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Abstract
Recent developments in beef marketing have created more opportunities for producers to reap greater financial rewards based on the carcass merit of the animal. Increased premiums are being offered for animals that excel in the USDA's Quality or Yield Grade scoring systems. There is an increasing focus on beef tenderness with today's consumer. Producers need to understand how on-farm production practices can affect feedlot performance and carcass merit. The study reported here used 74 Charolais x Angus cross steers to determine the effects of age-at-weaning and post-weaning management on performance and carcass characteristics.

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Introduction

According to the 2002 Census of Agriculture, there were 16,104 farming operations in Ohio raising 260,702 beef cows for an average herd size of 16 cows per farm (USDA-NASS, 2002). A majority of the herds are located in the Appalachian region of Eastern and Southern Ohio and provide a vital segment of the economic infrastructure to local communities. Many of the forage producing areas of the Eastern U.S. are in relatively close proximity to both grain producing regions and Eastern U.S. markets for fed cattle. Therefore, the choice of selling feeder cattle or retaining ownership of the feeder cattle and selling fed cattle is an economically viable option for many beef producers.

Rising land costs and the emergence of grid marketing systems that assign value to an individual carcass based on its USDA Yield and Quality Grade have made production decisions at the farm level much more complex in recent years. Many small-scale producers in the beef cattle industry need information that is applicable to diet and management situations that use minimally processed feed grains in order to optimize farm income. The objective of the study reported here was to determine the effects of management systems on the relative differences in feed inputs, final harvest weight, and carcass characteristics of cross Charolais x Angus steers. These results can be used by Extension professionals to help producers make economically sound management decisions.

Materials and Methods

Seventy-four, non-implanted Charolais-Angus steers born in 2003 and 2004 were used to determine the effect of age-at-weaning and post-weaning management on performance and carcass characteristics. The study was conducted at the Southern Agricultural Research Station of the Ohio Agricultural Research and Development Center located in Ripley, Ohio.

Purebred Charolais bulls were mated to commercial Angus females in both years for a calving season of approximately 90 days that lasted from early February through late April or early May. Females were mated to a single sire using artificial insemination (A. I.) in the first cycle of the breeding season and then exposed to two paternal brothers, sired by the A. I. sire, for the last 60-75 days of the breeding season.

Calf birth weight and gender were recorded within 24 hours postpartum. Prior to the date of early weaning, male calves were castrated, and all calves were vaccinated with Clostridium and respiratory complex vaccines. Animals were weaned at 100 or 200 days-of-age and managed using one of three systems: 1) weaned at 100 days-of-age and immediately fed a high-grain diet: early-weaned (EW), 2) weaned at 200 days-of-age and immediately fed a high-grain diet: normal-weaned (NW), and 3) yearling (YR), weaned at 200 days-of-age and back-grounded on pasture and hay until 400 days-of-age: before being fed a high-grain diet. No calves, regardless of treatment group, received creep feed while nursing their dams.

Steer calves were alternately assigned into the three treatment groups based on chronological birth order. Once placed in treatment groups, the calves were alternately assigned to three replication groups based on chronological birth order. In Year 1, there were 14 EW steers, 13 NW steers, and 14 YR steers. During the feedlot phase in Year 1, three replicate pens were used for each treatment group, with each pen containing four or five steers. In Year 2, there were 11 EW steers, 11 NW steers, and 11 YR steers. During the feedlot phase in Year 2, three replicate pens were used for each treatment group, with each pen containing three or four steers. All steers were fed at the Southern Agricultural Research Station from weaning until harvest.

Early-Weaned calves were fed a high-grain diet from weaning until harvest. Normal-Weaned calves were also fed a high-grain diet from weaning until harvest. Yearling calves were fed a high-forage diet during the backgrounding phase from weaning until approximately 400 days-of-age. Calves were then placed in the feedlot to receive a high-grain diet until harvest. The diet fed during the finishing phase to each group appears in Table 1.

