A study of the relationship between growth traits and carcass characteristics in beef cattle
by Richard Archie Henderson

A thesis submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree
MASTER OF SCIENCE in Animal Science
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Abstract:
Cattle records of the North Montana Branch Experiment Station at Havre, Montana covering a 15-year period (1952-1966) were analyzed by simple correlation and regression analyses to study the effect of growth traits on carcass characteristics. The study consists of two parts: (a) phenotypic correlations of 8 production traits of" crossline Hereford steers with 27 of their slaughter or carcass traits (n = 339); (b) 78 sires and their respective steer progeny groups in which 10 sire production traits were correlated with 27 slaughter or carcass progeny group means. The two studies were each sub-grouped into two time periods: period 1 (1952-59) during which the animals were slaughtered after a time-constant feeding period, and period 2 (1960-66) during which they were slaughtered on a relatively weight-constant basis.

In (a) period 1, all growth traits were significantly (P<.05) correlated with carcass size. In (a) period 2, highly significant (P<.01) negative correlations were obtained between all growth traits and slaughter age. Birth weight was negatively correlated with carcass grade in both time periods. Weanling traits were positively correlated with grade in period I and negatively correlated in period 2, while feedlot traits were negatively correlated with grade in period 1 but positively correlated in period 2. All growth traits were positively correlated with measures of carcass fatness. Preweaning growth had a stronger influence on carcass fatness than did postweaning growth. During period 2 a negative relationship was found between daily gain and fat thickness. Growth traits had a highly significant positive (P<.01) effect on rib-eye area in period 1.

All growth traits were negatively correlated with rib-eye area per 100 pounds of carcass weight. Growth was negatively correlated with cutability and showed little relationship with marbling score.

In the study (b) sire feedlot, traits influenced progeny slaughter and carcass measurements more than did sire weanling traits. A positive relationship was found with area of rib-eye during period 1 with sire score at end of feed test and with sire gain per day of age, both being significantly (P<.05) correlated. Sire growth traits were also associated with a , decrease in progeny fatness measured at the 12th rib. Faster-growing and higher-scoring bulls tended to produce offspring of higher cutability. Statistical relationships among sire growth rates and scores and their respective progeny carcass traits were somewhat divergent between period I and 2.

Heritabilfty estimates were made for several production traits utilizing the regression of offspring on sire: birth weight, 50%;'weaning weight, 6%; 180-day adjusted weaning weight, 1%; final weight, 53%; average daily gain on feed, 34%; and daily gain from birth to weaning, 4%..

A STUDY OF THE RELATIONSHIP BETWEEN GROWTH TRAITS AND CARCASS CHARACTERISTICS IN BEEF CATTLE

by

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ABSTRACT

Cattle records of the North Montana Branch Experiment Station at Havre, Montana covering a 15-year period (1952-1966) were analyzed by simple correlation and regression analyses to study the effect of growth traits on carcass characteristics. The study consists of two parts: (a) phenotypic correlations of 8 production traits of crossline Hereford steers with 27 of their slaughter or carcass traits (n = 339); (b) 78 sires and their respective steer progeny groups in which 10 sire production traits were correlated with 27 slaughter or carcass progeny group means. The two studies were each sub-grouped into two time periods: period 1 (1952-59) during which the animals were slaughtered after a time-constant feeding period, and period 2 (1960-66) during which they were slaughtered on a relatively weight-constant basis.

In (a) period 1, all growth traits were significantly ($P<.05$) correlated with carcass size. In (a) period 2, highly significant ($P<.01$) negative correlations were obtained between all growth traits and slaughter age. Birth weight was negatively correlated with carcass grade in both time periods. Weanling traits were positively correlated with grade in period 1 and negatively correlated in period 2, while feedlot traits were negatively correlated with grade in period 1 but positively correlated in period 2. All growth traits were positively correlated with measures of carcass fatness. Preweaning growth had a stronger influence on carcass fatness than did postweaning growth. During period 2 a negative relationship was found between daily gain and fat thickness. Growth traits had a highly significant positive ($P<.01$) effect on rib-eye area in period 1. All growth traits were negatively correlated with rib-eye area per 100 pounds of carcass weight. Growth was negatively correlated with cutability and showed little relationship with marbling score.

