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D.M. Marshall
South Dakota State University

M. D. Monfore
South Dakota State University

W. J. Costello
South Dakota State University

C. A. Dinkel

CHARACTERIZATION OF HEREFORD AND TWO-BREED ROTATIONAL CROSSES OF HEREFORD WITH ANGUS AND SIMMENTAL CATTLE: CARCASS TRAITS OF STEERS

D. M. Marshall[1], M. D. Monfore[2], W. J. Costello[3]
and C. A. Dinkel[4]
Department of Animal and Range Sciences

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Summary

Calf carcass traits were evaluated for Simmental (S) x Hereford (H) and Angus (A) x H cross cows in two-breed rotations and for straightbred H. Data were grouped into seven dam breed categories: straightbred Hereford (H), F1 S x H cows (SH), S x H cows of low percentage H (SHS), S x H cows of high percentage H (HSH), F1 A x H cows (AH), A x H cows of low percentage H (AHA) and A x H cows of high percentage H (HAH). Straightbred H and crossbred SH, AH, SHS and AHA cows were mated to H bulls, HSH cows were mated to S bulls and HAH cows were mated to A bulls. Calves from S x H dams produced heavier carcasses with less fat, lower quality grade, larger longissimus area and increased estimated cutability compared to calves from H or A x H dams. Some significant intergenerational differences were observed within rotations, particularly within S x H. Calves from HSH cows mated to S bulls produced carcasses with less fat cover, lower quality grade, larger longissimus muscle area and higher estimated cutability compared to calves from SHS dams mated to H bulls. Within both rotations, evaluation of carcass weight per day of age indicated lower postweaning rate of gain for generations in which H was the sire breed. A separate analysis evaluated carcass traits of calves from SHS, HSH, AHA and HAH dam breed groups from the last 3 years of the study when calves were fed under two different postweaning management systems. With Management System One, the concentrate to roughage ratio was increased less rapidly and calves averaged 122 days older at slaughter and carcass weights averaged 128 lb heavier compared to calves fed under Management System Two. The breed group x postweaning management system interaction effect approached significance only for marbling score, estimated cutability and kidney, pelvic and heart fat.

(Key Words· Beef, Breed Evaluation, Rotational Crossbreeding, Carcass.)

Introduction

It is important to characterize breeds for a wide spectrum of traits affecting net economic efficiency, since breed-types may rank differently for different traits. In rotational crossbreeding systems, breed composition fluctuates over generations within a rotation and utilization of complementarity can be limited. Each breed used in a conventional rotational system will contribute over half of the genetic makeup of some dams and calves. Thus, it is important the breeds perform adequately with respect to maternal, growth and carcass characteristics.

The present study is a portion of a comprehensive research project designed to investigate genetic aspects of efficiency of beef production. Characterization of the breed groups evaluated in this study for calf production to weaning was reported by Marshall et al. (1989). Production of carcasses with acceptable composition and quality is also an important component of total system efficiency. The objective of this study was to characterize performance of Simmental x Hereford and Angus x Hereford crosses in two-breed rotations and straightbred Hereford for carcass traits of steers.

Experimental Procedures

Data Collection and Description. This study included data from steers born to straightbred

[1]Assistant Professor.
[2]Former Assistant in Animal Science.
[3]Professor.
[4]Professor Emeritus.

Hereford (H), Simmental (S) x H cross and Angus (A) x H cross cows managed at the Antelope Range Livestock Station in northwest South Dakota. The two crossbred groups were managed in traditional two-breed rotational crossbreeding systems, eventually resulting in various levels of H breeding within each rotation. Management of the cow herd at the Antelope Station was described by Marshall et al. (1989). Calves were weaned in the fall when the entire group averaged approximately 7 months of age. Following weaning, steer calves remained at the Antelope Station for a preconditioning period. Although the length of the preconditioning period varied from 3 to 6 weeks over years, it was the same for all calves within a year.

