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Preweaning body measurements of beef calves and traits of their dams as predictors of calves' postweaning and lifetime performance

William Lester Brown

To the Graduate Council:

I am submitting herewith a dissertation written by William Lester Brown entitled "Preweaning body measurements of beef calves and traits of their dams as predictors of calves' postweaning and lifetime performance." I have examined the final electronic copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Animal Science.

Robert R. Shrode, Major Professor

We have read this dissertation and recommend its acceptance:

Charles S. Hobbs, L.M. Josephson, Robert L. Murphee, Don O. Richardson, Charles C. Trigpen

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Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

November 21, 1969

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PREWEANING BODY MEASUREMENTS OF BEEF CALVES AND TRAITS OF THEIR DAMS AS PREDICTORS OF CALVES' POSTWEANING AND LIFETIME PERFORMANCE

A Dissertation

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the Graduate Council of

The University of Tennessee

In Partial Fulfillment

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Doctor of Philosophy

by

William Lester Brown

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ABSTRACT

Body measurements, body composition traits, and certain performance traits of 74 Angus bull and 84 Angus heifer calves, recorded at three different observations up to weaning, were studied to assess their value as predictors of postweaning ADG, lifetime ADG (ADG from birth until the end of test), final condition score and fat thickness (measured ultrasonically when the postweaning feeding period was terminated). These calves were born from January 17, 1968, to April 26, 1968. A stepwise regression procedure was employed to construct prediction equations. Traits that could enter the regression equation as independent variables included heart girth, back length, loin length, rump length, total length, type score, condition score, weight, and age. Also, fat thickness measured ultrasonically over the twelfth and thirteenth ribs at weaning was considered among the independent variables.

Coefficients of multiple determination (R^2) for the equations to predict the dependent variables tended to be larger when the independent variables were the calves' weaning traits rather than preweaning or interim traits. It was concluded that if the dependent variables are to be predicted from calf traits observed at only one time of observation, that observation should be taken at an average age of about 220 to 225 days (weaning). Various combinations of the weaning body measurements and body composition traits explained significantly ($P < .05$) more variation in postweaning ADG, lifetime ADG, final condition score and final fat thickness than was explained by weight and age alone. For bulls,

the increases in R^2 were 0.239, 0.113, 0.155, and 0.207, respectively, for the dependent variables enumerated above. In the case of heifers, the increases in R^2 were 0.277, 0.089, 0.105, and 0.146, respectively. Hence, it appears from these results that body dimension measurements and estimates of fatness can be used effectively to improve the prediction of calf performance and subsequent body composition over conventional methods utilizing only calf weight and age.

The addition of traits of the dam (weight and condition score and linear, squared and cubed forms of change in weight and condition of the dam from April, 1968, until time of observation of calf) to the regression equations, after entering the calf traits, generally did not result in significant increases in the R^2 values for predicting postweaning and lifetime ADG. These cow variables tended to be slightly more important as predictors of final condition score and fat thickness of the calves. It is doubtful that the additional precision in predicting future performance and body composition of calves obtained by considering these traits of the dams, is large enough to warrant the extra effort and expense necessary to obtain these data.

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CHAPTER I

INTRODUCTION

For many years selection in beef cattle has been directed toward improvement of weaning traits such as average daily gain (ADG) and conformation, while the ultimate objective of the beef industry as a whole is to produce more pounds of high quality, nutritious beef as efficiently as possible. Selection based on traits measured at weaning may result in calves that are heavier at weaning, but not necessarily calves that will be the most efficient in terms of rate and economy of gain in the feedlot. More effective selection to improve "total" production could be made at older ages when animals normally reach market weight. In spite of this, it is desirable from both an economic and genetic standpoint to make selections of breeding animals as early as weaning.

The problem then, is to change the selection criteria at weaning such that maximum improvement can be made in feed lot gains, as well as in preweaning performance. A solution to this problem is to choose as selection criteria traits, in addition to weaning weight, that will more accurately reflect an animal's genetic potential for growth rate.

This study was undertaken as a preliminary effort to evaluate certain body measurements and various subjective estimates of body shape and composition as predictors of subsequent growth rate in beef cattle.

CHAPTER II

REVIEW OF LITERATURE

Many studies of body measurements of beef and dairy cattle have been reported. Most of these have investigated the relationships of body measurements taken on the live animals to carcass quality and carcass cutout (Black *et al.*, 1938; Yao *et al.*, 1953; Orme *et al.*, 1959; Tallis *et al.*, 1959; Cole *et al.*, 1960; Birkett *et al.*, 1965). These studies will not be reviewed. The discussion which follows will deal with the body of literature relating to calf performance, body measurements and their relationships.

I. GROWTH RATE, BODY MEASUREMENTS AND THEIR RELATIONSHIPS

Selection for growth rate. Most selection in beef cattle has been directed toward improving weaning traits, either disregarding the improvement of performance later in life or with the belief that selection based on weaning performance would be effective both to improve pre-weaning growth rate and gains made during postweaning periods.

An extensive summary of many estimates of genetic and phenotypic parameters of beef cattle traits has been made by Petty and Cartwright (1966). Averages of estimates from this summary are presented in Table I. Heritability estimates for performance traits measured at older ages, and their genetic correlations with performance during earlier periods, are relatively large. Differences in maternal environments of

TABLE I

SUMMARY OF ESTIMATES OF HERITABILITIES AND GENETIC AND PHENOTYPIC CORRELATIONS OF PERFORMANCE TRAITS OF BEEF CATTLE[a]

		1.	2.	3.	4.	5.	6.
1. Gain birth	(G)	.31 (24)[b]	.98 (7)	.35 (12)	.08 (2)	.73 (2)	
to weaning	(P)		.97 (7)	.33 (12)	.14 (2)	.63 (2)	
2. Weaning	(G)		.28 (38)	.39 (14)	.58 (10)	.79 (9)	.19 (5)
weight	(P)			.39 (14)	.17 (10)	.65 (9)	.22 (5)
3. Weaning	(G)			.32 (35)	.08 (6)	.43 (5)	.68 (5)
score	(P)				.00 (6)	.31 (5)	.40 (5)
4. Feedlot	(G)				.52 (31)	.86 (9)	.31 (5)
gain	(P)					.77 (9)	.39 (5)
5. Final feedlot	(G)					.58 (22)	.38 (4)
weight	(P)						.41 (4)
6. Final feedlot	(G)						.36 (15)
score	(P)						

[a]Estimates of heritabilities appear on the diagonal and estimates of genetic (G) and phenotypic (P) correlations appear in off-diagonal cells.

[b]Number of estimates in the average are given in parentheses.

calves up to weaning have been shown to be an important cause of the low heritability estimates for growth rate at early ages (Butts, 1966; Deese and Koger, 1967). Hence, selection at older ages would be expected to be more effective in improving "total" performance up to market weight than selection at or before weaning.

A possibility for improving early selection of calves for growth rate is to define calf weight in terms of body measurements and various estimates of body composition in such a way that the influence of maternal differences is less important. Traits measured on the dam also could be used.

Accuracy of obtaining body measurements. A study of the accuracy of linear body measurements of dairy cattle was reported by Touchberry and Lush (1950). Wither height, chest depth, body length, heart girth and paunch girth were observed at seven ages--six months, one, two, three, four, five and seven years. Relative accuracies at the various ages were not significantly different. In an earlier study by Lush and Copeland (1930), it was reported that little or no correlation exists between the average size of the measurement and the random error in taking the measurement. In both studies there was little improvement in the relative accuracy of obtaining the measurements by taking a second and third observation of the same trait. The repeated observations did serve as a check against gross recording errors.

Phenotypic variation of body measurements. Relative variability of various body measurements in Hereford and Angus cattle were reported by Brown (1958). Means and coefficients of variation of the measurements from this study are given in Table II. Coefficients of variation reported in other studies were similar (Kidwell, 1955; Ternan et al., 1959).

Relationship of age to body measurements and proportions. Early studies by Severson et al. (1917), Hultz (1927), Hultz and Wheeler (1927), and Lush (1928) were concerned primarily with measuring changes in certain body measurements of steers during fattening and, consequently, aging. The results of these studies can be best summarized by a statement of Lush (1928):

> During fattening, steers increase most in body width, next in body length, next in height to the top line from the ground and least in head measurements. While steers became broader, slightly taller and somewhat lower set during the fattening process, the fat steers were shorter and smaller boned, as well as broader and lower set, than thin steers of the same weight.

It has been reported that beef animals reach maturity for the dimensions of height, depth, width, length and heart girth at earlier ages than for body weight (Brown et al., 1956a, 1956b). Linear skeletal growth increases faster and is completed earlier than thickness growth (Guilbert and Gregory, 1952), indicating that much of the fluctuation in body weight of cattle at older ages is due to changes in the amount of body fat rather than changes in "true" skeletal size. It was reported by Brown and coworkers (1956a) that Hereford calves at eight months of age had attained 35 percent of their mature weight and from 69 percent to 81 percent of their mature size, whereas Angus calves (Brown et al., 1956b) at the same age had attained 41 percent of their mature weight and from 71 percent to 83 percent of their mature size as indicated by body measurements. From these findings, it appears that body

TABLE II

VARIABILITY OF BODY MEASUREMENTS IN BEEF CATTLE[a]

Measurement		Hereford		Angus	
		Mean	C.V.	Mean	C.V.
Weight	(lb.)	391.0	14.7	399.0	14.9
Wither height	(in.)	36.4	4.4	37.3	5.1
Hip height	(in.)	38.9	3.8	39.0	4.3
Chest depth	(in.)	18.5	5.4	19.0	4.7
Rear flank depth	(in.)	15.8	7.0	16.6	6.6
Shoulder width	(in.)	12.2	9.8	12.4	10.6
Hip width	(in.)	12.9	8.5	13.5	9.6
Body length	(in.)	44.4	4.7	45.6	5.1
Heart girth	(in.)	50.6	5.7	52.6	5.4

[a]Data corrected to 240 days of age, female and mature dam basis.

measurements may provide a means of more accurately characterizing mature size and shape at earlier ages than is possible using weight or other measures of early gain.

Relationships of growth rate and body measurements. Of the many studies of body measurements of cattle, relatively few have been concerned with the relationships of these measurements to growth rate. In certain of these reports (Black et al., 1938; Kohli et al., 1951) the relationships studied were with previous performance rather than subsequent growth rate.

In terms of number of animals studied, statistical analysis of the data and interpretation of the results, perhaps one of the best papers relating body measurements to future performance was published by Lush (1932). The measurements considered included body length, chest depth, loin width, various girth measurements and a number of measurements of the animal's head. The correlations between measurements of feeder steers and subsequent gain, dressing percentage and economic value of dressed beef were generally low but statistically significant. Multiple regression equations of feedlot gain on the body measurements were fitted. An equation including body length, wither height, loin width, flank girth and paunch girth accounted for 23.2 percent of the variation in feedlot gain. The relatively small R^2 values reported could be due in part to unexplained variation associated with the wide range of ages studied (calves, yearlings, and two-year-olds).

Kidwell and associates (1959) concluded that body measurements of feeder cattle are of little practical value as indicators of ability to gain rapidly and economically later in life. Various combinations of wither height, hook height, width of chest, hook width, heart girth, round thickness, body length and ratios of these accounted for 16 to 20 percent of the variation in ADG and economy of gain in steers. However, in this study steers of both dairy and beef breeding were represented. Half the steers were fed for approximately ninety days and the remainder for about 150 days. These steers were purchased from various sources; therefore, variation in the environmental conditions to which the steers had been subjected prior to the feeding test, were no doubt much greater than environmental differences expected within herds. These sources of variation in the dependent variables, which were not accounted for in the regression analysis, would have tended to make the R^2 values small.

Combinations of seven different body measurements of beef calves taken at birth explained very little of the variation in ADG from birth to weaning in a study by Flock and others (1962).

Heritabilities of body measurements. To evaluate body measurements or other traits as selection criteria, it is necessary to have an estimate of their heritabilities. Table III summarizes many of the heritability estimates for various body measurements. In general, these characteristics appear to be moderately to highly heritable as compared to the weaning performance traits. Heritability estimates of body measurements tend to be in the range of the estimates for postweaning performance.

TABLE III

SUMMARY OF HERITABILITY ESTIMATES OF BODY MEASUREMENTS OF CATTLE

Author	Breed[a]	Method[b]	No. of Animals	Wither Height	Chest Depth	Heart Girth	Body Length	Hook Width
Gowen (1933)	J	R_{po}	6000+	.60	.61	.65	.68	.81
Schutte (1935)	X	b_{od}	176	.76	.20	.35	.48	.62
Touchberry (1951)	Hol.	b_{od}	187	.73	.80	.61	.58	
Dawson *et al*. (1955)	MS	PHS	58	.66	.40			.01
Brown (1958)	A	PHS	212	.38	.17	.06	.00	.32
Brown (1958)	H	PHS	255	.29	.33	.44	.10	.15
Johnson (1958)	Hol.	b_{od}	128			.46	.48	.11
Brown and Franks (1964)	A,H	b_{od}	242	.76			.77	.21

[a]Breed designations: Angus (A), Hereford (H), Holstein (Hol), Jersey (J), Milking Shorthorn (MS), Crossbred (X).

[b]Method of estimation: Parent offspring correlations (r_{po}), Paternal half-sib method (PHS), Intra-sire regression of offspring on dam (b_{od}).

II. CHANGE IN COW WEIGHT AND FATNESS AS RELATED TO CALF PERFORMANCE

The relationship of cow weight to calf performance has been investigated by several workers. Positive relationships between cow weight and rate of gain of her calf to weaning have been reported (Gregory et al., 1950; Marchello et al., 1960; Brinks et al., 1962; Fitzhugh, 1965; Sanders, 1968; Shrode et al., 1969). However, cow weight and fat thickness were not important as sources of variation in post-weaning ADG of calves (Absher, 1969).