Table 1.
Diet Composition

Item	Diet
Ingredient, % Dry Matter Basis	
Whole shelled corn	65.000
Timothy hay	15.000
Ground corn	4.443
Soybean meal	12.000
Urea	0.500
Limestone	1.185
Dical-phos	0.500
Trace mineral salt	0.500
Vitamin A, 30,000 IU/g	0.010
Vitamin D, 3,000 IU/g	0.010
Vitamin E	0.030

Selenium, 201 mg Se/kg	0.050
Monensin	0.017
Tylosin	0.022
Potassium chloride	0.133
Dynamate	0.400
A-V blend	0.200
Nutrient Content, Calculated	
Crude protein, %	14.598
Calcium, %	0.634
Phosphorus, %	0.485
Potassium, %	1.112
NE_m	2.019
NE_g	1.371

During the feedlot phase for each treatment group, all grains and forages were weighed each day, prior to feeding, to determine dry matter intake (DMI). Pasture consumption during the backgrounding phase was estimated using Net Energy equations of the National Research Council (NRC), (NRC, 1996). The energy required to achieve the observed gains was calculated. The energy provided by the supplemental corn and hay was subtracted from this total. This difference represents the energy provided by the grazed forage. Pasture composition was estimated to be 60% grass species (predominantly orchardgrass and fescue) and 40% legume (predominantly alfalfa and red clover).

Calves were weighed every 28 days after weaning. Harvest time for the steers was determined by a combination of visual appraisal and monitoring the weight and average daily gain for each steer. Steers were selected for harvest using a combination of estimated backfat at the 12th rib and live weight. The desired combination was a minimum live weight of 1,150 pounds with a backfat between .40 and .55 inches. This combination was intended to yield a carcass of at least 700 pounds with a reasonable chance of achieving the USDA Choice quality grade.

Steers were harvested and their carcass measurements collected at The Ohio State University Animal Science Department's Meat Laboratory in Columbus, Ohio. Live weights were recorded at the Southern Station (SHIPWT) prior to shipment to Columbus. Live weights were also recorded at the Meat Laboratory (HVSTWT) prior to harvest in order to calculate the percent shrink (%SHRINK). Carcass measurements included: hot carcass weight (HCW); dressing percentage (DRESS%); backfat (BF); rib eye area (REA); percent kidney, pelvic, and heart fat (% KPH); marbling (MARB); Quality Grade (QG); and Yield Grade (YG).

Data were analyzed using the PROC GLM procedures of SAS version 9.1 (SAS Inst. Inc., Cary, NC) for a randomized complete block design. The model included effects due to age at feedlot entry, year, and the age at feedlot entry by year interaction. Pen was used as the experimental unit. Residual mean square was the error term, and Least Squares means are reported, with PDIFF being used for mean separation.

Results and Discussion

The effects of age at feedlot entry and year on steer performance are shown in Table 2. Due to below average rainfall and limited available pasture in 2004 (Year 2), calves on the early-weaned and normal-weaned feedlot groups entered the feedlot at a younger age ($P < .01$) and lighter weight ($P < .01$) than in 2003 (Year 1). However, due to compensatory growth following weaning, the yearling feedlot entry group in Year 2 was heavier than in Year 1, resulting in an age of feedlot entry by year interaction ($P < .01$). Final weight increased ($P < .01$), and days on feed decreased ($P < .01$) as cattle entered the feedlot at an older age.

As the age at feedlot entry increased, total concentrate dry matter intake (DMI), total hay DMI, and total DMI, increased ($P < .05$). However, there was no difference ($P > .05$) in feed efficiency between the early-weaned and normal-weaned groups. There was an age by year interaction for both ADG and feed efficiency, with the yearling group due to steers in Year 1 having superior performance compared with Year 2 ($P < .05$).

Using 56 pounds-per-bushel as the average bushel weight of whole-shelled corn, the early-weaned, normal-weaned, and yearling feedlot entry groups consumed an average of approximately 121, 70, and 54 bushels of concentrate feedstuffs, respectively. Forage dry matter intake for the 14 yearling steers during the 219-day backgrounding phase was 12.8 pounds per day for a total of 2800 pounds in 2003, and the forage dry matter intake for the 11 yearling steers during the 232-day backgrounding phase was 11.2 pounds per day for a total of 2598.7 pounds in 2004.

Statistical analysis was not performed on the pasture forage intake because of the lack of pasture forage consumption with the early- and normal-weaned groups. Therefore, the opportunity to market harvested grains and forage through cattle needs to be balanced with the opportunity to have cattle harvest their own stockpiled forage when making the economic decision as to the appropriate age to place cattle in the feedlot.

