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Effect of Age-at-Weaning and Post-Weaning Management on Performance and Carcass Characteristics of Angus Steers

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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. This study utilized 75 Angus steers to determine the effects of age-at-weaning and post-weaning management on performance and carcass characteristics of steers.

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Introduction

According to the 2002 Census of Agriculture, there were 16,104 farms in Ohio with beef cattle, having 260,702 beef cows for an average herd size of 16 cows (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 the 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 feeders and selling fed cattle is an economically viable option to 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. These results can be used by Extension professionals to help producers to make economically sound management decisions.

Materials and Methods

Seventy-five, non-implanted Angus steers born in 2001 and 2002 were used to determine the effects 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 Angus bulls were mated to commercial Angus females in both years for a calving season of approximately 90 days in early February through early May. Females were mated through artificial insemination in the first cycle of the breeding season and then exposed to two paternal brothers 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 Clostridial and respiratory complex vaccinations. Animals were weaned at 100 or 200 days of age (DOA) and managed using one of three systems: 1) weaned at 100 DOA and fed a high-grain diet immediately: early-weaned (EW), 2) weaned at 200 DOA and fed a high-grain diet immediately: normal-weaned (NW), and 3) weaned at 200 DOA and backgrounded on pasture and hay until 400 DOA: yearling (YR), before being fed a high-grain diet. No calves received creep feed while nursing their dams.

Steer calves were alternately assigned into the three treatment groups based on chronological birth order. Once placed into their treatment groups, calves were alternately assigned to replication groups based on chronological birth order. In 2001, there were 13 EW steers, 12 NW steers, and 12 YR steers. In 2002, there were 12 EW steers, 13 NW steers, and 13 YR steers. All steers were fed at the Southern Station from weaning until harvest.

Early-weaned and normal-weaned calves were fed a high-grain diet from their respective weaning dates until harvest. Yearling calves were fed a high-forage diet during the backgrounding phase from weaning until approximately 400 DOA. Calves were then placed in the feedlot and received a high-grain diet until harvest. The diet fed during the finishing phase to each group appears in Table 1.

Table 1.
Diet Composition

Ingredient	**% of Diet, 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
Dicalcium-phosphate	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
Animal-Vegetable fat blend	0.200
Total	100.000
Calculated Composition	
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 feed was weighed each day prior to feeding to allow dry matter intake (DMI) to be calculated. Pasture consumption during the backgrounding phase was estimated using Net Energy equations of the National Research Council (NRC, 1984). Energy required to achieve observed gains was calculated. 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. Steers were selected for harvest using a combination of visually estimated 12th rib backfat and a minimum live weight of 1075 pounds. The desired combination was a minimum live weight of 1,150 pounds with a backfat between .40 to .55 inches. This combination was expected to generate a carcass of at least 700 pounds with a reasonable chance of achieving the USDA Choice quality grade.

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

Steaks were dissected from the 13th rib, frozen after 24 hours, and stored at -20° C until determination of tenderness. Steaks were thawed and cooked to an average internal temperature of 71.7° C, and peak Warner-Bratzler shear force was used as a measure of tenderness according to American Meat Science Association (AMSA, 1995) recommendations.

Results and Discussion

The effects of age at feedlot entry and year on steer performance are shown in Table 2. Due to a severe drought in 2002 (Year 2), calves on the normal-weaned and yearling feedlot entry groups entered the feedlot at a lighter weight than in 2001 (Year 1). The lighter feedlot entry weights in Year 2 resulted in lighter harvest weights compared with Year 1 in each of the three treatment groups ($P < .01$). Additionally, as the age at feedlot entry increased, average daily gain (ADG), daily concentrate dry matter intake (DMI), total daily DMI, and body weight at harvest increased ($P < .01$). However, the efficiency of gain decreased as age at feedlot entry increased ($P < .01$). Nevertheless, total concentrate DMI and total DMI increased age at feedlot entry decreased ($P < .01$).

Assuming a concentrate weight of 56 pounds per bushel (the average bushel weight of whole-shelled corn), the early-weaned, normal-weaned, and yearling feedlot entry groups consumed an average of approximately 76, 66, and 54 bushels of concentrate feedstuffs, respectively. 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. Growing Angus steers in a backgrounding situation decreases the amount of harvested grains needed, but also decreases the efficiency with which those grains are used for weight gain.