For calf birth years 1975 through 1984, all steers were fed in a single feedlot in eastern South Dakota (Management System One = MS1). For birth year 1985 through 1987, half of the steers were fed under MS1 and half were fed at a commercial feedlot in western South Dakota (Management System Two = MS2). The primary difference between the two management systems was the postweaning diet, although effects due to location could have contributed to observed differences in performance. Primary feedstuffs used for both postweaning management systems were corn grain, corn silage and alfalfa hay. The diet fed to MS1 steers initially included relatively high levels of roughage, followed by a gradual increase in the concentrate to roughage ratio. Management System One resulted in a relatively long postweaning period (average 362 days) and relatively heavy carcass weight (average 844 lb) and older slaughter age (average 566 days). Under MS2, the concentrate to roughage ratio was increased relatively sooner, resulting in averages of 241 days postweaning, 716 lb carcass weight and 444 days of age at slaughter.

Within calf birth years 1975 and 1976, all calves were slaughtered on the same day. Calves were slaughtered on two dates each year from 1977 through 1982. Within birth years 1983 and 1984, calves were slaughtered on three dates. For 1985 through 1987, all calves within a year-management group were slaughtered on the same day. Steers were slaughtered at commercial slaughter facilities and carcass data were collected after a minimum 24-hour chill. External fat thickness and longissimus muscle area were measured at the 12th rib. Percentage of kidney, pelvic and heart (KPH) fat was visually estimated. Quality grade was assigned according to a scale where 18 = Select, 19 = low Choice, 20 = average Choice, etc. The longissimus muscle area interface was traced and the area measured with the use of a planimeter. Percentage of boneless, closely trimmed retail cuts was estimated by the USDA cutability equation (USDA, 1981).

Data from two-breed rotations were sorted so that cows within a group were of similar breed composition (Table 1). Data collected from calf birth years 1975-87 were categorized into seven dam breed groups: straightbred H cows (H), F1 S x H cows (SH), S x H cows of low percentage H (SHS), S x H cows of high percentage H (HSH), F1 A x H cows (AH), A x H cows of low percentage H (AHA) and A x H cows of high percentage H (HAH). Calf sire breed was confounded with dam breed group. Calves from H, SH, AH, SHS and AHA dams were sired by H bulls, calves from HSH dams were sired by S bulls and calves from HAH dams were sired by A bulls. Cows in the SHS and AHA groups were expected to range from 25 to 38% H and their calves from 62 to 69% H. Cows in the HSH and HAH groups were expected to range from 62 to 75% H and their calves from 31 to 38% H.

Distribution of observations by breed group is given in Table 2. Data were collected from a total of 742 calves, although estimated KPH fat and cutability were not available for 34 calves. Since replacements for the H, SH and AH dam groups were not continuously brought into the herd, these groups were eventually displaced completely by the HSH, SHS, AHA and HAH dam breed groups, representing subsequent generations of the two rotations.

The entire data set (birth years 1975 through 1987) was used in three sets of analyses: (1) without adjustment for carcass weight or slaughter age, (2) adjusted to a common carcass weight and (3) adjusted to a common slaughter age. Adjustment to a common slaughter age yielded similar results as without adjustment and so results of the age-adjusted analysis are not presented.

A subset of these data which included only the last three calf birth years (1985 through 1987) was analyzed in an additional analysis. The subset of data included observations only from the last 3 years of the study when calves were fed under two postweaning management systems. The purpose of analyzing this subset of data separately was to determine if breed group rankings varied under the two postweaning management systems. Only the SHS, HSH, AHA and HAH dam breed groups were included in this analysis because of a lack of available data for other groups during this period.

TABLE 1. MATING DESIGN AND BREED COMPOSITION OF BREED GROUPS[a]

Dam breed group	Dam breed composition % S	% A	% H	Sire breed	Calf breed composition % S	% A	% H
H	0	0	100	H	0	0	100
S x H rotation							
SH	50	0	50	H	25	0	75
HSH	25 to 38	0	62 to 75	S	62 to 69	0	31 to 38
SHS	62 to 75	0	25 to 38	H	31 to 38	0	62 to 69
A x H rotation							
AH	0	50	50	H	0	25	75
HAH	0	25 to 38	62 to 75	A	0	62 to 69	31 to 38
AHA	0	62 to 75	25 to 38	H	0	31 to 38	62 to 69

[a]S = Simmental, A = Angus and H = Hereford.

TABLE 2. NUMBERS OF OBSERVATIONS BY DAM BREED GROUP[a]

Dam breed group[b]	Total number
H	110 (104)
SHS	65 (63)
SH	130 (124)
HSH	138 (135)
AHA	55 (50)
AH	132 (120)
HAH	112 (112)
Total	742 (708)

[a]Second number (in parentheses) is for KPH fat and estimated cutability. First number is for all other traits.