In the study (b) sire feedlot traits influenced progeny slaughter and carcass measurements more than did sire weanling traits. A positive relationship was found with area of rib-eye during period 1 with sire score at end of feed test and with sire gain per day of age, both being significantly ($P<.05$) correlated. Sire growth traits were also associated with a decrease in progeny fatness measured at the 12th rib. Faster-growing and higher-scoring bulls tended to produce offspring of higher cutability. Statistical relationships among sire growth rates and scores and their respective progeny carcass traits were somewhat divergent between period 1 and 2.

Heritability estimates were made for several production traits utilizing the regression of offspring on sire: birth weight, 50%; weaning weight, 6%; 180-day adjusted weaning weight, 1%; final weight, 53%; average daily gain on feed, 34%; and daily gain from birth to weaning, 4%.

INTRODUCTION

In recent years the importance of records of performance in the beef cattle industry has become increasingly evident. This has been brought about primarily by increased competition within the meat production industry plus an ever-narrowing profit margin to the beef producer due to increased operating costs.

Of equal importance is the relationship between these various records of performance and measures of carcass quality. Since the beef carcass is essentially the end product or result of the production process, and since the ultimate criterion of the worth of a beef animal is the value of its carcass, the producer must concern himself with those factors which most affect the quality of that carcass. Competition dictates that the retailer pay more for good cutting carcasses than for those of lower yield. This in turn influences the price paid the feeder and, consequently, the cow-calf operator.

It is important to know the relative weight to place on the various measures of production in our selection indexes in order to make the most rapid progress in beef cattle carcass improvement. Close relationships between any of the live animal characteristics and one or more important carcass traits could afford an opportunity for carcass improvement through established records of performance. Considerable work has been done concerning the analysis of these relationships between production and carcass measurements. The purpose of this study is to add knowledge to that obtained by previous workers with the hope of establishing a clearer understanding of these relationships.

REVIEW OF LITERATURE

Considerable research has been accomplished concerning the relationships among production traits and carcass quality. It becomes apparent upon review of the literature that for some of the relationships, both positive and negative results can be cited. Consequently, it is difficult to organize the findings into concise clear-cut pictures.

This review examines a portion of the phenotypic and genetic correlations reported among production traits and carcass traits and some heritability estimates advanced for certain of these production traits. Due to the large number of authors and results, this review is presented in table form for brevity and ease of examination.

Phenotypic Correlations

Tables I, II, III, IV and V present reported phenotypic correlations of various carcass traits with birth weight, weaning weight (actual and 180-day adjusted), final weight, average daily gain on feed and gain per day of age, respectively. A brief notation on each study concerning materials and methods, etc. is presented the first time the study is quoted.

TABLE I. PHENOTYPIC CORRELATIONS BETWEEN BIRTH WEIGHT AND SLAUGHTER OR CARCASS TRAITS.

Slaughter or carcass trait	r	Authors and remarks
Slaughter weight	.48	Woodward et al. (1954). Time constant feed period of 252 days. Involves records from 635 steers from the U.S. Range Livestock Experiment Station, Miles City, Montana.
	.46	Shelby et al. (1963). Involves 616 steers, time constant feeding period of 252 days. Also contains data from the Miles City Station and probably uses some records common to Woodward et al. (1954) and Woodward et al. (1959).
Days to slaughter	-.39	Yao et al. (1953). Involves 101 beef Shorthorn and 62 Milking Shorthorn steers. Cattle were slaughtered at 900 pounds.
Carcass grade	-.18	Yao et al. (1953).
	-.04	Woodward et al. (1954).
	.08	Woodward et al. (1959). Continuation of Woodward et al. (1954). Involves 210 steers. 9-10-11th rib separations were done on 56 of these. Feed period was 252 days.
	-.09	Brown et al. (1962). Time constant feeding trial. Involves only 11 animals.
	-.05	Shelby et al. (1963).
Carcass weight	.40	Shelby et al. (1963).
Dressing percent	-.13	Yao et al. (1953).
	-.05	Woodward et al. (1959).
	.00	Brown et al. (1962).
	-.02	Shelby et al. (1963).
Rib-eye area	.26	Woodward et al. (1954). Partial correlation holding final weight constant was .07.
	.12	Woodward et al. (1959).
	-.03	Brown et al. (1962).
	.17	Shelby et al. (1963).