Table 2.
Effects of "Age on Feed" and "Year" on Calf 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**
Wt on feed, lb	317.7[e]	289.2[e]	575.0[c]	443.0[d]	792.1[a]	741.6[b]	15.8
Harvest wt,							

lb[i]	1190.8[h]	1148.0[h]	1219.6[g]	1164.6[g]	1265.0[f]	1235.7[f]	10.1
Age on feed, d	100.2[d]	103.0[d]	197.8[c]	200.0[c]	393.7[b]	411.9[a]	3.2
Days on feed	285.3[f]	285.6[f]	202.1[g]	216.7[g]	130.7[h]	132.8[h]	5.9
Age at harvest, d[j]	385.5[h]	388.6[h]	399.9[g]	416.6[g]	524.3[f]	544.7[f]	5.4
ADG, lb/d	3.08[h]	3.02[h]	3.21[g]	3.34[g]	3.64[f]	3.74[f]	0.10
Concentrate DMI, lb/d	15.02[h]	14.96[h]	17.85[g]	17.50[g]	22.58[f]	22.99[f]	0.38
Hay DMI, lb/d	0.46[p]	0.75[o]	1.30[k]	0.88[m]	0.82[n]	0.98[l]	0.02
Total DMI, lb/d	15.48[h]	15.71[h]	19.15[g]	18.38[g]	23.41[f]	23.96[f]	0.38
G/F, lb/lb	0.199[f]	0.192[f]	0.168[g]	0.182[g]	0.155[h]	0.156[h]	0.005
Total concentrate DMI, lb	4281[f]	4272[f]	3606[g]	3793[g]	2949[h]	3047[h]	109
Total Hay DMI, lb	132[n]	214[l]	263[k]	191[m]	108[o]	130[n]	6
Total DMI, lb	4414[f]	4486[f]	3870[g]	3984[g]	3057[h]	3177[h]	114

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

The effects of age at feedlot entry and year on carcass characteristics are shown in Table 3. Although harvest weight increased as age at feedlot entry increased from 1,143 pounds for the early-weaned group to 1,164 pounds for the normal-weaned group and 1216 pounds for the yearling group ($P < .01$), there were no differences in hot carcass weight (HCW) as age at feedlot entry increased. This occurred due to a reduction in the dressing percentage as age at feedlot entry increased, with the early-weaned and normal-weaned groups being similar, but higher ($P < .01$) than the yearling feedlot entry group average dressing percentages of 63.6%, 62.8%, and 60.9%, respectively. This can be explained as dressing percentage increases as the fat content of the carcass increases.

Table 3.
Effects of "Age on Feed" and "Year" on Calf Carcass Characteristics

	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**
Ship wt, lb[d]	1190.8[c]	1148.0[c]	1219.6[b]	1164.6[b]	1265.0[a]	1235.7[a]	10.1
Harvest wt, lb[d]	1168.1[c]	1118.0[c]	1196.5[b]	1131.5[b]	1232.3[a]	1200.0[a]	8.5
% Shrink[k]	2.0	2.6	1.9	2.8	2.6	2.9	0.3
HCW, lb[d]	740.5	714.6	746.8	715.4	744.5	737.4	6.9
Dress, %	63.4[a]	63.9[a]	62.4[a]	63.2[a]	60.4[b]	61.5[b]	0.5
BF, in	0.74[a]	0.65[a]	0.58[b]	0.59[b]	0.47[b]	0.56[b]	0.05
REA, in^2	11.69	11.29	11.45	11.58	11.52	10.80	0.25
KPH, %	3.0[e]	2.3[gh]	2.8[ef]	2.5[fg]	2.1[h]	2.4[g]	0.1

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

Twelfth rib backfat thickness 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 .69, .58, and .52 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 DOA versus 119 DOA and then feeding high-concentrate diets ad libitum, there were no differences in 12th rib backfat at harvest. Therefore, the frame size and lean growth potential of cattle certainly affects the carcass characteristics and, consequently, the management and marketing decisions of their owners. Kidney, pelvic, and heart (KPH) fat was not consistently greater as age at feedlot entry decreased, however, the early-weaned group had a greater ($P < .05$) KPH fat percentage than the yearling feedlot entry group in Year 1.

The effects of "age on feed" and "year" on USDA Quality and Yield Grades are shown in Table 4. There was an increase ($P < .01$) in both marbling score and USDA Quality Grade with the early-weaned and normal-weaned groups compared with the yearling feedlot entry group. The percentage of carcasses graded USDA Low Choice or higher was 100% for all of the carcasses in this study.