Table 2.
Effects of Age on Feed on Charolais Sired Steer Feedlot Performance

	Early Weaned/to Feedlot		**Normal Weaned/to Feedlot**		**Normal Weaned/Yearling Fed**		
Item	**Year 1**	**Year 2**	**Year 1**	**Year 2**	**Year 1**	**Year 2**	**SEM**
No. of steers	14	11	13	11	14	11	
Wt-on-feed, lb	332.3[d]	249.0[e]	468.4[c]	450.7[c]	806.8[b]	874.3[a]	17.0
Final wt, lb	1212.8[g]	1197.9[g]	1206.9[g]	1238.5[g]	1310.4[f]	1327.1[f]	19.3
Age-on-feed, d	110.5[d]	93.5[e]	205.2[b]	194.6[c]	423.4[a]	425.9[a]	2.4
Days-on-feed[i]	286.9[f]	296.4[f]	208.8[g]	228.3[g]	116.6[h]	151.3[h]	6.1
Age-at-harvest, d	397.3[de]	389.9[e]	414.0[cd]	422.9[c]	540.0[b]	577.2[a]	5.9
ADG, lb/d	3.08[d]	3.20[cd]	3.57[b]	3.45[bc]	4.36[a]	2.99[d]	0.12
Concentrate DMI, lb/d	15.63[m]	15.86[m]	18.04[l]	17.72[l]	24.67[j]	21.21[k]	0.54
Hay DMI, lb/d[i]	0.85[h]	1.07[h]	0.95[fg]	1.12[fg]	1.10[f]	1.14[f]	0.04
Total DMI, lb/d	16.48[m]	16.92[m]	18.99[l]	18.85[l]	25.77[j]	22.35[k]	0.57
Gain/Feed, lb/lb	0.187[jk]	0.189[j]	0.189[j]	0.183[jk]	0.170[k]	0.134[l]	0.006
Total concentrate DMI, lb[i]	4478[f]	4701[f]	3757[g]	4045[g]	2873[h]	3205[h]	92
Total hay DMI, lb[i]	244[f]	316[f]	199[g]	257[g]	128[h]	173[h]	12
Total DMI, lb[i]	4722[f]	5018[f]	3956[g]	4302[g]	3001[h]	3378[h]	100

[a,b,c,d,e]Age × year interaction ($P < 0.01$).
[f,g,h]Age effect ($P < 0.01$).
[i]Year effect ($P < 0.01$).
[j,k,l,m]Age × year interaction ($P < 0.05$).

The effects of age at feedlot entry and year on carcass characteristics are shown in Table 3. Two carcasses were removed from the data set during Year 1 due to the finding of testicular tissue post-harvest. Harvest weight and hot carcass weight were greater ($P < .01$) for steers in the yearling group (1280 lb and 784 lb, respectively), compared with those in the early-weaned group (1163 lb and 737 lb, respectively), or the normal-weaned group (1180 lb and 741 lb, respectively). However, dressing percentage decreased ($P < .01$) as age-at-feedlot entry increased, with the early-weaned and normal-weaned groups being similar, but higher than the yearling feedlot entry group, having average dressing percentages of 63.4%, 62.8%, and 61.3%, respectively. This can be easily explained as dressing percentage increases as the fat content of the carcass increases.

Table 3.
Effects of Age-on-Feed and Year on the Carcass Characteristics of Charolais Sired Steers

	Early Weaned/to Feedlot		**Normal Weaned/to Feedlot**		**Normal Weaned/Yearling Fed**		
Item	**Year 1**	**Year 2**	**Year 1**	**Year 2**	**Year 1**	**Year 2**	**SEM**
No. steers	14	11	12	11	13	11	
Ship wt, lb	1212.8[b]	1197.9[b]	1193.4[b]	1238.5[b]	1314.4[a]	1321.5[a]	18.5

Harvest wt, lb	1175.2[b]	1150.1[b]	1160.3[b]	1197.8[b]	1278.6[a]	1281.9[a]	14.1
% Shrink	3.1	3.9	2.8	3.3	2.7	3.6	0.4
HCW, lb	746.4[de]	727.0[e]	728.7[e]	752.3[d]	782.1[c]	786.6[c]	7.4
Dressing, %	63.5[a]	63.2[a]	62.8[a]	62.8[a]	61.2[b]	61.4[b]	0.4
12th Rib BF, in	0.51[a]	0.56[a]	0.49[b]	0.40[b]	0.39[b]	0.38[b]	0.04
REA, in^2	12.9[f]	12.1[gh]	11.7[h]	12.5[fg]	12.5[fg]	11.8[h]	0.2
% KPH fat	2.2[h]	3.0[f]	2.5[g]	2.2[h]	2.2[h]	2.1[h]	0.1

[a,b] Age effect ($P < 0.01$).
[c,d,e] Age × year interaction ($P < 0.05$).
[f,g,h] Age × year interaction ($P < 0.01$).
[i] 400-490 = small, 500-590 = modest
[j] 4 = choice$^-$, 5 = choice^o