TABLE I. (Continued)

Slaughter or carcass trait	r	Authors and remarks
Fat thickness	-.07	Woodward et al. (1954). Partial correlation holding final weight constant was -.24.
	.05	Woodward et al. (1959).
	-.04	Shelby et al. (1963).
Width of round	.21	Woodward et al. (1959).
Width of shoulder	.24	Woodward et al. (1959).
Depth of body	.30	Woodward et al. (1959).
Circumference of round	.10	Woodward et al. (1959).
Plumpness index	-.14	Woodward et al. (1959).
Length of body	.40	Woodward et al. (1954). Partial correlation holding final weight constant was .06.
	.42	Woodward et al. (1959).
	.36	Shelby et al. (1963).
Length of leg	.45	Woodward et al. (1954). Partial correlation holding final weight constant was .23.
	.43	Woodward et al. (1959).
	.44	Shelby et al. (1963).
Shear force	.09	Woodward et al. (1959).
	-.03	Brown et al. (1962).
Percent lean	.07	Woodward et al. (1959).
Percent fat	-.06	Woodward et al. (1959).
Percent bone	.10	Woodward et al. (1959).

The magnitude of the correlations reported indicate that birth weight is not a strong indicator of future performance as far as carcass traits are concerned. The strongest relationships appear to be with slaughter weight, carcass weight, length of body and length of leg. Thus, it appears birth weight is more indicative of future growth and size than it is of eventual carcass quality as determined by present quality standards.

TABLE II. PHENOTYPIC CORRELATIONS BETWEEN WEANING WEIGHT AND SLAUGHTER OR CARCASS TRAITS.

Slaughter or carcass trait	r	Authors and remarks
Slaughter weight	.60	Woodward et al. (1954).
	.63	Lindholm and Stonaker (1957). This study involved 118 Hereford steers slaughtered at a live grade of Low Choice.
	.62	Woodward et al. (1959). Weaning weight was adjusted to 180 days.
	.53	Blackwell et al. (1962). This study involved slaughter data from 421 steers killed at the conclusion of a 168 day fattening period. The steers were approximately 2 years old at the time of slaughter.
	.58	Shelby et al. (1963). 180 day weaning weight.
	.55	Christian et al. (1965). This study involves carcass data on 64 steers and heifers slaughtered at an estimated live grade of High Choice.
	.83	Dubose et al. (1967). 180 day weaning weight. Involved 231 crossbred calves slaughtered after a 140-day gain test. Average slaughter age was 424 days.
Slaughter age	-.40	Christian et al. (1965).
Carcass grade	.15	Woodward et al. (1965). Partial correlation holding final weight constant was .06.
	.23	Carter and Kincaid (1959). Weaning weight was expressed as 182 day weight. The study involved 195 Hereford and crossbred steers

TABLE II. (Continued)

Slaughter or carcass trait	r	Authors and remarks
Carcass grade (Continued)		slaughtered at the end of a 200 day test.
	.03	Woodward et al. (1959). 180 day weaning weight.
	.11	Blackwell et al. (1962).
	.09	Shelby et al. (1963). 180 day weaning weight.
	-.26	Christian et al. (1965).
	.06	Swiger et al. (1965). This study involved 480 steers, bulls and heifers slaughtered after a time constant feed period. Some of the animals were straightbred and some were crossbreds.
	.05	Dubose et al. (1967). 180 day weaning weight.
Carcass weight	.54	Blackwell et al. (1962).
	.57	Shelby et al. (1963). 180 day weaning weight.
	.70	Dubose et al. (1967). 180 day weaning weight.
Dressing percent	.12	Woodward et al. (1959). 180 day weaning weight.
	.14	Blackwell et al. (1962).
	.18	Shelby et al. (1963). 180 day weaning weight.
Rib-eye area	.30	Woodward et al. (1954). Partial correlation holding final weight constant was .26.
	.17	Woodward et al. (1959). 180 day weaning weight.
	.60	Brown et al. (1962).
	.24	Shelby et al. (1963). 180 day weaning weight.
	.52	Christian et al. (1965).
	.29	Dubose et al. (1967). 180 day weaning weight.
Fat thickness	.12	Woodward et al. (1954). Partial correlation holding final weight constant was .25.
	.19	Woodward et al. (1959). 180 day weaning weight.
	.14	Shelby et al. (1963). 180 day weaning weight.
	-.02	Christian et al. (1965).
	.18	Swiger et al. (1965).
	.02	Dubose et al. (1967). 180 day weaning weight.