It is a generally held belief that cow weight change during the lactation period is a good measure of her milk production (the relationship being negative). This belief seems warranted in view of the significant positive relationships reported between dam's milk production and gain of the calf from birth to weaning (Dawson et al., 1955; Neville, 1962; Christian et al., 1965; Melton et al., 1967) and the negative correlations reported between calf weaning weight and weight gain of the dam during lactation (Brinks et al., 1962; Gergory et al., 1950; Hawkins et al., 1965). Results reported by Vaccaro and Dillard (1966) indicate that age of dam influences the relationship between weight change of the dam and calf performance. It was reported that calf gain to 120 days of age was significantly influenced by weight change of the dam only among cows older than five years of age.

Sanders (1968) proposed that the relationship of cow weight change with milk production may not be a direct relationship, but an indirect one due to the part-whole relationship of weight change to change in fatness. Results reported by Sanders (1968) indicated that no significant relationship exists between change in fat thickness of the dam (measured ultrasonically) during lactation and ADG of her calf from birth to weaning. However, he did report a highly significant curvilinear relationship of change in fat thickness of the dam with calf condition score.

From this review, it appears that calf condition, change in weight or fatness of the dam while nursing the calf, or combinations of these may be used to appraise differences in the maternal environments to which calves were subjected prior to weaning. Being able to account for differences in calf performance due to such environmental factors would be of considerable value in increasing the accuracy of selection of calves with superior growth potential.

CHAPTER III

EXPERIMENTAL PROCEDURE

I. SOURCE AND DESCRIPTION OF DATA

Data used for this study were obtained from a group of Angus calves born from January 17, 1968, to April 26, 1968, at the Plateau Experiment Station, Crossville, Tennessee. Included were 74 bull calves and 84 heifer calves which were the progeny of 13 sires. A detailed description of the herd was given by Butts (1966). Calves were kept with their dams, without creep feed, from birth until they were weaned in early October, 1968. After weaning, the calves began a postweaning feeding period which was terminated on March 25, 1969. The ration feed consisted of silage with a small amount of grain. Bulls received more grain in addition to the silage than did the heifers which was reflected in the ADG of the two sexes (1.39 versus 0.95 pounds per day for bulls and heifers, respectively).

Data were collected at six different times of observation described in Table IV. The standard deviation of age at each time of observation was 22 days for bulls and 23 days for heifers. Data collected at each observation included the calf's weight (wt); type score (T), a subjective appraisal of body shape; condition score (C), a subjective estimate of overall fatness; and various body measurements including:

TABLE IV

DESCRIPTION OF TIMES OF OBSERVATION

Observation Name	Abbreviation	Average Age	
		Bulls	Heifers
Preweaning	Pr	124	126
Interim	In	173	175
Weaning	Wn	221	224
First Postweaning	Pt-1	285	287
Second Postweaning	Pt-2	339	340
Third Postweaning, or Final	Pt-3	395	398

1. Heart girth (HG) - a circumference measurement taken immediately posterior to the shoulders.
2. Length of back (B) - measured on the dorsal midline from the midpoint of the scapula to a line drawn perpendicular to the dorsal midline connecting the last ribs.
3. Length of loin (L) - measured from the posterior end of B to a line drawn perpendicular to the dorsal midline connecting the most prominent projection of the hip bones (hooks).
4. Length of rump (R) - measured from the posterior end of L to a line between the pin bones.
5. Total body length (BLR) - the sum of B, L, and R.
6. Hook width (HK) - the distance between the most prominent projections of the hip bones (hooks).

At weaning and at the end of the postweaning period, fat thickness (fat) was measured ultrasonically over the longissimus dorsi muscle between the twelfth and thirteenth ribs about three-fourths of the distance between the dorsal midline and the distal edge of the l. dorsi muscle. In the discussion which follows, unless otherwise stated, ADG will refer to average daily gain from birth; whereas, postweaning ADG will denote ADG from weaning until the time in question.

Weight and condition score of each calf's dam was recorded in early April, 1968, and at each of the observation times until the calf was weaned. From these records, changes in weight and condition were calculated and considered in certain of the analyses as a measure of the maternal environment provided by the dam.

II. METHOD OF ANALYSIS

The approach taken in the analysis of these data was first to study the variation that exists in calf performance and in body measurements. Therefore, means and residual standard deviations of the traits were calculated using the method of fitting constants as described by Harvey (1960). The standard deviations thus obtained represent the variation (assumed to be random) that exists in the calf traits adjusted to a common age with the effects of sire of calf and age of dam eliminated. Also in the case of body measurements, weight was adjusted simultaneously with the other effects so that the standard deviations would reflect variability in relative body proportions rather than simply the measurements per se. Means obtained by this procedure were free of bias caused by disproportionate subclass frequencies among the sire and age-of-dam subcells.

A range of inbreeding was present in the calves studied with an average of about 4 percent for each sex. The distribution of inbreeding in this investigation was not normal. Calves could be classified into one of three groups based on sire and level of inbreeding. These are tabulated in Table V. Calves in group one represent all the progeny of three sires; those in group two are all of the progeny of five other sires; and calves in group three are the progeny of another six sires. Hence, inbreeding was largely confounded with sire and therefore no adjustment was made for inbreeding in the analyses. In an earlier study utilizing data collected from this same cow herd, neither increeding

TABLE V

DESCRIPTION OF INBREEDING BY CALF GROUPS

Group	Inbreeding Level	Sires	Bulls	Heifers
1	Low to High (over 10%)	3	15	13
2	Zero to Low (0-10%)	5	31	40
3	Zero	6	28	31

level of the calf nor of the dam was a significant source of variation in calf performance (Butts, 1966).

Since the sexes were subjected to quite different conditions during the postweaning period, all analyses were conducted separately for each sex. The existence of heterogeneous subclass variances for many of the traits was another reason for analyzing the data separately by sex.

In accordance with the primary objective of this experiment, multiple regression equations utilizing calf information collected up to weaning as independent variables were fitted to predict subsequent performance and body composition at the end of the postweaning feeding period. Separate regression equations were fitted for the data collected at each of the observations (Pr, In, Wn).

In practical situations, it is desirable to collect body measurement data only once; therefore, variables from all three observations were not considered simultaneously. Regression equations were computed in a stepwise manner according to a procedure that would give a maximum coefficient of multiple determination (R^2). At each step, one variable was added to the equation. The variable added was the one which would give the greatest reduction in error sum of squares or, equivalently, the variable which had the largest partial correlation with the dependent variable, among those variables not yet included. Two restrictions were placed on this procedure. First, for a variable to be added to the equation, its reduction in error sum of squares had to be large enough to give an F-ratio greater than or equal to one. If after additional variables were added, the F-ratio for a variable entered in an earlier step became less than one, that variable was removed. A detailed description of stepwise regression procedures has been given by Draper and Smith (1966).

In the computation of all regression equations, sire differences were ignored. The basic objective of this study was to assess the usefulness of traits of the calves and their dams as predictors of postweaning growth rate of calves. To include sire effects in a prddiction equation requires an assessment of differences in the average performance of sire progenies. Progeny performance information would seldom be available for all sires considered in a given situation since at least some young sires without previous progeny records would usually be included. In herds where efforts are directed toward turning generations as rapidly as possible to maximize progress per unit of time, many such young sires would have progeny represented in given comparisons. Thus, sire effects were not considered in the construction of regression operations.

CHAPTER IV

RESULTS AND DISCUSSION

Least-squares means and residual standard deviations of the calf performance traits and body measurements are presented in Table VI. The existence of heterogeneous sex-subclass variances for certain of the traits is apparent from the differences in standard deviations. In general, mean differences between traits of the two sexes became larger with advancing age. Perhaps, part of this is due to true physiological sex differences; for example, differences in average age at puberty, but certainly, differences in postweaning environmental influences to which the two sexes were subjected are important.

I. AGE-MEASUREMENT RELATIONSHIPS

Age trends in weight and body measurements are shown in Figures 1 and 2. The equations for the curves shown in the figures represent the particular dependent variable regressed on various combinations of the linear, squared, and cubed forms of age. Only terms which explained a significant ($P < .05$) amount of variation in the dependent variable were included in the equations.

Curves for HG and R were quite similar for both sexes. This was not the case for B, L, or BLR. The slope of each of these curves tended to be less for heifers than for bulls over the age range studied. In heifers, there was a definite tendency for the slope of the curves for B, L, and BLR to approach zero as age approached 400 to 430 days; whereas,

TABLE VI

LEAST-SQUARES MEANS AND STANDARD DEVIATIONS OF CALF TRAITS

Variable	Bulls		Heifers	
	Mean[a]	SD[b]	Mean[a]	SD[b]
Preweaning:				
Wt (lb)	277.3	26.8	259.3	30.2
ADG (lb/ca)	1.71	0.22	1.61	0.24
T	12.47	0.86	12.33	0.92
C	8.54	0.50	8.80	0.58
HG (in)	45.15	1.37	44.35	1.24
B (in)	11.90	1.21	11.37	1.02
L (in)	6.13	0.66	6.32	0.76
R (in)	10.91	0.79	11.20	1.25
BLR (in)	28.94	1.10	28.89	1.62
HK (in)	10.84	0.82	11.02	0.61
Interim:				
WT	380.1	34.2	351.6	36.2
ADG	1.82	0.19	1.68	0.18
T	12.39	0.79	12.40	0.82
C	8.66	0.54	9.12	0.67
HG	49.65	1.13	48.76	1.43
B	13.58	1.10	13.28	0.94
L	6.73	0.54	6.76	0.57
R	13.15	0.61	13.00	0.77
BLR	33.46	1.17	33.04	1.07
HK	11.88	1.23	11.98	0.60
Weaning:				
WT	484.1	36.9	432.0	34.4
ADG	1.89	0.17	1.67	0.16
T	12.02	0.85	12.18	0.85
C	8.67	0.66	9.52	0.84
FAT (mm)	1.70	0.59	3.02	1.05
HG	53.78	1.06	52.61	0.93
B	14.98	1.18	14.74	1.04
L	6.91	0.69	6.86	0.70
R	13.80	0.67	14.09	0.80
BLR	35.68	1.05	35.69	1.17
HK	12.69	0.61	13.12	0.70

TABLE VI (continued)

Variable	Bulls		Heifers	
	Mean[a]	SD[b]	Mean[a]	SD[b]
First Postweaning:				
Wt	542.6	44.0	469.8	38.7
Postweaning ADG	0.92	0.37	0.58	0.25
Lifetime ADG	1.67	0.15	1.43	0.13
T	11.86	0.80	12.17	0.83
C	8.44	0.49	8.25	0.66
HG	56.87	1.10	54.50	1.01
B	16.02	1.28	15.04	1.04
L	7.38	0.72	7.67	0.72
R	15.12	0.84	14.83	0.68
BLR	38.53	1.26	37.54	1.21
HK	13.44	0.65	13.40	0.42
Second Postweaning:				
Wt	616.0	57.2	519.4	51.2
Postweaning ADG	1.12	0.30	0.75	0.23
Lifetime ADG	1.62	0.16	1.35	0.15
T	11.63	0.92	12.11	0.80
C	8.91	0.57	9.18	0.88
HG	60.10	1.15	56.65	1.32
B	17.10	0.92	16.91	0.93
L	7.90	0.69	7.72	0.78
R	15.05	0.72	14.94	0.70
BLR	40.04	1.19	39.57	1.13
HK	14.39	0.69	14.05	0.58

TABLE VI (continued)

Variable	Bulls Mean[a]	Bulls SD[b]	Heifers Mean[a]	Heifers SD[b]
Third Postweaning:				
Wt	727.0	59.8	594.7	57.0
Postweaning ADG	1.40	0.23	0.93	0.18
Lifetime ADG	1.67	0.15	1.34	0.14
T	12.30	0.99	11.88	0.77
C	8.74	0.59	8.86	0.80
Fat	2.54	0.59	3.19	0.88
HG	63.12	0.93	59.72	1.13
B	17.95	0.90	16.56	0.86
L	7.42	0.84	7.70	0.82
R	16.28	0.82	15.88	0.71
BLR	41.65	0.93	40.14	1.13
HK	15.97	0.66	15.31	0.62

[a]Least-squares means obtained from one of the two following models:

$$Y = \mu + \text{Sire} + \text{Age of Dam} + \text{Age of Calf}$$

where, y = Wt, ADG, T, C and Fat

or, $Y = \mu + \text{Sire} + \text{Age of Dam} + \text{Age of Calf} + \text{Wt of Calf}$

where, Y = Body Measurements.

[b]Residual standard deviations from the analyses of variance described above.