[b]H = Hereford, S = Simmental and A = Angus. Hereford, SHS, SH, AHA and AH dams were mated to H sires, HSH dams were mated to S sires and HAH dams were mated to A sires.

Results

Least squares means are presented by dam breed group (Tables 3 through 6). However, it is important to keep in mind that dam breed group and sire breed are confounded; thus, dam breed group comparisons are actually comparisons among dam breed group-sire breed combinations.

Table 3 includes least squares means from the complete data set not adjusted for continuous effects. Breed group was a significant source of variation for all traits. Breed group least squares means for slaughter age ranged from 540.8 days for calves from HAH dams mated to A sires to 552.2 days for calves from HSH dams mated to S sires. Carcass weights averaged 750, 819 and 771 lb for H, S-cross and A-cross calves, respectively. Average days from weaning to slaughter ranged from 338 for calves from HAH dams mated to A sires to 350 for calves from HSH dams mated to S sires. Carcass weight per day of age was the best available measure of cumulative growth rate through slaughter and averaged 1.41, 1.54 and 1.45 lb/day for H, S-cross and A-cross, respectively. Rankings of H, S x H rotation and A x H rotation were the same for carcass weight per day of age as for preweaning growth rate (Marshall et al., 1989). Within-rotation dam breed group contrasts of SHS minus HSH and AHA minus HAH for carcass weight per day of age were not significant but of the opposite sign compared to significant contrasts for preweaning growth rate (Marshall et al., 1989). This indicates faster average postweaning gains for calves from HSH vs SHS dams and for calves from HAH vs AHA dams, although postweaning gain per se was not actually measured.

Average longissimus muscle area was smaller and estimated cutability was lower for H calves compared to the average of crossbred groups (Table 3). Quality grade and estimated KPH fat were similar for H compared to the average of crossbred groups. Angus-cross calves exceeded S crosses for average external fat thickness, estimated KPH fat and carcass quality grade, while S crosses exceeded A crosses for longissimus muscle area and estimated cutability. The HSH dam breed group which produced S-sired calves differed from other breed groups for most traits. This group averaged .42 inch for external fat thickness compared to an average of .61 inch across all other groups. Among other traits, this group ranked highest for carcass weight, carcass weight per day of age, longissimus muscle area and estimated cutability and lowest for quality grade.

Least squares means adjusted to a common carcass weight are presented in Table 4. Breed group was a significant source of variation for all traits except slaughter age. Contrasts were alike in sign to those presented in Table 3, although some contrast values and significance levels were somewhat different. The difference in fat thickness of H calves vs crossbreds was .077 inch (P = .003) when adjusted to a common carcass weight vs .039 inch when unadjusted (P = .098). The difference in cutability of H vs crossbreds was -.84% (P = .001) when adjusted for carcass weight vs -.47% (P = .049) when unadjusted. The difference in cutability for AHA vs HAH dam breed groups was .34% (P = .17) when adjusted for carcass weight vs .45% (P = .088) when unadjusted.

Table 5 includes least squares means for the SHS, HSH, AHA and HAH dam breed groups computed from the last 3 years of the study when calves were split into two management groups after weaning. Means presented in Table 5 were not adjusted for carcass weight.

Dam breed group was a significant source of variation for all traits except slaughter age. Averaged across postweaning management systems, dam breed group rankings among SHS, HSH, AHA and HAH were consistent to those presented in Table 3 for the complete data set.

The effect of postweaning management system was significant for all traits except quality grade and marbling score. Calves fed under MS1 were in the feedlot an average 121 days longer and averaged 122 days older at slaughter compared to calves fed under MS2. Carcasses of MS1 calves were heavier, fatter and had larger absolute longissimus muscle areas, while carcass weight per day of age and estimated cutability were greater for MS2 calves.