Backfat thickness at the 12th rib decreased ($P < .01$) as age-at-feedlot entry increased, with the early-weaned, normal-weaned, and yearling feedlot entry groups having an average backfat thickness of .54 inches, .45 inches, and .39 inches, respectively. However, Schoonmaker, Cecava, Fluharty, Zerby, and Loerch (2004) fed Angus x Simmental steers and reported that, while harvest weight was increased by weaning calves at 205 days-of-age versus 119 days-of-age and then feeding high-concentrate diets ad libitum, there were no differences in 12th rib backfat at harvest. Therefore, frame size and lean growth potential of the cattle used affects the carcass characteristics and management and marketing decisions.

The effects of age-on-feed and year on USDA Quality and Yield Grades are shown in Table 4. There were no differences ($P > .10$) in USDA Quality or Yield Grades due to age-at-feedlot entry.

Table 4.
Effects of age-on-feed and year on the carcass characteristics of Charolais sired steers

	Early Weaned/to Feedlot		**Normal Weaned/to Feedlot**		**Normal Weaned/Yearling Fed**		
Item	**Year 1**	**Year 2**	**Year 1**	**Year 2**	**Year 1**	**Year 2**	**SEM**
Marbling [a]	484	526	501	493	473	469	38
USDA Quality Grade [b]	4.4	4.8	4.4	4.5	4.2	4.3	0.4
USDA Yield Grade	2.9[de]	3.4[c]	3.3[cd]	2.8[e]	2.9[de]	3.1[cde]	0.1
% Select	20.0	11.1	16.7	16.7	28.9	11.1	13.6
% Low Choice, Ch$^-$	23.3	38.9	41.7	44.4	31.1	52.8	12.2
% Average Choice, Ch^o	50.0	16.7	25.0	8.3	33.3	36.1	12.6
% High Choice, Ch$^+$	6.7	25.0	16.7	30.5	6.7	0.0	11.1
% Ch^o, Ch$^+$	56.7	41.7	41.7	38.9	40.0	36.1	16.5
% Prime, Pr$^-$	0.0	8.3	0.0	0.0	0.0	0.0	3.4
% â‰¥ Ch^o	56.7	50.0	41.7	38.9	40.0	36.1	18.2
% Yield Grade 2	46.7	19.4	25.0	75.0	60.0	36.1	15.7
% Yield Grade 3	53.3	69.4	58.3	25.0	40.0	63.9	17.4
% Yield Grade 4	0.0	11.1	16.7	0.0	0.0	0.0	5.7

[a]400-490 =small, 500-590 = modest
[b]4= choice⁻, 5 = choice°
[c,d,e]Age × year interaction ($P < 0.05$).

No economic analysis was conducted due to the age × year interaction ($P < .05$), which occurred for hot carcass weight (Table 3), and the large difference in percentages of cattle achieving each of the USDA Quality Grades for the early-weaned group in Year 1 compared with Year 2. However, the early-weaned, normal-weaned, and yearling feedlot entry groups had an average hot carcass weight of 737 lb., 741 lb., and 784 lb., respectively, resulting in a 47-pound difference in HCW between the early-weaned and yearling feedlot entry groups. It would not be feasible for any potential Quality Grade premiums for USDA Choice carcasses over USDA Select carcasses to make up for this difference in HCW, because the early-weaned group had 15.5% USDA Select carcasses, and the yearling feedlot entry group was very close with 20% USDA Select carcasses.

Summary

These data show that there are very few differences in carcass characteristics of Charolais x Angus cross steers due to age-at-feedlot entry. The major decision points regarding age-at-weaning and the management of calves should be cost of feed, expected harvest weight, and expected date of harvest as carcass prices vary by month in a relatively predictable manner.

Results from the study reported here as well as other research on early weaning in beef cattle can be used by Extension professionals when consulting with cow-calf producers. The study focused on the potential marketing advantages for crossbred feedlot cattle that were weaned and placed in the feedlot at various ages. Other research on early weaning has shown beneficial applications for this management tool when producers are faced with limited feed resources for the lactating female, environmental extremes in terms of moisture and temperature, situations where the body condition of the breeding female is critically low, or as a tool to help increase stocking rates on limited acreage.

These applications frequently exist, but early weaning should not be considered a standard management practice for all situations. The Extension professional should use the data from the study reported here and other early weaning research to assist the cow-calf producer in determining when to practically apply this practice for maximum efficiency and profitability.

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