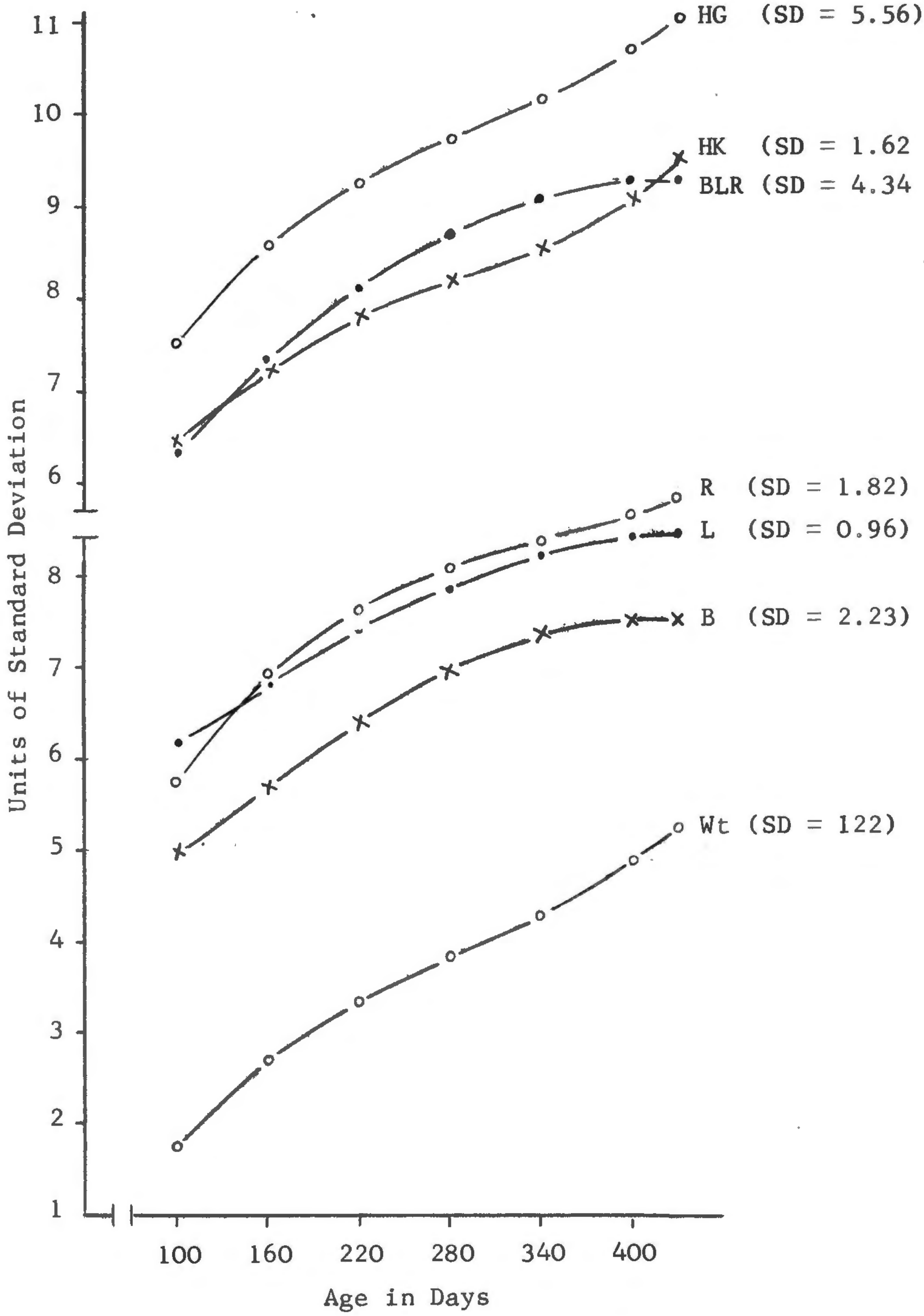

Figure 1. Age trends in weight and body measurements of heifers.

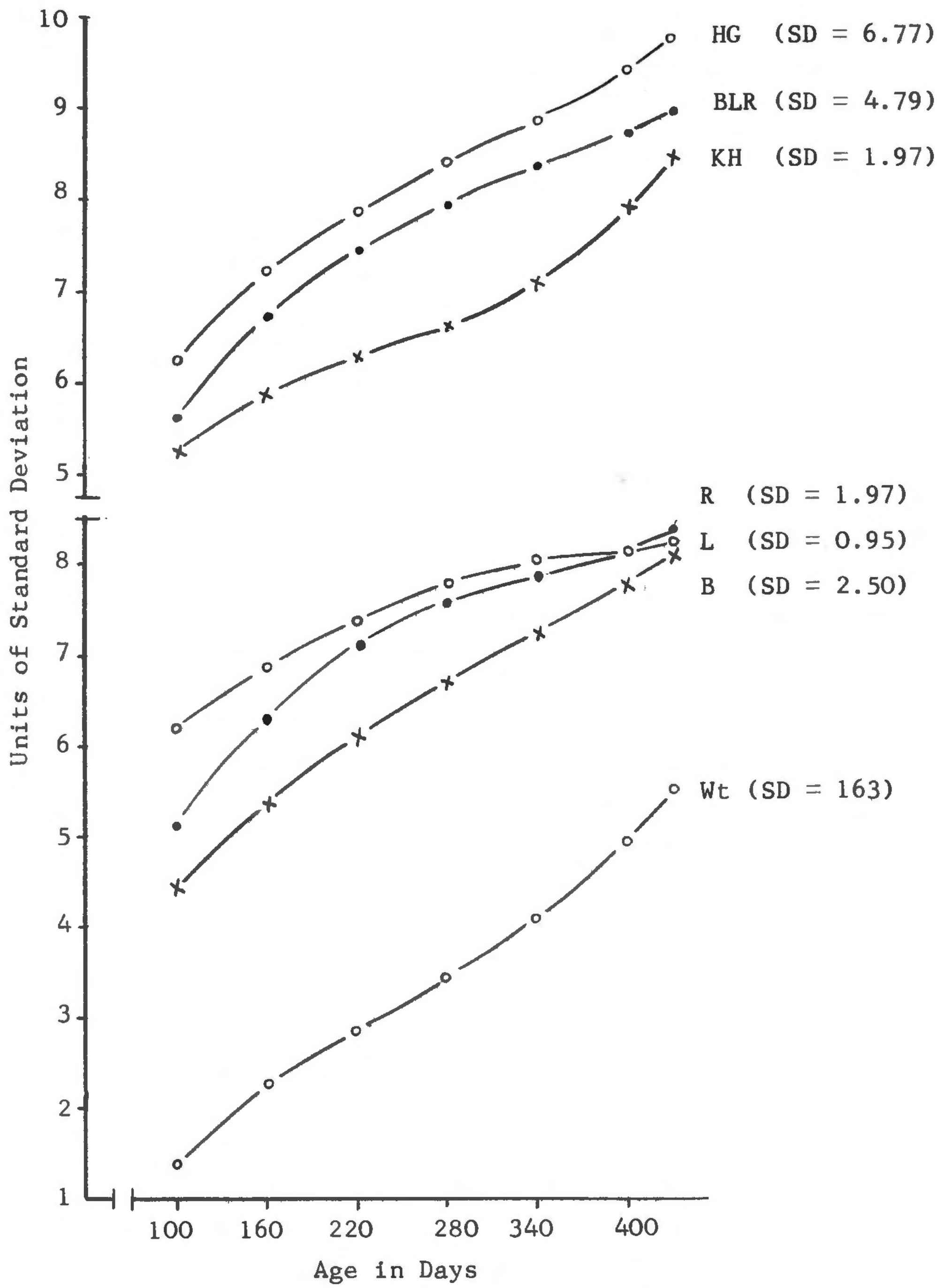

Figure 2. Age trends in weight and body measurements of bulls.

for bulls the slope of these curves was still increasing in this last segment of the age range. Hook width and weight increased at a greater rate for bulls than for heifers over the entire age range. The reduction in rate of weight gain at about 220 days of age, shown for both sexes, reflects the stress encountered by the calves at weaning. The important point illustrated by these figures is that the body measurements generally tend to reach an "asymptotic value," sooner than does weight. Thus, body measurements may provide an estimate of mature skeletal size of the animal at an earlier age than is possible by considering weight only.

II. PREDICTION OF POSTWEANING ADG

Multiple regression equations for predicting postweaning ADG from calf traits are presented in Tables VII and VIII. Separate equations were fitted for each time of observation up to weaning. Weight and age of a calf (or equivalently, weights adjusted to a common age) have been widely used in estimating a calf's potential for growth rate. Since calf weight can be obtained with greater ease than body measurement data and the major criterion of market value of beef is weight, it is impractical to consider eliminating the use of weight in predicting future growth. Therefore, weight and age were forced into each equation before incorporation of the other variables. Independent variables for each of the equations were selected, as described previously, from the following: T, C, HG, B. L, R, BLR, HK, and fat (weaning equation only). In all tables where regression equations are presented, the variables other than age and weight are listed according to the order in which they entered

TABLE VII

MULTIPLE REGRESSION EQUATIONS FOR PREDICTING POSTWEANING ADG OF HEIFERS[a]

Variable Name	Coefficient	$R^2_{yi..m}$	$R^2_{yk..m/ij}$
Preweaning Equation:			
Intercept	0.9181		
Wt	0.0018	0.076	
Age	-.0025	0.082	
T	-.0802	0.226	
B	0.0589	0.314	
L	0.0304	0.328	0.246**
Interim Equation:			
Intercept	0.2819		
Wt	0.0009	0.087	
Age	-.0015	0.090	
T	-.0505	0.129	
BLR	0.0513	0.169	
B	-.0336	0.188	0.098*
Weaning Equation:			
Intercept	0.4044		
Wt	0.0025	0.105	
Age	-.0020	0.109	
C	-.0533	0.244	
BLR	0.0554	0.295	
T	-.0618	0.342	
L	-.0428	0.363	
HK	-.0328	0.378	
Fat	-.0206	0.386	0.277**

[a]$R^2_{yi..m}$ is the coefficient of multiple determination after the variable in question was added, and $R^2_{yk..m/ij}$ is the fraction of variation in y attributable to the k..m th traits independent of weight (i) and age (j).

*(.01 $<$ P $<$ .05).

**(p $<$ .01).

TABLE VIII

MULTIPLE REGRESSION EQUATIONS FOR PREDICTING POSTWEANING ADG OF BULLS[a]

Variable Name	Coefficient	$R^2_{yi..m}$	$R^2_{yk..m/ij}$
Preweaning Equation:			
Intercept	0.8446		
Wt	0.0012	0.153	
Age	-.0003	0.153	
HK	0.0722	0.203	
C	-.0616	0.217	0.064
Interim Equation:			
Intercept	0.2022		
Wt	0.0013	0.180	
Age	-.0009	0.180	
L	0.0898	0.240	
C	-.0712	0.258	
T	-.0476	0.272	
HG	0.0291	0.289	0.109*
Weaning Equation:			
Intercept	-3.7413		
Wt	-.0034	0.134	
Age	0.0017	0.142	
HG	0.0681	0.226	
HK	0.1236	0.277	
Fat	-.0819	0.310	
B	-.0815	0.337	
BLR	0.0563	0.363	
T	0.0446	0.381	0.239**

[a]$R^2_{yi..m}$ is the coefficient of multiple determination after the variable in question was added, and $R^2_{yk..m/ij}$ is the fraction of variation in y attributable to the k..m th traits independent of weight (i) and age (j).

*(.01 < P < .05).

**(P < .01).

the equation; i.e., in order of their decreasing importance, whereas, age and weight were always entered first, irrespective of their importance.

The amounts of variation in postweaning ADG accounted for by the various equations ($R^2_{yi\ldots m}$) were all highly significant ($P < .01$). To obtain the amount of variation accounted for by the body measurements and body composition traits independent of weight and age ($R^2_{yk..m/ij}$), the coefficient of multiple determination for weight and age (R^2_{yij}) was subtracted from $R^2_{yi..m}$, the coefficient of multiple determination for the complete model. The corresponding reduction in sum of squares was tested against the residual mean square for the complete model to determine whether these variables other than weight and age contributed significantly to the prediction of postweaning ADG.

With the exception of the equation to predict postweaning ADG of bulls from data collected at preweaning, the incorporation of combinations of body measurements and estimates of fatness into the regression equation of both sexes resulted in significant increases in $R^2_{yi..m}$. These traits contributed more to the "explained" variation in postweaning ADG of heifers than of bulls, adding 27.7 percent over weight and age alone at weaning for heifers. In both sexes, the body measurement and body composition traits appear to be more descriptive of true growth potential when observed at weaning than at earlier ages as indicated by their larger contribution to $R^2_{yi..m}$. The fact that body measurements, including T and C, observed at preweaning, contributed significantly to the prediction of postweaning ADG of heifers but not of bulls may be because heifers are more mature at this age than are bulls. Consquently, their body measurements may be more accurate estimates of mature size which has been shown to be closely associated with growth rate throughout an animal's life.

Measures of body length (B, L, R, BLR) appeared to be of more importance in heifers than in bulls in predicting subsequent growth rate, whereas, measures of body composition and thickness such as T, C, fat, HK, and HG were more important in bulls.

Variables measured on the calves' dams that are generally believed to reflect differences in maternal abilities of the dams were given third priority in the construction of multiple regression equations after weight and age (which were considered as a base for comparison) and body measurement and composition traits. Dams' traits received this priority because the primary objective of the study was to evaluate the measurements taken on the calves as predictors of subsequent growth before considering other variables. Thus, traits of the dams were not allowed to enter the regression equations until after the calf traits were included. Variables that could enter the equations included: dam's weight (Dwt.), and dam's condition score (DC) recorded at the time of observation of her calf, change (from early April until time of observation) in dam's weight (Δ Dwt.) and change in dam's condition score (ΔDC). Also, squared and cubed forms of Δ Dwt. and ΔDC were included. The regression equations obtained by this procedure with postweaning ADG as the dependent variable are shown in Tables IX and X.

In only two of the six equations, did the addition of traits of the dam to the regression equation result in a reduction in sums of squares that was significant ($P < .05$) or closely approaching

TABLE IX

MULTIPLE REGRESSION EQUATIONS FOR PREDICTING POSTWEANING ADG OF HEIFERS WITH TRAITS OF THE DAM INCLUDED AMONG THE INDEPENDENT VARIABLES[a]

Variable Name	Coefficient	$R^2_{yi..p}$	$R^2_{yn,,p/i..m}$
Preweaning Equation:			
No variables of the dam met the requirements to enter the equation (F < 1.0) when considered after the calf traits were included.			
Interim Equation:			
Intercept	0.1164		
Wt	0.0005	0.087	
Age	-.0021	0.090	
T	-.0554	0.129	
BLR	0.0653	0.169	
B	-.0374	0.188	
ΔCWT	-.0004	0.217	
ΔDC^3	0.0065	0.261	
ΔDC	-.0558	0.298	0.110*
Weaning Equation:			
Intercept	0.4839		
Wt	0.0024	0.105	
Age	-.0023	0.109	
C	-.0573	0.244	
BLR	0.0528	0.295	
T	-.0568	0.342	
L	-.0346	0.363	
HK	-.0352	0.378	
Fat	-.0163	0.386	
ΔDWT^2	$0.1X10^{-5}$	0.399	0.013

[a] $R^2_{yi..p}$ is the coefficient of multiple determination after the variable in question was added, and $R^2_{yn..p/i..m}$ is the fraction of variation in y attributable to the n..p th cow traits independent of the i..m th calf traits.