However, the percentage of carcasses graded USDA Average Choice or High Choice was higher ($P < .05$) for the early-weaned and normal-weaned groups compared with the yearling feedlot entry group, averaging 75.9%, 75.9%, and 45%, respectively. Additionally, the percentage of carcasses graded USDA Prime for the early-weaned, normal-weaned, and yearling feedlot entry groups averaged 15.8%, 8.3%, and 0%, respectively. This increase in carcasses reaching the higher USDA Quality Grades has tremendous economic potential as grid marketing systems place premiums on carcasses that meet the minimum criteria of USDA Average Choice and higher premiums for those that meet the minimum criteria of USDA Prime.

Table 4.
Effects of "Age on Feed" and "Year" on USDA Quality and Yield Grades

	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^{j}	633^{a}	594^{a}	572^{a}	595^{a}	509^{b}	507^{b}	24
QG^{k}	5.9^{a}	5.4^{a}	5.4^{a}	5.5^{a}	4.6^{b}	4.6^{b}	0.2
YG	4.0^{h}	3.7^{hi}	3.7^{hi}	3.5^{hi}	3.3^{i}	3.8^{h}	0.2
% Choice^{-}	0.0^{b}	16.7^{b}	25.0^{b}	6.7^{b}	58.3^{a}	51.7^{a}	11.9
% Choice^{o}	31.7	41.7	33.3	45.0	25.0	40.0	11.9
% Choice^{+}	45.0	33.3	33.3	40.0	16.7	8.3	13.6
% Choice^{o} or choice^{+}	76.7^{l}	75.0^{l}	66.7^{l}	85.0^{l}	41.7^{m}	48.3^{m}	12.0
% Prime	23.3	8.3	8.3	8.3	0.0	0.0	5.9
% YG2	6.7	25.0	8.3	15.0	33.3	0.0	10.5
% YG3	38.3	41.7	58.3	70.0	66.7	68.3	12.9
% YG4	55.0^{d}	33.3^{de}	25.0^{e}	15.0^{ef}	0.0^{f}	31.7^{g}	7.3
% YG5	0.0	0.0	8.3	0.0	0.0	0.0	3.4
Warner Bratzler Shear Force, lb	4.0^{e}	10.4^{d}	3.7^{e}	10.6^{d}	9.8^{d}	10.5^{d}	0.7

^{a,b,c}Age effect (P <0.01).
^{d,e,f,g}Age × year interaction ($P < 0.01$).
^{h,i}Age × year interaction ($P < 0.05$).
^{j}500-590 = Modest, 600-690 = Moderate
^{k}4 = Ch^{-}, 5 = Ch°
^{l,m}Age effect ($P < 0.05$).

Fluharty, Loerch, Turner, Moeller, and Lowe (2000) reported that 85% of steer calves weaned at 103 DOA, immediately started on a high concentrate diet, and harvested at 385 DOA (282 days on feed) graded choice, with 60% of the calves being in the upper 2/3 of the choice grade. In the current study, calves started directly on a high concentrate diet were 394 days at slaughter (268 days on high concentrate diet), and the pasture calves were 431 DOA at slaughter (222 days on high concentrate diet). At harvest, 89% of the concentrate fed calves graded low choice or higher, with 56% average choice or higher. Eighty-nine percent of the pasture fed calves also graded low choice or higher, with 38% grading average choice or higher.

However, during Year 1, the percentage of carcasses that were USDA Yield Grade 4 for the early-weaned, normal-weaned, and yearling feedlot entry groups were 55%, 25%, and 0%, respectively. Due to the large discounts placed on USDA Yield Grade 4 carcasses, this must be controlled, or any premiums received for higher USDA Quality Grades would be more than offset by discounts for USDA Yield Grade 4 carcasses. There were no clear trends in meat tenderness, due to large variation between Year 1 and Year 2.

Summary

These data show that if fed cattle are marketed on a live weight basis, there may be benefits from marketing cattle that have been placed into the feedlot as yearlings, if forage costs from weaning until feedlot entry are minimal. This is due to the reduction in total pounds of concentrate required to finish the cattle to harvest weight and the increase in harvest weight as cattle are placed into the feedlot at an older age. However, if cattle are marketed on a grid basis using HCW and USDA Quality and Yield Grades, then placing cattle into the feedlot at an earlier age has the potential for greater economic advantage, assuming that feed grain costs are low and the cattle are marketed at an endpoint that avoids Yield Grade discounts, including lighter weight carcasses.

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 feedlot cattle that were early weaned. 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, and situations where the body condition of the breeding female is critically low or when they need 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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