[b]**	**NWC[c]**	**NWN[d]**	**SEM[e]**	***P*-value[f]**
Finishing performance						
No. head	19	20	19	20	-	-
Initial weight, lb.	694	700	726	711	13.6	0.42
Period 1, day 0-44						
Weight, lb.	821[h,i]	804[h]	878[j]	853[i,j]	13.7	0.02
43-day gain, lb.	125	115	147	133	7.10	0.06
ADG, lb./d	2.91	2.67	3.42	3.09	0.17	0.06
Period 2, day 45-86						
Weight, lb.	967[h]	969[h]	1045[i]	1009[h,i]	15.8	0.02
42-day gain, lb	151	165	168	164	4.69	0.14
ADG, lb./d	3.60	3.92	3.99	3.90	0.11	0.14
Period 3, day 87-99						
Weight, lb.	1013[h]	1007[h]	1105[i]	1045[h]	17.1	0.01
13-day gain, lb.	45[h]	38[h]	60[i]	36[h]	3.13	0.002
ADG, lb./d	3.48[h]	2.94[h]	4.61[i]	2.73[h]	0.24	0.002
Period 4, day 100-119						
No. head	2	3	8	7	-	-
Weight, lb.	1206[i]	1099[h]	1257[i]	1215[i]	29.4	0.03
20-day gain, lb.	89[i]	51[h]	83[i]	48[h]	8.75	0.03
ADG, lb./d	4.43[i]	2.54[h]	4.17[i]	2.38[h]	0.44	0.03
Period 5, day 100-133						
No. head	17	17	11	13	-	-
Weight, lb.	1128[h,i]	1097[h]	1162[i]	1087[h]	15	0.03
34-day gain, lb.	127[i]	97[h]	130[i]	93[h]	5.26	0.002
ADG, lb./d	3.73[i]	2.85[h]	3.82[i]	2.73[h]	0.15	0.002
Overall, day 0-133						
Final weight, lb.	1136[h]	1097[h]	1211[i]	1122[h]	16.1	0.005
Total gain, lb.	443[i]	408[h]	484[i]	411[h]	10.3	0.003
ADG, lb./d	3.38[i]	3.11[h]	3.82[j]	3.22[h,i]	0.11	0.01
Carcass Traits						
No. head	18	20	19	20	-	-
Hot carcass weight, lb.	672[h]	644[h]	721[i]	659[h]	13.7	0.02
Marbling score[g]	409	430.7	403.3	425.3	15.3	0.57
12th rib fat thickness, in.	0.57	0.51	0.56	0.58	0.04	0.68
Longissimus area, in^2	11.7	11.2	12	11.5	0.36	0.53
Kidney, pelvic and heart fat, %	1.93	2.07	1.90	1.97	0.07	0.40
USDA Yield grade (adjusted)	3.20	3.11	3.23	3.19	0.15	0.94

[a]EWC: Early wean, conventional calves; wean date = Sept. 13 and 14, 2007.
[b]EWN: Early wean, natural calves; wean date = Sept. 13 and 14, 2007.
[c]NWC: Normal wean, conventional calves; wean date = Nov. 16 and 17, 2007.
[d]NWN: Normal wean, natural calves; wean date = Nov. 16 and 17, 2007.
[e]Standard error of mean; n = 3 observations per treatment.
[f]*P*-value for F-test of treatment.
[g]Slight = 200 to 299; Small = 300 to 399; Modest = 400 to 499; Moderate = 500 to 599.
[h,i,j]Means with different subscripts differ ($P < 0.05$).