*(.01< P <.05).

**(P< .01).

TABLE X

MULTIPLE REGRESSION EQUATIONS FOR PREDICTING POSTWEANING ADG OF BULLS WITH TRAITS OF THE DAM INCLUDED AMONG THE INDEPENDENT VARIABLES[a]

Variable Name	Coefficient	$R^2_{yi..p}$	$R^2_{yn..p/i..m}$
Preweaning Equation:			
Intercept	1.3421		
Wt	0.0014	0.153	
Age	-.0009	0.153	
HK	0.0740	0.203	
O	-.0865	0.217	
DWT	-.0003	0.234	0.017
Interim Equation:			
Intercept	-.0936		
Wt	0.0012	0.180	
Age	-.0006	0.180	
L	0.0879	0.240	
O	-.0648	0.258	
T	-.0474	0.272	
HG	0.0350	0.289	
Δ DWT	0.0004	0.301	0.012
Weaning Equation:			
Intercept	-3.3113		
Wt	-0.0030	0.134	
Age	0.0018	0.142	
HG	0.0634	0.226	
HK	0.1400	0.277	
Fat	-.0676	0.310	
B	-.0641	0.337	
BLR	0.0292	0.363	
T	0.0455	0.381	
Δ DC^3	0.0087	0.396	
Δ DC	-.1099	0.438	
Δ DWT^3	$-.2X10^{-7}$	0.454	
Δ DWT^2	$-.4X10^{-5}$	0.464	0.083[b]

[a] $R^2_{yi..p}$ is the coefficient of multiple determination after the variable in question was added, and $R^2_{yn..p/i..m}$ is the fraction of variation in y attributable to the n..p the cow traits independent of the i..m th calf traits.

[b] $(.05 < P < .10)$.

significance ($P < .10$). For this reason it is doubtful that the benefits of considering these cow traits are large enough to compensate for the extra effort necessary to obtain the cow data.

III. PREDICTION OF LIFETIME ADG

Regression equations similar to those for predicting postweaning ADG, were computed with lifetime ADG as the dependent variable. These are presented in Tables XI and XII. Coefficients of multiple determination were substantially larger for these equations than for the earlier equations where postweaning ADG was the dependent variable. In these equations, weight and age were the major contributors to the total reduction in sums of squares for each of the models. The R^2 values as well as the importance of weight generally increased with advancing age from preweaning to weaning as would be expected because of the part-whole nature of the relationship of weight with lifetime ADG. Again, the body measurement traits of bulls which were taken at the preweaning observation and which met the requirements to enter the equation did not make a significant contribution to the reduction in sums of squares when entered after weight and age. For predicting lifetime ADG, the length measurements as a group and the thickness and body composition measurements as another group were of more nearly equal importance in the two sexes. The fact that these two groups of traits had somewhat different importance in the two sexes as predictors of postweaning ADG but not as predictors of lifetime ADG suggests that the type of feeding and management conditions to which animals will be subjected during the feeding period may

TABLE XI

MULTIPLE REGRESSION EQUATIONS FOR PREDICTING LIFETIME ADG OF HEIFERS[a]

Variable Name	Coefficient	$R^2_{yi..m}$	$R^2_{yk..m/ij}$
Preweaning Equation:			
Intercept	0.5860		
Wt	0.0024	0.258	
Age	-.0050	0.461	
B	0.0300	0.516	
T	-.0277	0.553	
HK	0.0201	0.562	
HG	0.0094	0.569	
L	0.0174	0.577	0.116**
Interim Equation:			
Intercept	-.0354		
Wt.	0.0010	0.275	
Age	-.0037	0.404	
BLR	0.0460	0.484	
HG	0.0175	0.525	
B	-.0298	0.552	0.148**
Weaning Equation:			
Intercept	0.8367		
Wt	0.0034	0.464	
Age	-.0040	0.673	
C	-.0248	0.717	
BLR	0.0228	0.736	
T	-.0246	0.749	
L	-.0177	0.757	
HK	-.0155	0.762	0.089**

[a]$R^2_{yi..m}$ is the coefficient of multiple determination after the variable in question was added, and $R^2_{yk..m/ij}$ is the fraction of variation in y attributable to the k..m th traits independent of weight (i) and age (j).

**(P < .01).

TABLE XIV (continued)

Variable Name	Coefficient	$R^2_{yi..p}$	$R^2_{yn..p/i..m}$
Weaning Equation:			
Intercept	-.7541		
Wt	0.0009	0.561	
Age	-.0027	0.634	
HG	0.0306	0.683	
HK	0.0679	0.713	
T	0.0212	0.722	
B	-.0243	0.732	
BLR	0.0060	0.740	
Fat	-.0190	0.747	
ΔDC^2	-.0167	0.756	
ΔDC	-.0520	0.776	
ΔDWT^3	$-.6X10^{-8}$	0.785	
ΔDWT^2	$-.2X10^{-5}$	0.789	0.042*

[a]$R^2_{yi..p}$ is the coefficient of multiple determination after the variable in question was added, and $R^2_{yn..p/i..m}$ is the fraction of variation in y attributable to the n..p th cow traits independent of the i..m th calf traits.

*(.01 < P < .05).

Thus, regression equations, similar to those previously discussed, were calculated with condition score and fat thickness, measured at the end of the postweaning period, as dependent variables. Equations with C and fat as dependent variables are given in Tables XV through XVIII. Weaning and interim calf traits, considered in addition to weight and age, contributed significantly to the explanation of C and fat measured at the end of the postweaning period in both sexes. In those equations where the body measurements and body composition traits made a significant contribution to the value of R^2, variables measuring fatness of the animal at the time of observation were of primary importance with a tendency for calves fatter early in life to be fatter at the end of the postweaning period. Since calf traits other than those reflecting body composition were also included, any statements about relationships of particular variables with a dependent variable must be made relative to the other traits included in the model as independent variables.

Traits measured on calves' dams, when included in regression equations after the calf traits had been entered, tended to produce greater reductions in sums of squares of final C and fat thickness of heifers than of bulls. These equations are presented in Tables XIX through XXII. With the exception of the weaning equation shown in Table XIX, the amounts of variation in final C and fat thickness of heifers explained by the cow traits, independently of the calf variables, were either significant ($P < .05$) or closely approaching significance ($P < .10$) for each time of observation. In bulls, however, the amount of variation in final C and fat attributable to the cow variables was smaller and in

TABLE XV

MULTIPLE REGRESSION EQUATIONS FOR PREDICTING FINAL CONDITION SCORE OF HEIFERS[a]

Variable Name	Coefficient	$R^2_{yi..m}$	$R^2_{yk..m/ij}$
Preweaning Equation:			
Intercept	4.0228		
Wt	0.0050	0.186	
Age	0.0024	0.186	
R	-.1811	0.212	
C	0.2880	0.232	
BLR	0.0950	0.247	0.061
Interim Equation:			
Intercept	1.3025		
Wt	0.0014	0.155	
Age	0.0030	0.163	
C	0.4672	0.289	
R	0.2776	0.324	
HK	-.2301	0.341	
B	0.1090	0.359	0.196**
Weaning Equation:			
Intercept	1.8223		
Wt	0.0017	0.232	
Age	0.0037	0.233	
Fat	0.0220	0.302	
BLR	0.1347	0.338	0.105*

[a] $R^2_{yi..m}$ is the coefficient of multiple determination after the variable in question was added, and $R^2_{yk..m/ij}$ is the fraction of variation in y attributable to the k..m th traits independent of weight (i) and age (j).

*(.01 $<$ P $<$ .05).

**(P $<$ .01).

TABLE XVI

MULTIPLE REGRESSION EQUATIONS FOR PREDICTING FINAL CONDITION SCORE OF BULLS[a]

Variable Name	Coefficient	$R^2_{yi..m}$	$R^2_{yk..m/ij}$
Preweaning Equation:			
Intercept	5.7586		
Age	0.0147	0.214	
Wt	0.0033	0.219	
HK	-.1781	0.243	
C	0.2464	0.264	0.045
Interim Equation:			
Intercept	4.9229		
Age	0.0131	0.217	
Wt	0.0026	0.239	
C	0.4554	0.351	
T	-.1634	0.377	
HK	-.1200	0.400	0.161**
Weaning Equation:			
Intercept	4.1006		
Age	0.0176	0.217	
Wt	0.0005	0.235	
Fat	0.4726	0.345	
B	-.1417	0.373	
T	0.1469	0.390	0.155

[a]$R^2_{yi..m}$ is the coefficient of multiple determination after the variable in question was added, and $R^2_{yk..m/ij}$ is the fraction of variation in y attributable to the k..m th traits independent of weight (i) and age (j).

**(P < .01).

TABLE XVII

MULTIPLE REGRESSION EQUATIONS FOR PREDICTING FINAL FAT THICKNESS OF HEIFERS[a]

Variable Name	Coefficient	$R^2_{yi..m}$	$R^2_{yk..m/ij}$
Preweaning Equation:			
Intercept	-.2459		
Wt	0.0030	0.082	
Age	0.0004	0.082	
B	0.1401	0.099	
L	0.1497	0.113	0.031
Interim Equation:			
Intercept	-4.0364		
Wt	-.0013	0.069	
Age	-.0012	0.073	
BLR	0.1512	0.135	
C	0.3349	0.162	
T	-.1992	0.186	
R	0.1729	0.203	0.130*
Weaning Equation:			
Intercept	1.2545		
Wt	0.0052	0.126	
Age	0.0012	0.126	
Fat	0.2836	0.200	
BLR	0.1577	0.230	
T	-.2100	0.263	
HG	-.0878	0.272	0.146**

[a] $R^2_{yi..m}$ is the coefficient of multiple determination after the variable in question was added, and $R^2_{yk..m/ij}$ is the fraction of variation in y attributable to the k..m th traits independent of weight (i) and age (j).

*(.01 < P < .05).

**(P < .01).

TABLE XVIII

MULTIPLE REGRESSION EQUATIONS FOR PREDICTING FINAL FAT THICKNESS OF BULLS[a]

Variable Name	Coefficient	$R^2_{yi..m}$	$R^2_{yk..m/ij}$
Preweaning Equation:			
Intercept	1.6085		
Age	0.0044	0.153	
Wt	0.0059	0.163	
HK	-.1967	0.200	
R	0.1307	0.224	
T	-.1870	0.241	
C	0.2011	0.254	0.091*
Interim Equation:			
Intercept	-1.4277		
Wt	0.0033	0.160	
Age	0.0095	0.178	
C	0.5526	0.290	
T	-.3034	0.378	0.200**
Weaning Equation:			
Intercept	-1.0963		
Age	0.0166	0.156	
Wt	0.0014	0.177	
Fat	0.4507	0.331	
R	0.2793	0.362	
BLR	-.1192	0.384	0.207**

[a]$R^2_{yi..m}$ is the coefficient of multiple determination after the variable in question was added, and $R^2_{yk..m/ij}$ is the fraction of variation in y attributable to the k..m th traits independent of weight (i) and age (j).

*(.05 $<$ P $<$ .10).

**(P $<$ .01).

TABLE XIX

MULTIPLE REGRESSION EQUATIONS FOR PREDICTING FINAL CONDITION SCORE OF HEIFERS WITH TRAITS OF THE DAM INCLUDED AMONG THE INDEPENDENT VARIABLES[a]

Variable Name	Coefficient	$R^2_{yi..p}$	$R^2_{yn..p/i..m}$
Preweaning Equation:			
Intercept	4.5202		
Wt	0.0044	0.186	
Age	0.0027	0.186	
R	-.1522	0.212	
C	0.2748	0.232	
BLR	0.0722	0.247	
Δ DC	0.1816	0.275	
Δ DWT	-.0030	0.302	0.05**
Interim Equation:			
Intercept	1.2496		
Wt	$0.2X10^{-4}$	0.155	
Age	0.0054	0.163	
C	0.4752	0.289	
R	0.2550	0.324	
HK	-.1963	0.341	
B	0.1037	0.359	
Δ DC^3	0.0194	0.394	
Δ DC^2	0.0427	0.409	0.050*

TABLE XIX (continued)

Variable Name	Coefficient	$R^2_{yi..p}$	$R^2_{yn..p/i..m}$
Weaning Equation:			
Intercept	1.9358		
Wt	0.0010	0.232	
Age	0.0031	0.233	
Fat	0.2233	0.302	
BLR	0.1384	0.338	
ΔDWT^3	0.0267	0.352	
ΔDWT^2	0.0478	0.366	
ΔDC	-.1584	0.381	0.043

[a]$R^2_{yi..p}$ is the coefficient of multiple determination after the variable in question was added, and $R^2_{yn..p/i..m}$ is the fraction of variation in y attributable to the n..p th cow traits independent of the i..m th calf traits.

*($.05 < P < .10$).

**($.01 < P < .05$).

TABLE XX

MULTIPLE REGRESSION EQUATIONS FOR PREDICTING FINAL CONDITION SCORE OF BULLS WITH TRAITS OF THE DAM INCLUDED AMONG THE INDEPENDENT VARIABLES[a]

Variable Name	Coefficient	$R^2_{yi..p}$	$R^2_{yn..p/i..m}$
Preweaning Equation:			
Intercept	5.8868		
Age	0.0174	0.214	
Wt	0.0028	0.219	
HK	-.2298	0.243	
C	0.2734	0.264	
ΔDC^3	0.0009	0.298	0.034*
Interim Equation:			
Intercept	4.8326		
Age	0.0143	0.217	
Wt	0.0030	0.239	
C	0.4462	0.351	
T	-.1663	0.377	
HK	-.1212	0.400	
ΔDC^2	-.0386	0.424	0.024*
Weaning Equation:			
No variables of the dam met the requirements to enter the equation ($F > 1.0$) when considered after the calf traits were included.			