TABLE II. (Continued)

Slaughter or carcass trait	r	Authors and remarks
Width of round	.40	Woodward et al. (1959). 180 day weaning weight.
	.32	Dubose et al. (1967). 180 day weaning weight.
Width of shoulder	.38	Woodward et al. (1959). 180 day weaning weight.
Depth of body	.29	Woodward et al. (1959). 180 day weaning weight.
Circumference of round	.26	Woodward et al. (1959). 180 day weaning weight.
Plumpness index	-.07	Woodward et al. (1959). 180 day weaning weight.
Length of body	.57	Woodward et al. (1959). 180 day weaning weight.
	.51	Shelby et al. (1963). 180 day weaning weight.
	.69	Dubose et al. (1967). 180 day weaning weight.
Length of leg	.59	Woodward et al. (1959). 180 day weaning weight.
	.50	Shelby et al. (1963). 180 day weaning weight.
	.50	Dubose et al. (1967). 180 day weaning weight.
Cutability	-.18	Swiger et al. (1965).
Shear force	.05	Woodward et al. (1959). 180 day weaning weight.
Marbling score	-.36	Christian et al. (1965).

TABLE II. (Continued)

Slaughter or carcass trait	r	Authors and remarks
Percent lean	.08	Woodward et al. (1959). 180 day weaning weight.
Percent fat	.12	Woodward et al. (1959). 180 day weaning weight.
Percent bone	-.14	Woodward et al. (1959). 180 day weaning weight.

The correlations reported indicate that weaning weight has more predictive value than does birth weight for certain carcass traits. The correlations indicate weaning weight to be more indicative of future size and growth than of future carcass quality. The trend of the correlations between birth weight and carcass grade was negative but weaning weight tended to be positively correlated with carcass grade. Weaning weight was also more strongly correlated with measures of carcass lean such as area of rib-eye and percent separable lean in the 9-10-11th rib section. The literature reviewed indicates that weaning weight is more predictive of future growth and carcass traits than is birth weight.

TABLE III. PHENOTYPIC CORRELATIONS BETWEEN FINAL WEIGHT AND SLAUGHTER OR CARCASS TRAITS.

Slaughter or carcass trait	r	Authors and remarks
Carcass grade	.54	Knapp and Nordskog (1946). This study was done at the Miles City Station and involved 177 steer calves. They were all slaughtered at the end of the feed trial after being shipped to South St. Paul or Chicago.
	.40	Woodward et al. (1954).

TABLE III. (Continued)

Slaughter or carcass trait	r	Authors and remarks
Carcass grade (Continued)	.52	Magee et al. (1958). This study involved steers from two different sources. The total number involved was 104. They were slaughtered at the end of time constant feeding periods.
	.21	Woodward et al. (1959).
	.36	Blackwell et al. (1962).
	.52	Matthews and Bennett (1962). This study involved a total of 24 steers and heifers and utilized varying feed rations. It was designed primarily to study the effect of rate of gain on carcass traits. The cattle were slaughtered after a time-constant feeding period. Carcass weight, a function of final weight, was correlated with various carcass measures and these values are reported here.
	.49	Neville et al. (1962). This experiment was conducted in Georgia and involved 98 steers and heifers. The cattle were fattened on experimental rations on winter pasture of oats and ryegrass for 132 days.
	.35	Shelby et al. (1963).
	.16	Swiger et al. (1965).
	.09	Dubose et al. (1967).
Carcass weight	.95	Blackwell et al. (1962).
	.93	Neville et al. (1962).
	.96	Shelby et al. (1963).
	.86	Dubose et al. (1967).
Dressing percent	.25	Woodward et al. (1954).
	.03	Woodward et al. (1959).
	.26	Blackwell et al. (1962).
	.54	Matthews and Bennett (1962). Carcass weight x dressing percent.
	.19	Shelby et al. (1963).
Rib-eye area	.14	Knapp and Nordskog (1946).
	.44	Woodward et al. (1954).