The breed group x postweaning management system interaction effect approached significance only for marbling score (P = .064), KPH fat (P = .033) and estimated cutability (P = .17). Calves from the A x H rotation had higher carcass marbling scores and quality grades than calves from the S x H rotation under MS1, but S and A crosses were similar for these traits under MS2. Interpreted another way, A crosses had higher average carcass marbling score and quality grade under MS1 than under MS2, while S crosses had similar values across management systems for these two characteristics. Estimated percent cutability of S crosses exceeded that of A crosses by 1.45% under

TABLE 3. LEAST SQUARES MEANS AND CONTRAST VALUES FROM COMPLETE DATA SET, UNADJUSTED FOR COVARIATES

Dam breed group[a]	Days postweaning	Slaughter age, days	Carcass wt, lb	Carcass wt/day of age, lb/day	Carcass quality grade[b]	External fat thickness, in.	Est. KPH fat, %	Longissimus muscle area, in.^{2}	Est. cuta-bility %
H	343.4	550.5	750	1.41	19.0	.62	2.20	12.1	48.7
SHS	340.4	544.8	810	1.54	18.7	.59	2.33	13.3	48.9
SH	344.5	551.7	814	1.52	18.8	.56	2.18	13.4	49.3
HSH	349.9	552.2	832	1.56	18.3	.42	2.29	14.5	50.6
AHA	341.3	550.1	779	1.45	18.9	.65	2.27	13.3	49.0
AH	341.5	548.3	763	1.44	19.2	.65	2.38	12.5	48.5
HAH	338.1	540.8	770	1.47	19.2	.61	2.52	12.5	48.5
Avg SE of mean	1.7	2.8	11.3	.021	.12	.022	.088	.19	.23
Contrasts									
H - 1/2 ($\bar{S}$ + $\bar{A}$)[c]	NS	NS	-44.8**	-.086**	NS	.039+	NS	-1.12**	-.5*
$\bar{S}$ - $\bar{A}$	4.6**	NS	48.1**	.084**	-.5**	-.114**	-.12*	.93**	.9**
SHS - HSH	-9.5**	-7.4*	-21.4*	NS	.4**	.169**	NS	-1.24**	-1.8**
AHA - HAH	NS	9.3**	NS	NS	-.3*	NS	-.26*	.79**	.5+

[a] H = Hereford, S = Simmental and A = Angus. Hereford, SHS, SH, AHA and AH dams were mated to H sires, HSH dams were mated to S sires and HAH dams were mated to A sires.
[b] 18 = Select, 19 = low Choice, 20 = average Choice, etc.
[c] Straightbred vs crossbred.
+ P<.10.
* P<.05.
** P<.01.

TABLE 4. LEAST SQUARES MEANS AND CONTRAST VALUES FROM COMPLETE DATA SET, ADJUSTED FOR CARCASS WEIGHT

Dam breed group[a]	Slaughter age, days	Quality grade[b]	External fat thickness, in.	Estimated KPH fat, %	Longissimus muscle area, $in.^2$	Estimated cutability, %
H	551.8	19.1	.66	2.31	12.4	48.1
SHS	543.2	18.7	.58	2.29	13.0	48.8
SH	552.1	18.8	.60	2.16	13.3	49.2
HSH	546.9	18.3	.40	2.22	13.9	50.7
AHA	550.6	19.0	.65	2.26	13.4	48.7
AH	548.9	19.3	.67	2.46	12.7	48.2
HAH	544.0	19.3	.62	2.53	12.7	48.3
Avg SE of mean	2.6	.12	.028	.089	.167	.23
Contrasts						
$H - 1/2(\bar{S} + \bar{A})$[c]		NS	.077**	NS	-.76**	-.84**
$\bar{S} - \bar{A}$		-.6**	-.117**	-.19**	.47**	1.2**
SHS - HSH		.4**	.180**	NS	-.97**	-1.9**
AHA - HAH		-.3+	NS	-.28**	.67**	NS

[a] H = Hereford, S = Simmental and A = Angus. Hereford, SHS, SH, AHA and AH dams were mated to H sires, HSH dams were mated to S sires and HAH dams were mated to A sires.
[b] 18 = Select, 19 = low Choice, 20 = average Choice, etc.
[c] Straightbred vs crossbred.
+ P<.10.
* P<.05.
** P<.01.