[a]$R^2_{yi..p}$ is the coefficient of multiple determination after the variable in question was added, and $R^2_{yn..p/i..m}$ is the fraction of variation in y attributable to the n..p th cow traits independent of the i..m th calf traits.

*($.05 < P < .10$).

TABLE XXI

MULTIPLE REGRESSION EQUATION FOR PREDICTING FINAL FAT THICKNESS OF HEIFERS WITH TRAITS OF THE DAM INCLUDED AMONG THE INDEPENDENT VARIABLES[a]

Variable Name	Coefficient	$R^2_{yi..p}$	$R^2_{yn..p/i..m}$
Preweaning Equation:			
Intercept	-.3137		
Wt	0.0056	0.082	
Age	-.0003	0.082	
B	0.1181	0.099	
L	0.1582	0.113	
ΔDC^2	-.0899	0.163	
ΔDC^3	-.0493	0.177	
ΔDC	0.3480	0.224	0.111*
Interim Equation:			
Intercept	-3.8582		
Wt	-.0002	0.069	
Age	-.0008	0.073	
BLR	0.1422	0.135	
C	0.2960	0.162	
T	-.2155	0.186	
R	0.2065	0.203	
ΔDC^2	-.0878	0.251	
ΔDC^3	-.0119	0.265	0.062*

TABLE XXI (continued)

Variable Name	Coefficient	$R^2_{yi..p}$	$R^2_{ym..p/i..m}$
Weaning Equation:			
Intercept	1.3388		
Wt	0.0077	0.126	
Age	-.0016	0.126	
Fat	0.2742	0.200	
BLR	0.1610	0.230	
T	-.2784	0.263	
HG	-.0823	0.272	
ΔDC^2	-.0911	0.318	
ΔDC	-.1928	0.358	0.086**

[a]$R^2_{yi..p}$ is the coefficient of multiple determination after the variable in question was added, and $R^2_{yn..p/i..m}$ is the fraction of variation in y attributable to the n..p th cow traits independent of the i..m th calf traits.

*(.01< P< .05).

**(P< .01).

TABLE XXII

MULTIPLE REGRESSION EQUATIONS FOR PREDICTING FINAL FAT THICKNESS OF BULLS WITH TRAITS OF THE DAM INCLUDED AMONG THE INDEPENDENT VARIABLES[a]

Variable Name	Coefficient	$R^2_{yi..p}$	$R^2_{yn..p/i..m}$
Preweaning Equation:			
Intercept	0.9600		
Age	0.0064	0.153	
Wt	0.0036	0.163	
HK	-.2465	0.200	
R	0.2154	0.224	
T	-.1472	0.241	
C	0.1920	0.254	
ΔDC^3	0.0011	0.294	
ΔDWT^2	$0.4X10^{-4}$	0.317	
ΔDWT^3	$0.1X10^{-6}$	0.328	0.074[b]
Interim Equation:			
No variables of the dam met the requirements to enter the equation ($F > 1.0$) when considered after the calf traits were included.			

TABLE XXII (continued)

Variable Name	Coefficient	$R^2_{yi..p}$	$R^2_{yn..p/i..m}$
Weaning Equation:			
Intercept	-.1106		
Age	0.0075	0.156	
Wt	0.0014	0.177	
Fat	0.4758	0.331	
R	0.3054	0.362	
BLR	-.1173	0.384	
Δ DWT	-.0017	0.397	
DWT	-.0019	0.418	
DC	0.1034	0.433	0.049

[a] $R^2_{yi..p}$ is the coefficient of multiple determination after the variable in question was added, and $R^2_{yn..p/i..m}$ is the fraction of variation in y attributable to the n..p th cow traits independent of the i..m th calf traits.

[b] $(.05 < P < .10)$.

no case significant ($P < .05$), although in some of the equations it approached significance ($P < .10$).

V. CONCLUSIONS AND SUGGESTIONS FOR ADDITIONAL RESEARCH

The results of this investigation strongly indicate that body dimension measurements and estimates of fatness can be used effectively to improve the prediction of subsequent growth rate of beef calves over that attainable using weight and age alone. These traits contributed significantly also to the prediction of lifetime ADG from birth to the end of the postweaning period (about 400 days of age). For both post-weaning and lifetime ADG the weaning equations for bulls and for heifers explained more of the variation than equations involving traits from earlier observations. Therefore, it data are to be collected at a single observation time in order to predict postweaning or lifetime performance, they should be collected at weaning rather than at times before weaning. If however, the primary objective is to select calves on the basis of weight, body dimension measurements and body composition estimates in order to improve the genetic potential of a herd for post-weaning and lifetime ADG, the previous statement may not be true. To make recommendations concnerning the optimum age at which data should be collected or the specific combination of calf traits that should be used as criteria of selection to improve growth rate to, say, 400 days of age would require a knowledge of the heritabilities of the traits in question and their genetic correlations with each other and with the performance traits. Such information is not presently available. Hence, more extensive research, similar to that reported here, involving large enough numbers of animals to accurately estimate these genetic parameters should be undertaken. When such information is available, a more precise appraisal can be made of the effectiveness of individual body measurements and groups of these as selection criteria.

CHAPTER V

SUMMARY

Body measurements, body composition traits and certain performance traits of 74 Angus bull and 84 Angus heifer calves, recorded at three different observations up to weaning, were studied to assess their value as predictors of postweaning ADG, lifetime ADG (ADG from birth until the end of test), final condition score and fat thickness (measured ultrasonically when the postweaning feeding period was terminated). These calves were born from January 17, 1968, to April 26, 1968. A stepwise regression procedure was employed to construct prediction equations. Traits that could enter the regression equation as independent variables included heart girth, back length, loin length, rump length, total length, type score, condition score, weight and age. Also, fat thickness measured ultrasonically over the twelfth and thirteenth ribs at weaning was considered among the independent variables.

Coefficients of multiple determination (R^2) for the equations to predict the dependent variables tended to be larger when the independent variables were the calves' weaning traits rather than preweaning or interim traits. It was concluded that if the dependent variables are to be predicted from calf traits observed at only one time of observation, that observation should be taken at an average age of about 220 to 225 days (weaning). Various combinations of the weaning body measurements and body composition traits explained significantly ($P < .05$) more variation in postweaning ADG, lifetime ADG, final condition score and final fat thickness than was explained by weight and age alone. For bulls the increases in R^2 were 0.239, 0.113, 0.155, and 0.207, respectively, for the dependent variables enumerated above. In the case of heifers, the increases in R^2 were 0.277, 0.089, 0.105, and 0.146, respectively. Hence, it appears from these results that body dimension measurements and estimates of fatness can be used effectively to improve the prediction of calf performance and subsequent body composition over conventional methods utilizing only calf weight and age.

The addition of traits of the dam (weight and condition score and linear, squared and cubed forms of change in weight and condition of the dam from April, 1968, until time of observation of calf) to the regression equations, after entering the calf traits, generally did not result in significant increases in the R^2 values for predicting postweaning and lifetime ADG. These cow variables tended to be slightly more important as predictors of final condition score and fat thickness of the calves. It is doubtful that the additional precision in predicting future performance and body composition of calves obtained by considering these traits of the dams, is large enough to warrant the extra effort and expense necessary to obtain these data.

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LITERATURE CITED

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APPENDIX

TABLE XXIII

LEAST-SQUARES CONSTANTS FOR PREWEANING PERFORMANCE TRAITS OF HEIFERS EXPERESED AS DEVIATIONS FROM THE MEAN

	No. in Subclass	Preweaning			
		T	C	ADG	WT
Mean	84	12.33	8.80	1.61	259.3
Sire					
1011	4	-.41	-.15	-.18	-22.4
2024	2	-.15	0.44	0.06	-2.4
2694	11	-.40	-.28	-.16	-14.6
5014	5	-.75	-.30	0.05	2.9
5126	5	0.13	-.17	0.06	12.5
5205	2	0.80	-.07	0.30	28.2
5432	11	-.08	0.09	0.01	3.7
5486	5	0.50	-.04	0.00	-.3
5631	3	-.25	-.06	-.09	-12.4
5913	18	0.10	-.14	0.12	14.6
8023	4	-.42	-.01	-.09	-12.3
9777	2	0.94	0.78	0.10	16.4
9875	8	0.30	0.22	0.07	-6.6
5795	4	-.33	-.31	-.11	-7.3
Age of Dam					
2	6	-.67	-.07	-.05	-7.4
3	12	-.29	-.20	-.07	-14.2
4	15	-.09	-.05	-.02	-3.6
5	10	0.32	-.12	0.04	6.1
6	8	0.06	-.14	0.00	4.3
7	6	-.30	-.05	-.07	-5.3
8	10	0.39	0.15	0.03	6.3
9	3	0.34	0.30	0.08	4.6
10 + over	14	0.25	0.18	0.05	9.1
Regression on Age		-.002	0.003	-.002[a]	1.30**

[a](.05 < P < .10).

**(P < .01).

TABLE XXIV

LEAST-SQUARES CONSTANTS FOR PREWEANING BODY MEASUREMENTS OF HEIFERS EXPRESSED AS DEVIATIONS FROM THE MEAN

	No. in Subclass	Preweaning					
		HG	B	L	R	BLR	HK
Mean	84	44.35	11.37	6.32	11.20	28.89	11.02
Sire		*					a
1011	4	0.78	0.24	0.16	-.74	-.34	0.10
2024	2	0.26	0.06	-.56	0.99	0.50	0.39
2694	11	1.39	-.80	0.30	0.21	-.30	0.04
5014	5	-.31	0.66	-.05	-.11	0.50	0.94
5126	5	-.57	-.09	0.11	0.29	0.31	-.19
5205	2	1.38	-.73	0.26	0.26	-.20	-.65
5432	11	0.16	0.57	-.57	-.05	-.05	0.14
5486	5	-.22	-.30	0.28	0.10	0.07	0.05
5631	3	-1.28	-.37	0.53	-.75	-.59	-.81
5913	18	-.61	0.32	0.05	0.28	0.76	-.09
8023	4	0.11	0.09	0.03	0.15	0.27	0.33
9777	2	0.01	-.51	-.36	0.77	-.10	-.63
9875	8	-.84	0.78	-.10	-1.36	-.68	0.11
5795	4	-.26	-.04	-.06	-.03	-.14	0.27
Age of Dam		**					
2	6	-.14	0.19	0.12	-.15	0.15	0.41
3	12	0.37	-.78	0.30	-.24	-.72	-.18
4	15	0.32	-.13	-.02	-.77	-.92	-.21
5	10	0.04	0.39	-.46	-.14	-.21	-.16
6	8	0.90	0.07	0.10	-.26	-.08	-.26
7	6	1.32	0.08	0.14	0.31	0.56	0.14
8	10	0.70	-.29	-.03	0.52	0.20	0.00
9	3	-4.16	0.44	0.03	0.44	0.91	0.26
10 + over	14	0.64	0.03	-.17	0.26	0.12	0.00
Regression on Age		0.039**	-.003	0.004	0.009	0.010	0.006
Regression on Wt		0.043**	0.008[a]	0.009**	0.010[a]	0.026**	0.012**

[a](.05< P <.10).

*(.01< P <.05).

**(P <.01).

TABLE XXV

LEAST-SQUARES CONSTANTS FOR PREWEANING PERFORMANCE TRAITS OF BULLS EXPRESSED AS DEVIATIONS FROM THE MEAN

	No. in Subclass	Preweaning			
		T	C	ADG	WT
Mean	74	12.47	8.54	1.71	277.3
Sire					
1011	4	-.15	-.06	0.04	3.3
2024	2	0.66	0.22	0.12	12.7
2694	9	-.60	-.47	-.19	-15.1
5014	6	-.73	-.13	0.12	9.5
5126	3	-.48	-.53	-.09	-19.1
5205	7	0.12	0.10	0.08	11.7
5432	10	0.20	-.08	0.08	6.4
5486	8	0.08	-.01	-.06	-6.2
5631	6	-.48	-.10	0.05	8.2
5913	6	0.63	-.05	0.22	33.2
8023	4	0.16	0.13	-.11	-9.6
9777	3	0.54	0.65	-.16	-16.0
9875	6	0.05	0.33	-.10	-19.1
Age of Dam		*			
2	5	-.61	0.07	-.07	-13.5
3	10	-.36	-.12	0.03	6.1
4	10	0.19	0.11	0.05	0.1
5	10	-.07	0.06	-.05	-11.3
6	11	-.23	-.05	-.04	-4.2
7	7	-.31	-.46	-.14	-13.2
8	5	-.15	0.09	0.17	16.3
9	8	0.66	-.06	-.03	1.1
10 + over	8	0.88	0.34	0.08	18.6
Regression on Age		0.013*	0.001	0.004**	2.22**

*(.01 < P <.05).

**(P <.01).

TABLE XXVI

LEAST-SQUARES CONSTANTS FOR PREWEANING BODY MEASUREMENTS OF BULLS EXPRESSED AS DEVIATIONS FROM THE MEAN

	No. in Subclass	Preweaning					
		HG	B	L	R	BLR	HK
Mean	74	45.15	11.90	6.13	10.91	28.94	10.84
Sire		a					***
1011	4	0.61	1.01	0.29	-.36	0.94	0.09
2024	2	-1.03	-.87	-.65	0.82	-.70	0.24
2694	9	0.12	-.06	0.19	-.04	0.09	0.05
5014	6	1.56	0.10	-.19	0.09	0.00	0.25
5126	3	-.34	-.70	-.28	0.62	-.36	-.37
5205	7	-.44	1.21	-.15	0.13	1.20	0.24
5432	10	0.57	0.06	0.23	-.05	0.24	0.17
5486	8	-.18	-.10	0.13	-.63	-.61	-.45
5631	6	-1.44	-.31	0.30	-.02	-.04	-1.40
5913	6	-.98	0.26	-.07	0.68	0.87	0.14
8023	4	0.16	-.67	0.43	0.08	-.16	0.31
9777	3	0.52	0.07	-.24	-.55	-.72	0.20
9875	6	0.86	0.00	0.00	-.76	-.76	0.52
Age of Dam							
2	5	-.03	-.29	0.18	0.00	-.12	-.19
3	10	0.19	-.14	0.08	0.32	0.27	-.08
4	10	-.03	0.28	-.37	0.14	0.06	0.03
5	10	-.11	0.05	-.24	-.26	-.45	0.31
6	11	-.21	-.39	-.12	-.02	-.53	-.09
7	7	0.54	0.07	0.41	0.00	0.48	-.03
8	5	-.82	0.78	-.37	0.49	0.90	-.08
9	8	0.53	0.04	0.65	-.77	-.07	-.07
10 + over	8	-.06	-.41	-.22	0.10	-.53	0.20
Regression on Age		0.004	0.014	-.003	0.018[a]	0.030*	-.001
Regression on Wt		0.053**	0.013*	0.007*	0.007[a]	0.027**	0.013**

[a](.05 < P < .10).