TABLE III. (Continued)

Slaughter or carcass trait	r	Authors and remarks
Rib-eye area (Continued)	.38	Orme et al. (1959a). This study was composed of 8 Angus and 23 Hereford steers. They apparently were not slaughtered after a time constant feed period but the authors did not report what the slaughter conditions were, ie., weight or grade-constant.
	.20	Woodward et al. (1959).
	.64	Matthews and Bennett (1962). Carcass weight x rib-eye area.
	.02	Matthews and Bennett (1962). Carcass weight x rib-eye area/100 pounds carcass weight.
	.41	Shelby et al. (1963).
	.31	Dubose et al. (1967).
	.75	Abraham et al. (1968). This study examined the relationships between carcass weight and measures of carcass merit. The carcass measurements were taken as described by Orts (1962). This study involved 835 steers of several breeds and crossbreeds from varying sources and slaughter conditions.
Length of leg	.70	Woodward et al. (1954).
	.71	Woodward et al. (1959).
	.70	Shelby et al. (1963).
	.54	Dubose et al. (1967).
	.67	Abraham et al. (1968). Carcass weight x length of leg.
Length of loin	.49	Birkett et al. (1965). This study involved 32 steers killed as a group. The carcasses ranged from 498 to 749 pounds. The steers were about 18 months old when slaughtered and were all Herefords. Carcass measurements were taken as described by Naumann (1952).
Cutability	-.21	Swiger et al. (1965).
	-.52	Birkett et al. (1965). Carcass weight x percent trimmed round, loin, rib, and chuck.

TABLE III. (Continued)

Slaughter or carcass trait	r	Authors and remarks
Marbling score	.58	Matthews and Bennett (1962). Carcass weight x marbling score.
Shear force	.10	Woodward et al. (1959).
	.34	Matthews and Bennett (1962). Carcass weight x shear force.
Percent lean	-.06	Woodward et al. (1959). 9-10-11th rib separation.
	-.28	Brackelsburg and Willham (1968). This study involved 51 bulls, steers and heifers killed at the end of a 168-day feed trial. Percent lean, fat and bone estimates were made following separations of the entire carcass. Correlations are with carcass weight.
Percent fat	.30	Woodward et al. (1959). 9-10-11th rib separation.
	.18	Brackelsburg and Willham (1968). Carcass weight.
Percent bone	-.31	Woodward et al. (1959). 9-10-11th rib separation.
	-.33	Brackelsburg and Willham (1968). Carcass weight.
Fat thickness	.33	Woodward et al. (1954).
	.33	Woodward et al. (1959).
	.31	Shelby et al. (1963).
	.27	Swiger et al. (1965).
	.13	Dubose et al. (1967).
	.34	Matthews and Bennett (1962). Carcass weight x fat thickness.
	.01	Matthews and Bennett (1962). Carcass weight x fat thickness/100 pounds carcass weight.
	.60	Abraham et al. (1968). Carcass weight x average fat thickness.
	.47	Abraham et al. (1968). Carcass weight x single fat thickness.

TABLE III. (Continued)

Slaughter or carcass trait	r	Authors and remarks
Width of round	.80	Orme et al. (1959). The animals used in this study were the same ones used in the study by Orme et al. (1959a). Carcass measurements were taken on the unsplit carcass.
	.55	Woodward et al. (1959).
	.32	Dubose et al. (1967).
	.74	Abraham et al. (1968). Carcass weight x width of round.
Circumference of round	.44	Orme et al. (1959). Unsplit carcass.
	.56	Woodward et al. (1959).
Width of shoulder	.79	Orme et al. (1959). Unsplit carcass.
	.68	Woodward et al. (1959).
Depth of body	.67	Orme et al. (1959). Unsplit carcass.
	.48	Woodward et al. (1959). Measured at 7th rib.
Length of body	.78	Woodward et al. (1954).
	.66	Orme et al. (1959). Unsplit carcass.
	.68	Woodward et al. (1959).
	.76	Shelby et al. (1963).
	.79	Dubose et al. (1967).
	.80	Abraham et al. (1968). Carcass weight x length of body.

TABLE IV. PHENOTYPIC CORRELATIONS BETWEEN AVERAGE DAILY GAIN ON FEED AND SLAUGHTER OR CARCASS TRAITS.