TABLE 5. LEAST SQUARES MEANS AND CONTRAST VALUES FOR 1985 THROUGH 1987 BY DAM BREED GROUP AND POSTWEANING MANAGEMENT SYSTEM

Dam breed group[a]	No. steers	Days from weaning to slaughter	Slaughter age, days	Carcass wt, lb	Carcass wt/day of age, lb/day	Quality grade[b]	Marbling score[c]	External fat thickness, in.	Est. KPH fat, %	Longissimus muscle area, $in.^2$	Est. cutability, %
					Management System One (MS1)						
SHS	27	359.6	567.8	862	1.56	18.7	10.6	.61	2.37	14.2	49.2
HSH	26	359.7	562.1	853	1.56	18.8	10.4	.43	2.14	15.1	51.0
AHA	16	369.1	568.7	826	1.49	19.1	11.1	.68	2.34	14.0	48.7
HAH	38	359.7	564.2	831	1.51	19.7	12.9	.61	2.35	13.3	48.6
Avg SE of mean		1.3	3.0	13.7	.028	.20	.45	.035	.119	.299	.34
					Management System Two (MS2)						
SHS	20	239.9	444.5	723	1.67	19.0	11.6	.51	1.52	12.3	49.9
HSH	32	240.3	444.5	745	1.72	18.8	10.7	.36	1.55	13.3	51.5
AHA	17	244.0	444.8	681	1.57	18.6	10.6	.47	1.59	12.7	50.7
HAH	38	240.1	442.8	715	1.66	19.3	11.8	.49	2.06	12.2	50.0
Avg SE of mean		1.4	3.1	13.7	.028	.20	.45	.036	.122	.31	.35
					Main Effect Contrasts						
S vs A		-3.3**		32.6**	.070**	-.3*	-.8*	-.089**	-.19*	.68**	.9**
SHS vs HSH		NS		NS	NS	NS	NS	.166**	NS	-.89**	-1.7**
AHA vs HAH		6.6**		NS	-.053+	-.64**	-1.5**	NS	-.24+	.61*	NS
					Interaction Contrasts						
S vs A[d]		NS		NS	NS	-.509+	-1.41*	NS	NS	NS	1.07*
SHS vs HSH[e]		NS		NS	NS	NS	NS	NS	NS	NS	NS
AHA vs HAH[f]		-5.54*		NS	NS	NS	NS	NS	.46+	NS	NS

[a] H = Hereford, S = Simmental and A = Angus. Hereford, SHS, SH, AHA and AH dams were mated to H sires, HSH dams were mated to S sires and HAH dams were mated to A sires.

[b] Scale: 18 = high select, 19 = low Choice, 20 = average Choice, etc.

[c] Scale: 9 = slight$^+$ through 15 = modest$^+$.

[d] (S - A for MS1) - (S - A for MS2).

[e] (SHS - HSH for MS1) - (SHS - HSH for MS2).

[f] (AHA - HAH for MS1) - (AHA - HAH for MS2).

$^+P<.10$. $^*P<.05$. $^{**}P<.01$.

MS1 but only by .35% under MS2. The longer postweaning period of MS1 resulted in a greater reduction in estimated cutability compared to MS2 for A-cross calves than for S-cross calves. Within the S x H rotation, differences between SHS and HSH were quite consistent over the two management systems for all traits evaluated. Within the A x H rotation, calves from HAH dams exceeded calves from AHA for KPH fat under MS2 (2.06 vs 1.59%) but not under MS1 (2.35 vs 2.34%).

Discussion

In the previous paper summarizing calf weaning production for the present study, Marshall et al. (1989) reported lighter calf birth weights but increased gains from birth to weaning for generations in which H was the sire breed within the S x H and A x H rotations. The possible influence of maternal and(or) grandmaternal effects on breed group rank changes for the two traits were discussed. Although postweaning gain was not directly measured, evaluation of carcass weight per day of age in the present study indicated lower postweaning ADG for generations in which H was the sire breed, suggesting compensatory gain during the postweaning period for calves produced by the HSH and HAH dam breed groups (S- and A-sired calves). Assuming greater preweaning maternal value (i.e., milk production) for S and A compared to H, the change in rankings for preweaning vs postweaning calf rate of gain could be explained by a negative relationship between maternal effects on calf preweaning vs postweaning gain.

In conclusion, important differences among straightbred Hereford and two-breed rotations of Simmental x Hereford and Angus x Hereford for carcass traits were observed, as were intergenerational differences within each rotation for some traits. With a few exceptions, breed group rankings were quite consistent over the two postweaning management systems. Breed group rankings differed some across various traits. Of particular interest was a different ranking for preweaning vs postweaning gains among groups within a rotation. Such changes in rankings over traits indicate the importance of characterizing breed types for a wide spectrum of economically important traits to evaluate net merit for commercial production.

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