*(.01 < P < .05).

**(P < .01).

TABLE XXVII

LEAST-SQUARES CONSTANTS FOR INTERIM PERFORMANCE TRAITS OF HEIFERS EXPRESSED AS DEVIATIONS FROM THE MEAN

	No. in Subclass	Interim			
		T	C	ADG	WT
Mean	84	12.4	9.12	1.68	351.6
Sire		a			
1011	4	-.40	0.13	-.08	-17.1
2024	2	0.53	-.04	-.07	-8.9
2694	11	-.25	-.52	-.14	-19.0
5014	5	-1.22	-.40	0.04	4.0
5126	5	-.25	0.23	0.02	9.2
5205	2	0.76	0.88	0.26	41.0
5432	11	0.23	0.28	0.06	12.5
5486	5	-.03	-.02	-.04	-10.9
5631	3	-.61	0.37	-.10	-18.8
5913	18	0.20	-.04	0.06	16.7
8023	4	0.15	-.45	-.03	-15.6
9777	2	0.47	-.10	0.06	10.1
9875	8	0.55	-.04	-.04	-4.7
5795	4	-.12	-.29	0.01	1.5
Age of Dam					
2	6	-.60	-.38	-.09	-19.2
3	12	-.14	-.04	-.10	-23.3
4	15	-.19	-.04	-.04	-11.8
5	10	0.10	0.15	0.03	24.6
6	8	0.05	-.14	0.01	2.8
7	6	0.05	-.22	-.02	-3.0
8	10	0.38	0.02	0.06	7.2
9	3	-.06	0.53	0.12	13.0
10 + over	14	0.41	0.12	0.04	8.6
Regression on Age		0.002	0.009*	-.003**	1.27**

[a](.05 < P < .10).

*(.01 < P < .05).

**(P < .01).

TABLE XXVIII

LEAST-SQUARES CONSTANTS FOR INTERIM BODY MEASUREMENTS OF HEIFERS EXPRESSED AS DEVIATIONS FROM THE MEAN

	No. in Subclass	Interim					
		HG	B	L	R	BLR	HK
Mean	84	48.76	13.28	6.76	13.00	33.04	11.98
Sire			*			*	
1011	4	0.64	-.44	-.21	-.14	-.79	-.25
2024	2	-.38	-.38	-.10	-.24	-.24	0.00
2694	11	0.44	-.17	-.29	0.00	-.46	-.31
5014	5	-.65	0.98	0.25	0.34	1.57	-.12
5126	5	-1.02	-.64	0.68	0.35	0.39	-.04
5205	2	0.32	-.09	0.37	-.04	0.24	-.38
5432	11	-.23	-.15	-.15	-.10	-.39	0.25
5486	5	0.11	0.57	0.05	-.04	0.58	0.26
5631	3	-.84	0.47	-.39	-.38	-.30	-.08
5913	18	0.23	-.59	-.19	0.44	-.34	-.05
8023	4	0.15	0.14	0.32	-.40	0.06	-.07
9777	2	1.79	-.27	-.02	-.01	-.31	0.55
9875	8	-.18	1.22	-.08	-.14	1.00	-.06
5795	4	-.40	-.65	-.24	-.12	-1.01	0.32
Age of Dam				*			
2	6	-.76	0.50	0.25	-.26	0.49	-.07
3	12	-.55	-.37	0.03	-.18	-.52	-.35
4	15	-.26	0.07	-.10	-.14	-.17	0.14
5	10	-.45	-.04	-.51	0.06	-.48	0.00
6	8	0.72	0.00	-.21	-.18	-.38	-.33
7	6	0.58	-.98	0.25	0.38	-.35	0.00
8	10	0.43	0.22	0.37	0.19	0.77	-.03
9	3	0.32	0.94	-.40	-.17	0.37	0.54
10 + over	14	-.02	-.35	0.32	0.30	0.26	0.09
Regression on Age		0.024*	-.013[a]	0.004	0.008	-.001	0.003
Regression on Wt		0.030**	0.014**	0.003[a]	0.005[a]	0.023**	0.009**

[a]$(.05 < P < .10)$.

*$(.01 < P < .05)$.

**$(P < .01)$.

TABLE XXIX

LEAST-SQUARES CONSTANTS FOR INTERIM PERFORMANCE TRAITS OF BULLS EXPRESSED AS DEVIATIONS FROM THE MEAN

	No. in Subclass	Interim			
		T	C	ADG	WT
Mean	74	12.39	8.66	1.82	280.1
Sire		*			
1011	4	-.23	-.10	0.02	-3.2
2024	2	0.88	0.10	0.08	14.4
2694	9	-.05	-.44	-.13	-17.6
5014	6	-.95	0.26	0.04	16.8
5126	3	-.14	0.50	-.12	-28.9
5205	7	0.58	0.01	0.08	12.4
5432	10	0.73	0.08	0.17	23.4
5486	8	0.28	-.12	-.04	-7.3
5631	6	-.77	0.56	0.01	2.5
5913	6	0.04	-.06	0.16	30.8
8023	4	0.21	-.44	-.06	-8.0
9777	3	-.34	-.22	-.13	-17.3
9875	6	-.23	-.14	-.06	-18.0
Age of Dam		a			
2	5	-.60	-.10	-.12	-26.7
3	10	-.54	-.20	0.02	8.1
4	10	0.31	0.11	0.06	0.7
5	10	-.23	0.08	-.08	-18.4
6	11	-.02	-.02	0.00	6.9
7	7	-.42	-.30	-.08	-9.7
8	5	0.22	0.38	0.15	22.2
9	8	0.61	-.15	0.00	-1.6
10 + over	8	0.55	0.21	0.06	18.3
Regression on Age		0.028**	0.007 [a]	0.002 [a]	2.19**

[a](.05 < P < .10).

*(.01 < P < .05).

**P < .01).

TABLE XXX

LEAST-SQUARES CONSTANTS FOR INTERIM BODY MEASUREMENTS OF BULLS EXPRESSED AS DEVIATIONS FROM THE MEAN

	No. in Subclass	Interim					
		HG	B	L	R	BLR	HK
Mean	74	49.65	13.58	6.73	13.15	33.46	11.88
Sire				**			
1011	4	0.56	0.59	-.10	-.08	0.42	0.32
2024	2	-.60	0.44	-.44	0.07	0.06	-.36
2694	9	0.28	-.98	-.48	0.08	-1.38	0.72
5014	6	-.91	0.45	-.32	0.13	0.26	-.04
5126	3	0.34	0.22	-.61	-.32	-.71	-.50
5205	7	-.42	-.29	0.18	0.26	0.15	0.32
5432	10	0.14	-.01	0.56	-.22	0.33	0.43
5486	8	-.10	0.36	-.38	-.03	-.05	0.11
5631	6	-.55	-.02	0.71	-.58	0.11	-.40
5913	6	-1.07	-.31	0.14	0.08	-.08	0.57
8023	4	-.42	-.51	0.45	0.17	0.11	-.66
9777	3	1.56	0.14	0.35	0.74	1.24	-.53
9875	6	1.21	-.07	-/07	-.31	-.45	0.01
Age of Dam							
2	5	-.16	0.00	0.32	-.79	-.47	-.54
3	10	-.66	-.47	-.05	0.10	-.41	-.13
4	10	0.72	-.13	-.20	-.04	-.36	-.26
5	10	0.26	0.28	-.21	-.22	-.15	-.34
6	11	-.51	-.24	0.05	0.00	-.18	-.12
7	7	0.05	-.38	-.14	0.32	-.19	1.17
8	5	0.07	0.52	0.06	0.39	0.97	0.13
9	8	-.23	0.46	0.54	-.15	0.84	-.09
10 + over	8	0.46	-.04	-.37	0.37	-.04	0.08
Regression on Age		0.031*	0.010	-.004	0.008	0.014	0.016
Regression on Wt		0.039**	0.007	0.002**	0.010**	0.019	-.001

*(.01< P <.05).

**(P< .01).

TABLE XXXI

LEAST-SQUARES CONSTANTS FOR WEANING PERFORMANCE TRAITS OF HEIFERS EXPRESSED AS DEVIATIONS FROM THE MEAN

	No. in Subclass	Weaning				
		T	C	Fat	ADG	Wt
Mean	84	12.18	9.52	3.02	1.67	432.0
Sire						
1011	4	-.45	0.25	-.67	-.08	-17.5
2024	2	-.70	0.12	p.05	-.02	-9.7
2694	11	-.20	-.48	0.21	-.10	-18.6
5014	5	-.61	-.67	0.04	0.05	8.1
5126	5	-.01	0.60	0.28	0.09	25.4
5205	2	0.81	-.06	0.23	0.20	38.9
5432	11	0.12	-.02	0.17	0.04	11.5
5486	5	-.12	-.14	-.52	-.05	-12.8
5631	3	-.31	0.37	0.15	-.12	-30.8
5913	18	0.27	-.34	0.58	0.02	3.5
8023	4	0.13	-.18	-.58	0.00	4.3
9777	2	0.51	0.83	0.30	0.03	8.5
9875	8	0.44	0.24	0.40	-.03	-5.3
5795	4	0.12	-.51	-.53	-.03	-5.4
Age of Dam		*				
2	6	-.64	-.33	-.54	-.09	-19.8
3	12	-.25	-.40	-.79	-.06	-19.0
4	15	-.47	-.20	-.50	-.05	-12.6
5	10	0.34	0.25	0.22	0.07	15.0
6	8	0.01	0.05	0.09	-.02	-1.8
7	6	0.25	0.40	0.89	-.02	-3.8
8	10	0.66	0.45	0.11	0.08	19.1
9	3	-.37	-.44	0.69	0.05	6.5
10 + over	14	0.46	0.24	-.05	0.05	16.4
Regression on Age		0.000	0.001	0.005	-.002*	1.11**

*(.01< P <.05).

**(P <.01).

TABLE XXXII

LEAST-SQUARES CONSTANTS FOR WEANING BODY MEASUREMENTS OF HEIFERS EXPRESSED AS DEVIATIONS FROM THE MEAN

	No. in Subclass	Weaning					
		HG	B	L	R	BLR	HK
Mean	84	52.61	14.74	6.86	14.09	35.69	13.12
Sire					a		
1011	4	0.85	-.42	0.03	-.19	-.58	-.27
2024	2	-.44	-.14	0.61	-.60	-.12	-.45
2694	11	0.50	-.08	0.00	0.47	0.40	-.28
5014	5	-.44	0.20	0.06	0.11	0.37	0.38
5126	5	-.96	-1.18	0.29	0.36	-.54	0.26
5205	2	1.15	0.60	-.06	-.68	-.14	0.00
5432	11	-.48	0.55	-.35	-.40	-.19	-.22
5486	5	0.15	0.36	0.04	-.16	0.24	0.02
5631	3	-.41	-.19	-.10	0.12	-.17	-.24
5913	18	-.12	-.05	-.05	0.64	0.53	0.19
8023	4	0.20	-.12	-.14	-.35	-.61	-.28
9777	2	-.33	-1.18	-.01	0.62	-.57	0.44
9875	8	0.49	1.24	-.30	0.47	1.41	0.12
5795	4	-.16	0.39	0.00	-.42	-.03	0.34
Age of Dam		*					
2	6	-.80	0.13	-.13	0.54	0.54	-.24
3	12	-.60	0.00	0.08	-.42	-.34	-.63
4	15	0.14	-.12	0.29	-.23	-.06	0.11
5	10	-.02	0.09	-.11	-.19	-.21	0.29
6	8	0.73	0.66	-.53	0.32	0.45	-.09
7	6	0.66	0.21	0.61	0.42	1.25	0.12
8	10	0.50	-.02	-.08	0.09	-.01	0.06
9	3	-.02	-.57	-.11	-.18	-.86	0.37
10 + over	14	-.58	-.37	-.02	-.36	-.75	0.01
Regression on Age		0.012[a]	0.0004	0.007	-.006	0.002	0.002
Regression on Wt		0.040**	0.011**	0.003	0.008**	0.022**	0.008**

[a](.05 < P < .10).

*(.01 < P < .05).

**(P < .01).

TABLE XXXIII

LEAST-SQUARES CONSTANTS FOR WEANING PERFORMANCE TRAITS OF BULLS EXPRESSED AS DEVIATIONS FROM THE MEAN

	No. in Subclass	Weaning				
		T	C	Fat	ADG	Wt
Mean	74	12.02	8.67	1.70	1.89	484.1
Sire						
1011	4	-.20	-.26	-.28	-.02	-4.9
2024	2	0.56	0.50	0.73	0.09	18.1
2694	9	-.54	0.04	-.13	-.08	-13.9
5014	6	-.44	-.09	p.24	-.03	-11.1
5126	3	0.05	-.08	0.45	-.17	-43.7
5205	7	0.32	-.14	-.18	0.05	14.2
5432	10	0.28	-.21	-.19	0.06	10.2
5486	8	-.03	-.58	-.40	-.07	-15.1
5631	6	-.48	0.21	0.31	0.00	0.6
5913	6	0.65	-.20	-.40	0.11	26.4
8023	4	0.42	-.03	-.34	0.00	3.2
9777	3	-.25	0.36	0.28	0.03	16.7
9875	6	-.34	0.35	0.39	0.03	-.4
Age of Dam		[a]				
2	5	-.73	-.40	-.52	-.16	-40.4
3	10	-.25	0.07	-.06	-.01	1.6
4	10	-.12	0.42	0.26	0.07	10.0
5	10	-.50	0.04	-.03	-.12	-30.2
6	11	-.05	0.25	0.23	0.03	8.9
7	7	-.08	-.17	-.17	0.00	1.2
8	5	0.42	-.34	0.11	0.12	24.4
9	8	0.57	-.12	0.31	0.00	3.6
10 + over	8	0.73	0.32	-.14	0.06	21.0
Regression on Age		0.018**	0.008[a]	0.001	0.002	2.34**

[a](.05 < P < .10).