Slaughter or carcass trait	r	Author and remarks
Slaughter weight	.53	Lindholm and Stonaker (1957).
	.89	Woodward et al. (1959).
	.19	Neville et al. (1962).
	.81	Shelby et al. (1963).
	.86	Swiger et al. (1965).
	.66	Dubose et al. (1967).
Slaughter age	-.16	Lindholm and Stonaker (1957). This was expressed as "days on feed x slaughter age" and is not a true picture of the relationship between daily gain and slaughter age. It actually says that older animals required fewer days on feed to reach a live grade of Low Choice than did younger animals.
Carcass grade	.37	Hankins and Burk (1932). This study involved 2,073 cattle from experiment stations in 18 states. It contained both steers and heifers from varying environments.
	.25	Durham and Knox (1953). This study involved 59 steers which were fed for 196 days prior to slaughter.
	.08	Yao et al. (1953).
	.40	Woodward et al. (1954).
	-.31	Cartwright et al. (1958). This study involved 18 Hereford and 20 Brahman x Hereford steers randomly assorted to two feed rations. The correlations are pooled for breeds and rations. The negative relationship with carcass grade actually indicates a favorable relationship since a decreasing numerical score indicates an increase in carcass quality grade.
	.43	Magee et al. (1958).
	.31	Carter and Kincaid (1959).
	.27	Woodward et al. (1959).
	.43	Blackwell et al. (1962).
	-.05	Brown et al. (1962).
	.24	Neville et al. (1962).
	.37	Shelby et al. (1963).
	.17	Swiger et al. (1965).

TABLE IV. (Continued)

Slaughter or carcass trait	r	Author and remarks
Carcass grade (Continued)	.17	Dubose et al. (1967).
Carcass weight	.51	Cartwright et al. (1958).
	.72	Blackwell et al. (1962).
	.19	Neville et al. (1962).
	.81	Shelby et al. (1963).
	.59	Dubose et al. (1967).
Dressing percent	-.32	Stroble et al. (1951). This study involved 75 cattle slaughtered at a constant weight of 900 pounds.
	-.09	Yao et al. (1953).
	.11	Woodward et al. (1954).
	-.05	Woodward et al. (1959).
	.26	Blackwell et al. (1962).
	.27	Brown et al. (1962).
	.10	Shelby et al. (1963).
Rib-eye area	.33	Woodward et al. (1954). The authors calculated the partial correlation holding final weight constant and found this correlation dropped to zero.
	.39	Cartwright et al. (1958).
	.15	Woodward et al. (1959).
	.72	Brown et al. (1962).
	-.04	Neville et al. (1962). This correlation was between daily gain and rib-eye area/100 pound carcass.
	.36	Shelby et al. (1963).
	.23	Dubose et al. (1967).
Fat thickness	.33	Woodward et al. (1954). The partial correlation holding final weight constant was -.21.
	.26	Cartwright et al. (1958).
	.29	Woodward et al. (1959).
	.30	Shelby et al. (1963).
	.25	Swiger et al. (1965).
	.06	Dubose et al. (1967).

TABLE IV. (Continued)

Slaughter or carcass trait	r	Author and remarks
Width of round	.47	Woodward et al. (1959).
	.31	Dubose et al. (1967).
Circumference of round	.54	Woodward et al. (1959).
Width of shoulder	.65	Woodward et al. (1959).
Depth of body	.40	Woodward et al. (1959). Measured at 7th rib.
Length of body	.57	Woodward et al. (1954). Partial correlation holding final weight constant was -.03.
	.54	Woodward et al. (1959).
	.60	Shelby et al. (1963).
	.61	Dubose et al. (1967).
Length of leg	.49	Woodward et al. (1954). Partial correlation holding final weight constant was -.09.
	.55	Woodward et al. (1959).
	.56	Shelby et al. (1963).
	.46	Dubose et al. (1967).
Plumpness index	.22	Woodward et al. (1959).
Cutability	-.16	Swiger et al. (1965).
Marbling score	.20	Cartwright et al. (1958).
Shear force		Marion et al. (1949) reported higher gaining steers produced more tender meat than lower gaining ones. The sample size was small in this study.
	.09	Woodward et al. (1959).
	.14	Brown et al. (1962).
		Matthews and Bennett (1962) found no signifi-

TABLE IV. (Continued)

Slaughter or carcass trait	r	Author and remarks
Shear force (Continued)		cant relationship between rate of gain and tenderness as measured organoleptically or with the Warner-Bratzler shear.
	-.15	Suess et al. (1966). This study involved 128 Angus steer and heifer progeny from six different herds.
Percent lean	-.24	Cartwright et al. (1958).
	-.15	Woodward et al. (1959).
Percent fat	.30	Cartwright et al. (1958).
	.34	Woodward et al. (1959).
	.11	Brown et al. (1962). Chemical analysis.
Percent bone	-.33	Woodward et al. (1959).