**(P < .01).

TABLE XXXIV

LEAST-SQUARES CONSTANTS FOR WEANING BODY MEASUREMENTS OF BULLS EXPRESSED AS DEVIATIONS FROM THE MEAN

	No. in Subclass	Weaning					
		HG	B	L	R	BLR	HK
Mean	74	53.78	14.98	6.91	13.80	35.68	12.69
Sire							
1011	4	0.34	-.13	-.16	-.23	-.51	-.12
2024	2	0.28	-.10	-.22	-.28	-.60	0.54
2694	9	0.81	-.40	0.36	-.12	-.15	0.03
5014	6	0.19	1.06	-.32	0.42	1.16	0.11
5126	3	0.03	-.23	0.37	0.11	0.24	0.31
5205	7	-.42	0.43	-.06	0.20	0.58	-.26
5432	10	0.02	0.54	0.07	-.17	0.44	-.05
5486	8	-.25	0.46	0.15	-.39	0.22	-.07
5631	6	-1.01	-.40	-.30	0.91	0.21	-.21
5913	6	-1.17	-.06	-.05	-.08	-.20	-.21
8023	4	0.05	-.30	0.05	-.20	-.46	0.37
9777	3	0.86	-.30	0.25	-.16	-.22	-.56
9875	6	0.26	-.58	-.15	0.00	-.73	0.12
Age of Dam							
2	5	0.22	-.04	0.42	0.17	0.55	0.13
3	10	-.10	-.11	0.26	0.13	0.50	0.25
4	10	-.16	0.13	-.07	-.31	-.25	0.28
5	10	0.69	-.53	-.18	0.03	-.68	-.05
6	11	0.11	-.42	0.13	0.12	-.17	-.22
7	7	-.25	-.16	-.07	-.22	-.44	-.02
8	5	-.37	0.46	-.17	0.01	0.29	-.23
9	8	-.39	-.14	-.02	0.46	0.30	-.22
10 + over	8	0.15	0.59	-.29	-.39	-.09	0.08
Regression on Age		-.006	0.015	-.008	-.004	0.003	-.002
Regression on Wt		0.042**	0.007[a]	0.007**	0.009**	0.024**	0.013**

[a](.05 $<$ P $<$ .10).

**(P $<$ .01).

TABLE XXXV

LEAST-SQUARES CONSTANTS FOR FIRST POSTWEANING PERFORMANCE TRAITS OF HEIFERS EXPRESSED AS DEVIATIONS FROM THE MEAN

	FIRST POSTWEANING					
	No. in Subclass	Postweaning			Lifetime	
		T	C	ADG	ADG	Wt
Mean	84	12.17	8.25	0.58	1.43	469.8
Sire						
1011	4	-.94	0.25	0.06	-.05	-14.4
2024	2	0.08	0.23	-.27	-.08	-19.2
2694	11	-.20	-.33	0.06	-.07	-13.4
5014	5	-.74	-.50	0.10	0.06	12.3
5126	5	0.05	0.22	-.14	0.04	11.5
5205	2	0.58	-.25	-.16	0.12	27.5
5432	11	0.12	0.01	0.07	0.05	14.9
5486	5	-.14	0.19	0.02	-.03	-13.4
5631	3	-.08	0.15	0.03	-.08	-33.3
5913	18	0.15	-.34	0.12	0.04	6.5
8023	4	0.14	0.31	0.06	0.02	9.4
9777	2	-.06	0.42	0.14	0.05	10.5
9875	8	0.58	-.08	0.06	-.01	-2.0
5795	4	0.44	-.27	-.16	-.06	3.1
Age of Dam						
2	6	-.25	-.41	0.04	-.06	-15.0
3	12	-.31	-.18	-.09	-.07	-18.0
4	15	-.54	-.17	0.06	-.03	-14.7
5	10	-.13	-.41	-.16	0.01	3.6
6	8	-.05	-.10	0.19	0.03	9.1
7	6	0.42	0.25	0.18	0.02	9.4
8	10	0.37	0.50	-.01	0.06	17.5
9	3	0.24	0.31	-.09	0.02	-1.4
10 + over	14	0.25	0.19	-.11	0.02	9.4
Regression on Age		0.009[a]	0.006	-.004*	-.002*	0.97**

[a](.05 < P < .10).

*(.01 < P < .05).

**(P < .01).

TABLE XXXVI

LEAST-SQUARES CONSTANTS FOR FIRST POSTWEANING BODY MEASUREMENTS OF HEIFERS EXPRESSED AS DEVIATIONS FROM THE MEAN

	No. in Subclass	First Postweaning					
		HG	B	L	R	BLR	HK
Mean	84	54.50	15.04	7.67	14.86	37.54	13.40
Sire							
1011	4	-.05	-.15	0.25	-.37	-.26	-.22
2024	2	-.61	-.48	0.45	-.29	-.32	0.47
2694	11	0.10	-.46	-.05	0.10	-.41	0.13
5014	5	-.05	-.09	0.26	-.08	0.09	0.23
5126	5	-.80	0.27	-.26	0.87	0.87	0.22
5205	2	0.81	-1.25	-.44	0.16	-1.54	-.30
5432	11	-.12	0.25	-.34	0.10	0.01	-.09
5486	5	-.09	0.25	0.53	-.18	0.60	0.31
5631	3	-.32	0.51	-.84	0.08	-.40	-.15
5913	18	-.53	0.51	-.23	0.14	0.42	0.05
8023	4	0.86	0.43	-.12	-.10	0.20	-.31
9777	2	1.10	-.56	0.13	0.25	-.18	-.04
9875	8	0.11	0.83	0.35	-.18	1.00	-.08
5795	4	-.49	-.06	0.31	-.34	-.09	-.22
Age of Dam		*			a	a	a
2	6	-.60	0.38	-.01	-.21	0.16	-.18
3	12	-.27	-.36	0.09	-.15	-.41	0.14
4	15	0.29	-.19	0.10	-.11	-.20	-.07
5	10	-.05	-.36	-.03	-.30	-.68	0.01
6	8	0.83	0.05	-.13	0.24	0.16	-.33
7	6	1.10	0.46	-.07	0.53	0.93	-.42
8	10	-.29	0.20	-.14	0.66	0.72	0.16
9	3	-.41	0.60	0.11	-.83	-1.32	0.60
10 + over	14	-.60	0.41	0.07	0.17	0.66	0.09
Regression on Age		0.003	-.004	0.004	0.003	0.004	0.003
Regression on Wt		0.388**	0.063[a]	0.052*	0.025	0.140**	0.072**

[a](.05 < P < .10).

*(.01 < P < .05).

**(P < .01).

TABLE XXXVII

LEAST-SQUARES CONSTANTS FOR FIRST POSTWEANING PERFORMANCE TRAITS OF BULLS EXPRESSED AS DEVIATIONS FROM THE MEAN

		FIRST POSTWEANING				
	No. in Subclass	Postweaning Lifetime				
		T	C	ADG	ADG	Wt
Mean	74	11.86	8.44	0.92	1.67	542.6
Sire				*		
1011	4	0.19	-.11	0.06	0.00	-1.1
2024	2	-.10	0.06	-.25	0.01	2.6
2694	9	-.14	-.24	-.11	-.08	-20.9
5014	6	-.01	0.27	0.28	0.04	6.4
5126	3	-1.18	0.01	0.35	-.05	-22.2
5205	7	-.16	-.37	-.25	-.02	-1.5
5432	10	0.54	0.10	0.23	0.09	25.0
5486	8	0.08	-.53	-.26	-.11	-31.7
5631	6	0.54	0.17	0.21	0.04	13.2
5913	6	0.45	-.15	0.20	0.13	38.8
8023	4	0.06	0.07	-.06	-.01	-.7
9777	3	0.20	0.51	-.02	0.02	15.6
9875	6	-.47	0.22	-.37	-.06	-23.6
Age of Dam		*	*		a	*
2	5	-.83	-.58	0.03	-.12	-38.3
3	10	-.06	-.17	0.20	0.04	14.0
4	10	-.27	0.22	-.12	0.02	2.2
5	10	-.55	-.06	-.33	-.16	-50.9
6	11	0.20	0.11	0.05	0.04	12.2
7	7	0.10	-.26	0.05	0.01	4.0
8	5	0.18	0.22	-.06	0.09	20.9
9	8	0.54	-.11	0.10	0.02	9.5
10 + over	8	0.68	0.64	0.08	0.06	26.3
Regression on Age		0.019**	0.016**	-.003	0.002*	2.32**

[a](.05 < P < .10).

*(.01 < P < .05).

**(P < .01).

TABLE XXXVIII

LEAST-SQUARES CONSTANTS FOR FIRST POSTWEANING BODY MEASUREMENTS OF BULLS EXPRESSED AS DEVIATIONS FROM THE MEAN

	No. in Subclass	First Postweaning					
		HG	B	L	R	BLR	HK
Mean	74	56.87	16.02	7.38	15.12	38.53	13.44
Sire							
1011	4	0.46	-.79	0.54	-.07	-.32	0.00
2424	2	1.28	0.83	-.59	0.71	0.95	-.18
2694	9	0.47	0.00	0.16	-.26	-.09	0.14
5014	6	0.00	0.51	-.43	-.06	0.01	0.14
5126	3	-.20	0.54	-.26	0.00	0.28	-.48
5205	7	-.02	1.20	-.37	-.09	0.74	0.41
5432	10	0.33	0.02	0.14	0.05	0.22	0.04
5486	8	0.17	0.50	0.06	-.34	0.22	0.10
5631	6	-.96	-.25	-.53	0.55	-.22	-.50
5913	6	-1.32	-.06	0.24	0.04	0.22	0.17
8023	4	-.76	-.79	0.50	-.52	-.81	0.18
9777	3	0.08	-1.34	0.59	0.54	-.21	-.18
9875	6	0.47	-.36	-.06	-.55	-.98	0.16
Age of Dam		a					
2	5	-.71	-.16	-.19	0.35	0.00	-.25
3	10	-.12	-.59	0.20	0.05	-.33	0.04
4	10	0.50	0.04	-.39	0.22	-.13	0.18
5	10	1.06	0.32	-.41	0.08	-.01	0.26
6	11	0.25	-.16	0.13	-.42	-.44	-.15
7	7	0.15	-.09	0.50	-.18	0.23	0.41
8	5	-.35	1.48	-.09	-.01	1.38	-.39
9	8	-.90	-.50	0.37	0.01	-.12	0.10
10 + over	8	0.13	-.34	-.13	-.10	-.58	-.20
Regression on Age		0.010	0.018	-.005	-.002	0.011	0.002
Regression on Wt		0.366**	0.083*	0.059**	0.073**	0.215**	0.090**

[a]($.05 < P < .10$).

*($.01 < P < .05$).

**($P < .01$).

TABLE XXXIX

LEAST-SQUARES CONSTANTS FOR SECOND POSTWEANING PERFORMANCE TRAITS OF HEIFERS EXPRESSED AS DEVIATIONS FROM THE MEAN

		SECOND POSTWEANING				
	No. in Subclass	Postweaning			Lifetime	
		T	C	ADG	ADG	Wt
Mean	84	12.11	9.18	0.75	1.35	519.4
Sire						
1011	4	-.14	-.21	-.01	-.06	-18.7
2024	2	-.17	-.25	-.13	-.07	-24.5
2694	11	-.45	-.20	0.10	-.03	-6.7
5014	5	-.60	-.16	0.24	0.12	36.4
5126	5	0.30	0.02	-.06	0.04	18.1
5205	2	-.24	-.79	-.30	0.03	3.5
5432	11	0.32	0.44	0.12	0.07	25.2
5486	5	-.32	-.07	-.05	-.05	-19.0
5631	3	-.73	0.51	0.00	-.08	-31.8
5913	18	0.05	-.40	0.06	0.03	10.2
8023	4	0.56	0.48	0.04	0.03	9.3
9777	2	1.00	0.02	-.06	0.00	1.6
9875	8	0.52	0.32	0.02	-.01	-2.4
5795	4	0.02	0.27	0.03	-.01	-1.2
Age of Dam						
2	6	-.16	-.30	0.10	-.02	-8.2
3	12	0.06	-.01	0.06	-.02	-11.7
4	15	-.49	-.32	-.08	-.06	-22.0
5	10	-.16	-.10	-.12	0.00	1.3
6	8	-.34	0.55	0.05	0.00	3.8
7	6	0.25	0.26	0.13	0.03	11.9
8	10	0.08	0.16	0.01	0.06	20.3
9	3	0.99	-.03	-.06	0.01	-1.0
10 + over	14	-.23	-.20	-.09	0.00	5.7
Regression on Age		0.010*	0.010*	0.001	-.0002	1.24**

*(.01 < P < .05).