TABLE V. PHENOTYPIC CORRELATIONS BETWEEN GAIN PER DAY OF AGE AND SLAUGHTER OR CARCASS TRAITS.

Slaughter or carcass trait	r	Author and remarks
Slaughter weight	.86	Neville et al. (1962). Wt./day of age at slaughter.
Carcass grade	-.34	Cartwright et al. (1958). Gain to 180 days x carcass grade. (Decreasing score = increasing grade).
	-.35	Cartwright et al. (1958). Wt./day of age at end of test x carcass grade.
	.39	Neville et al. (1962). Wt./day of age at slaughter x carcass grade.
Carcass weight	.81	Cartwright et al. (1958). Gain to 180 days x carcass weight.
	.79	Cartwright et al. (1958). Wt./day of age at end of test x carcass weight.
	.77	Neville et al. (1962). Wt./day of age at slaughter x carcass weight.
Rib-eye area	.31	Cartwright et al. (1958). Gain to 180 days x rib-eye area.
	.38	Cartwright et al. (1958). Wt./day of age at end of test x rib-eye area.
	-.57	Cartwright et al. (1958). Gain to 180 days x rib-eye area/100 lbs. carcass wt.
	-.46	Cartwright et al. (1958). Wt./day of age at end of test x rib-eye area/100 lbs. carcass wt.
	-.34	Neville et al. (1962). Wt./day of age at slaughter x rib-eye area/100 lbs. carcass wt.
Fat thickness	.56	Cartwright et al. (1958). Gain to 180 days x fat thickness.
	.50	Cartwright et al. (1958). Wt./day of age at end of test x fat thickness.
Marbling score	.30	Cartwright et al. (1957). Gain to 180 days x estimated percent marbling.

TABLE V. (Continued)

Slaughter or carcass trait	r	Author and remarks
Marbling score (Continued)	.36	Cartwright et al. (1958). Wt./day of age at end of test x estimated percent marbling.
Shear force	.01	Suess et al. (1966). Wt./day of age at slaughter x shear force.
Percent lean	-.56	Cartwright et al. (1958). Gain to 180 days x percent lean in 9-10-11th rib section.
	-.45	Cartwright et al. (1958). Wt./day of age at end of test x percent lean in 9-10-11th rib section.
Percent fat	.59	Cartwright et al. (1958). Gain to 180 days x percent fat in 9-10-11th rib section.
	.52	Cartwright et al. (1958). Wt./day of age at end of feed test x percent fat in 9-10-11th rib section.

The phenotypic correlations reported concerning final weight and average daily gain as they are related to various measures of carcass quality, indicate they are of considerably higher predictive value than is birth weight or weaning weight.

If both final weight and average daily gain are available as selection tools it appears that final weight has somewhat more value in predicting carcass quality than does average daily gain. The magnitude of the correlations reported indicate final weight is more predictive than average daily gain of carcass grade, rib-eye area, fat thickness, most linear measurements (width, circumference and length), marbling score and shear force. These are characteristics which are all quite important in

determining overall carcass quality and composition. It should be pointed out however, that the differences in the magnitudes of the correlations produced by these two traits is not great in any instance.

Gain or weight per day-of-age did not appear to be of any more value than either final weight or average daily gain as a selection tool in beef carcass improvement. They did appear, from the articles reviewed, to be somewhat more strongly related to fat content of the 9-10-11th rib section, both from the standpoint of fat thickness and percent fat. Many of the correlations quoted involved weight per day of age and it must be recognized that this value is influenced by birth weight where gain per day of age is not.

Genetic Correlations

A review is also presented of the genetic correlations reported between production and carcass traits. The present study includes calculation of correlation and regression values between the production traits of sires and the means of the carcass traits of their respective progeny. Although it is recognized that these correlations are not actually true genetic correlations since measurements of both production and carcass traits were not available on both sire and progeny, it was felt that the nearness of these values to true genetic correlations warranted this review.

Tables VI, VII, VIII, IX and X present genetic correlations reported between various carcass traits and birth weight, weaning weight (actual and adjusted 180-day), average daily gain, final weight and gain per day of age.

TABLE VI. GENETIC CORRELATIONS BETWEEN BIRTH WEIGHT AND SLAUGHTER OR CARCASS TRAITS.

Slaughter or carcass trait	r	Author and remarks
Slaughter weight	.51	Shelby et al. (1963). This study involves 616 steers slaughtered after a feed period of 252 days. The experiment was done at the U. S. Range Livestock Experiment Station at Miles City, Montana.
Yearling weight	.40	Koch and Clark (1955). This study involved comparisons of 1694 Hereford cattle at the Miles City, Montana Station. The data were adjusted to a heifer basis. This was the yearling weight and not the final or slaughter weight.
	.56	Brinks et al. (1964). All the animals used in this study were females. The study involves records on over 3500 females from the Miles City Experiment Station.
Final weight	.75	Brinks et al. (1962). This study involved 1029 bulls performance tested at Miles City, Montana. This correlation is between birth weight and final weight at the end of a 196 day feed trial.
Carcass grade	-.43	Shelby et al. (1963).
Carcass weight	.39	Shelby et al. (1963).
Dressing percent	-.25	Shelby et al. (1963).
Area of rib-eye	-.01	Shelby et al. (1963).
Fat thickness	-.16	Shelby et al. (1963).
Length of body	.30	Shelby et al. (1963).
Length of leg	.66	Shelby et al. (1963).

TABLE VII. GENETIC CORRELATIONS BETWEEN WEANLING TRAITS AND SLAUGHTER OR CARCASS TRAITS.

Slaughter or carcass trait	r	Author and remarks
Yearling weight	.54	Koch and Clark (1955). 182-day weaning weight.
	.71	Brinks et al. (1964). Trial involved only females.
Final weight	.67	Brinks et al. (1962). 180-day weaning weight x final weight at end of 196 day feed test.
Slaughter weight	.89	Shelby et al. (1963). 180-day weaning weight.
Yearling weight	.31	Koch and Clark (1955). Weaning score x yearling weight.
Carcass grade	.84	Carter and Kincaid (1959). Weaning weight was expressed as 182-day weight. The study involves 195 steers fed for 200 days and slaughtered.
	.92	Blackwell et al. (1962). This study involved data from 421 steers killed at the end of a 168 day fattening period. The steers were approximately 2 years old at slaughter.
	-.04	Shelby et al. (1963). 180-day weaning weight.
	-.43	Swiger et al. (1945). Involves 480 steers, bulls and heifers slaughtered after a time-constant feed period. Includes both straight-bred and crossbred cattle.
Carcass weight	1.10	Blackwell et al. (1962).
	.90	Shelby et al. (1963). 180-day weaning weight.
Dressing percent	1.56	Blackwell et al. (1962).
	.30	Shelby et al. (1963). 180-day weaning weight.
Area of rib-eye	.40	Shelby et al. (1963). 180-day weaning weight.
Fat thickness	.91	Shelby et al. (1963). 180-day weaning weight.
	-.29	Swiger et al. (1965).

TABLE VII. (Continued)

Slaughter or carcass trait	r	Author and remarks
Length of body	.81	Shelby et al. (1963). 180-day weaning weight.
Length of leg	.92	Shelby et al. (1963). 180-day weaning weight.
Percent retail prod. (cutability)	.09	Swiger et al. (1965). This was expressed as percent of boneless closely trimmed retail cuts.

TABLE VIII. GENETIC CORRELATIONS BETWEEN AVERAGE DAILY GAIN AND SLAUGHTER OR CARCASS TRAITS.

Slaughter or carcass trait	r	Author and remarks
Yearling weight	.83	Koch and Clark (1955). Gain wean to yearling x yearling weight.
Slaughter weight	.91	Shelby et al. (1963).
Carcass grade	.85	Carter and Kincaid (1959).
	.78	Blackwell et al. (1962).
	.25	Shelby et al. (1963).
	.08	Swiger et al. (1965).
Carcass weight	.98	Blackwell et al. (1962).
	.90	Shelby et al. (1963).
Dressing percent	.94	Blackwell et al. (1962).
	.01	Shelby et al. (1963).
Area of rib-eye	-.10	Shelby et al. (1963).
Fat thickness	.14	Shelby et al. (1963).
	.49	Swiger et al. (1965).
Length of body	.85	Shelby et al. (1963).
Length of leg	.87	Shelby et al. (1963).
Cutability	-.45	Swiger et al. (1965). This correlation was between daily gain x percent retail product.