**(P < .01).

TABLE XL

LEAST-SQUARES CONSTANTS FOR SECOND POSTWEANING BODY MEASUREMENTS OF HEIFERS EXPRESSED AS DEVIATIONS FROM THE MEAN

	No. in Subclass	Second Postweaning					
		HG	B	L	R	BLR	HK
Mean	84	56.65	16.91	7.72	14.94	39.57	14.05
Sire			*				
1011	4	0.31	0.10	0.08	-.14	0.03	0.04
2024	2	-.55	-.49	0.16	0.04	-.29	0.50
2694	11	0.57	-.49	0.09	0.03	-.36	0.14
5014	5	-.44	-.38	0.08	0.30	0.01	0.60
5126	5	-.16	0.00	0.02	0.47	0.50	-.24
5205	2	-.58	1.37	0.21	-.02	1.56	-.50
5432	11	0.30	-.04	0.33	-.13	0.16	0.16
5486	5	-.12	1.26	-.11	-.30	0.86	0.06
5631	3	-1.15	0.29	-.38	-.48	-.58	-.65
5913	18	-.46	0.05	0.01	0.35	0.41	0.07
8023	4	1.60	-.83	-.10	-.66	-1.60	-.28
9777	2	0.70	-1.57	0.14	0.76	-.67	0.50
9875	8	-.02	0.29	0.18	-.22	0.25	0.04
5795	4	0.02	0.44	-.71	-.01	-.28	0.54
Age of Dam							
2	6	0.01	0.06	-.08	0.36	0.33	0.21
3	12	0.00	0.12	-.14	-.04	-.06	0.15
4	15	-.01	0.28	-.15	0.25	0.38	0.16
5	10	0.34	-.14	-.14	-.30	-.58	-.20
6	8	0.25	-.12	0.40	-.55	-.27	-.13
7	6	0.71	-.03	0.09	-.38	-.31	-.36
8	10	-.33	-.09	0.21	-.11	0.01	-.15
9	3	-.42	-.30	-.32	0.61	-.01	0.32
10 + over	14	-.55	0.22	0.14	0.16	0.51	0.00
Regression on Age		0.011	-.002	-.002	0.005	0.001	0.011**
Regression on Wt		0.033**	0.008**	0.004[a]	0.003[a]	0.015**	0.005**

[a](.05 < P < .10).

*(.01 < P < .05).

**(P < .01).

TABLE XLI

LEAST-SQUARES CONSTANTS FOR SECOND POSTWEANING PERFORMANCE TRAITS OF BULLS EXPRESSED AS DEVIATIONS FROM THE MEAN

	No. in Subclass	SECOND POSTWEANING				
		Postweaning			Lifetime	
		T	C	ADG	ADG	Wt
Mean	74	11.63	8.91	1.12	1.62	616.0
Sire						
1011	4	0.10	0.34	0.22	0.07	21.4
2024	2	0.03	-.06	-.06	0.04	12.4
2694	9	-.33	-.36	-.04	-.06	-17.7
5014	6	0.51	0.27	0.06	0.00	-4.3
5126	3	-.22	0.12	0.01	-.11	-43.5
5205	7	0.36	-.22	-.15	-.02	-3.6
5432	10	0.64	-.02	0.13	0.08	25.4
5486	8	-.15	-.13	-.28	-.14	-49.3
5631	6	-.46	0.15	0.02	0.00	1.9
5913	6	-.04	-.31	0.17	0.13	46.3
8023	4	0.07	-.02	0.09	0.03	14.3
9777	3	-.51	0.09	0.01	0.02	18.7
9875	6	0.01	0.15	-.19	-.05	-22.0
Age of Dam						
2	5	-.21	-.45	-.02	-.12	-44.9
3	10	0.21	-.07	0.14	0.04	17.8
4	10	-.22	0.37	-.09	0.02	-.3
5	10	-.28	0.03	-.12	-.12	-44.0
6	11	-.07	-.12	-.04	0.01	4.9
7	7	0.46	0.18	0.17	0.06	21.0
8	5	-.05	-.16	-.13	0.04	9.0
9	8	-.14	-.25	0.06	0.02	10.5
10 + over	8	0.30	0.46	0.04	0.05	25.9
Regression on Age		0.018**	0.017**	0.004*	0.004**	2.87**

*(.01< P <.05).

**(P <.01).

TABLE XLII

LEAST-SQUARES CONSTANTS FOR SECOND POSTWEANING BODY MEASUREMENTS OF BULLS EXPRESSED AS DEVIATIONS FROM THE MEAN

	No. in Subclass	Second Postweaning					
		HG	B	L	R	BLR	HK
Mean	74	60.10	17.10	7.90	15.05	40.04	14.39
Sire		**			a	**	
1011	4	1.58	-.58	0.02	-.38	-.95	-.11
2024	2	0.13	-.11	-.34	0.16	-.28	0.59
2694	9	1.39	-.30	0.15	-.34	-.48	0.05
5014	6	-.44	0.09	-.12	0.36	0.33	0.59
5126	3	0.60	-.64	-.14	-.81	-1.59	0.12
5205	7	-.29	0.80	0.30	0.63	1.74	0.36
5432	10	-.44	0.39	0.08	0.43	0.90	-.11
5486	8	-.59	0.42	-.49	0.42	0.35	-.13
5631	6	-1.16	0.63	-.14	-.36	0.14	-.22
5913	6	-1.17	0.73	0.14	0.41	1.28	0.11
8023	4	-.18	-.06	0.45	-.42	-.03	-.62
9777	3	0.59	-.83	0.49	-.04	-.38	-.29
9875	6	-.01	-.55	-.40	-.07	-1.02	-.32
Age of Dam						a	*
2	5	0.28	0.39	-.04	0.35	0.70	0.96
3	10	-.35	0.14	0.25	-.16	0.23	-.22
4	10	0.32	-.41	-.53	-.02	-.96	-.49
5	10	0.09	-.03	-.42	-.22	-.68	0.38
6	11	-.07	-.20	0.29	0.02	0.11	0.06
7	7	-.04	0.18	-.25	0.17	0.10	-.28
8	5	-.54	0.00	0.35	0.08	0.43	0.51
9	8	-.28	0.61	0.09	0.19	0.88	-.48
10 + over	8	0.58	-.67	0.26	-.41	-.82	-.43
Regression on Age		0.029*	-.003	0.004	-.003	-.002	0.0005
Regression on Wt		0.032**	0.006**	0.002	0.006**	0.014**	0.009**

[a](.05 < P < .10).

*(.01 < P < .05).

**(P < .01).

TABLE XLIII

LEAST-SQUARES CONSTANTS FOR FINAL POSTWEANING PERFORMANCE TRAITS OF HEIFERS EXPRESSED AS DEVIATIONS FROM THE MEAN

	No. in Subclass	THIRD POSTWEANING					
		Postweaning				Lifetime	
		T	C	Fat	ADG	ADG	Wt
Mean	84	11.88	8.86	3.19	0.93	1.34	594.7
Sire		*					
1011	4	-.12	0.64	-.14	0.01	-.04	-15.4
2024	2	0.08	-.61	-.64	-.16	-.10	-35.7
2694	11	-.54	-.08	0.02	0.07	-.02	-5.3
5014	5	-.24	0.45	0.63	0.15	0.10	34.8
5126	5	0.09	0.70	0.79	-.03	0.04	18.9
5205	2	-.08	-.33	-.45	-.18	0.03	7.4
5432	11	0.60	0.24	-.32	0.09	0.07	27.9
5486	5	-.11	-.45	-.14	-.08	-.06	-26.6
5631	3	-1.26	0.03	0.43	-.06	-.09	-42.1
5913	18	0.03	-.08	-.08	0.05	0.04	13.1
8023	4	0.51	-.22	-.08	0.13	0.07	26.9
9777	2	0.16	-.03	-.91	-.12	-.04	-13.8
9875	8	0.64	0.42	0.45	0.06	0.01	6.3
5795	4	0.25	-.68	0.45	0.05	0.00	3.7
Age of Dam							
2	6	0.43	-.08	0.26	0.13	0.01	3.3
3	12	0.30	0.12	-.14	0.02	-.03	-15.0
4	15	-.43	-.08	-.18	-.08	-.06	-26.2
5	10	0.00	-.18	-.31	-.12	-.02	-6.2
6	8	-.54	-.14	-.04	0.05	0.01	6.8
7	6	0.33	-.02	0.56	0.10	0.03	13.4
8	10	0.03	0.12	-.11	0.03	0.06	25.4
9	3	-.25	0.52	0.44	-.08	0.00	-7.7
10 + over	14	0.12	-.27	-.48	-.06	0.00	6.1
Regression on Age		0.004	0.007	0.008	0.0007	-.0002	1.24**

*(.01 < P < .05).

**(P < .01).

TABLE XLIV

LEAST-SQUARES CONSTANTS FOR FINAL POSTWEANING BODY MEASUREMENTS OF HEIFERS EXPRESSED AS DEVIATIONS FROM THE MEAN

	No. in Subclass	Third Postweaning					
		HG	B	L	R	BLR	HK
Mean	84	59.72	16.56	7.70	15.88	40.14	15.31
Sire					*		
1011	4	-/91	-.65	-.30	-.16	-1.11	-.66
2024	2	-.78	0.30	-.85	0.30	-.24	0.65
2694	11	0.16	0.00	0.29	-.15	0.15	0.01
5014	5	-.24	0.40	0.57	-1.10	-.13	0.25
5126	5	-1.03	-.20	1.26	0.18	1.25	0.30
5205	2	0.13	0.09	0.12	0.44	0.65	-.37
5432	11	-.34	0.49	-.05	-.42	0.01	-.27
5486	5	0.01	1.06	-.47	-.35	0.24	0.34
5631	3	0.74	-.47	-.42	0.30	-.59	0.33
5913	18	-.51	-.03	0.14	0.10	0.20	0.26
8023	4	0.82	-.40	0.05	-.93	-1.28	-.68
9777	2	1.80	-.24	-.40	1.84	1.19	-.23
9875	8	0.33	-.32	0.03	-.05	-.34	0.02
5795	4	-.18	-.02	0.02	0.01	0.00	0.04
Age of Dam		**			*		
2	6	-1.00	0.83	0.74	-.97	0.59	-.11
3	12	0.29	-.27	-.11	0.09	-.29	-.07
4	15	0.48	-.26	-.12	0.34	-.04	0.21
5	10	0.01	0.49	-.52	0.69	0.04	0.35
6	8	1.00	-.32	0.15	-.26	-.43	-.18
7	6	1.88	-.14	-.21	0.86	0.51	-.12
8	10	-.82	0.09	0.02	0.16	0.27	0.03
9	3	-1.44	-.33	-.04	-.18	-.55	-0.04
10 + over	14	-.41	-.08	0.09	-.11	-.10	-.06
Regression on Age		0.004	-.005	-.006	-.001	-.012	0.001
Regression on Wt		0.039**	0.012**	0.001	0.009**	0.022**	0.013**

*(.01< P <.05).

**(P <.01).

TABLE XLV

LEAST-SQUARES CONSTANTS FOR FINAL POSTWEANING PERFORMANCE TRAITS OF BULLS EXPRESSED AS DEVIATIONS FROM THE MEAN

	No. in Subclass	THIRD POSTWEANING					
		Postweaning				Lifetime	
		T	C	Fat	ADG	ADG	Wt
Mean	74	12.30	8.74	2.54	1.40	1.67	727.0
Sire			**	**			
1011	4	0.13	0.20	0.18	0.14	0.05	20.6
2024	2	-.11	0.26	0.00	0.01	0.06	20.5
2694	9	-.04	-.89	-.86	-.06	-.06	-23.8
5014	6	-.33	0.25	0.35	0.02	-.01	-9.2
5126	3	-1.13	0.92	0.95	-.05	-.12	-54.5
5205	7	03.2	-.75	-.69	-.09	-.01	-1.5
5432	10	0.75	-.09	-.17	0.10	0.08	28.4
5486	8	-.45	-.82	-.70	-.28	-.16	-62.9
5631	6	-.25	0.68	0.84	0.02	0.01	2.6
5913	6	-,25	-.28	0.00	0.05	0.09	35.8
8023	4	0.83	0.10	0.25	0.24	0.11	44.8
9777	3	0.06	0.21	0.02	-.02	0.01	14.3
9875	6	0.47	0.22	-.18	-.09	-.03	-15.0
Age of Dam				*			
2	5	-.98	-.38	-.43	0.01	-.09	-39.1
3	10	0.26	0.41	0.46	0.15	0.07	28.0
4	10	-.18	0.05	0.05	-.06	0.01	0.2
5	10	-.15	0.01	-.28	-/08	-.10	-43.3
6	11	0.36	0.25	0.39	-.02	0.01	5.9
7	7	0.25	0.06	0.20	0.12	0.05	22.6
8	5	-.75	-.39	-.45	-.17	-.01	-6.0
9	8	0.53	-.42	-.22	-.01	0.00	1.8
10 + over	8	0.66	0.41	0.27	0.05	0.06	29.9
Regression on Age		0.018**	0.014**	0.009*	0.004*	0.003**	3.02**

*(.01 < P < .05).

**(P < .01).

TABLE XLVI

LEAST-SQUARES CONSTANTS FOR FINAL POSTWEANING BODY MEASUREMENTS OF BULLS EXPRESSED AS DEVIATION FROM THE MEAN

	No. in Subclass	Third Postweaning					
		HG	B	L	R	BLR	HK
Mean	74	63.12	17.95	7.42	16.28	41.65	15.97
Sire		**	**			**	
1011	4	0.54	0.39	-.35	-.02	0.02	0.32
2024	2	-1.20	-1.80	-.32	0.61	-1.50	-.74
2694	9	1.88	-.91	0.78	-.40	-.53	-.08
5014	6	0.20	0.52	0.12	-.11	0.53	-.39
5126	3	-.19	-.07	-.29	0.19	-.17	-.71
5205	7	-.14	0.94	0.06	0.27	1.27	0.50
5432	10	0.03	0.73	0.14	-.12	0.75	0.15
5486	8	0.35	0.62	0.41	-.42	0.61	0.37
5631	6	-.14	-.18	-.09	0.25	-.03	0.07
5913	6	-1.26	0.10	-.62	0.58	0.07	0.22
8023	4	-.37	0.26	0.35	-.59	0.01	-.05
9777	3	0.29	-.44	-.24	0.32	-.36	0.74
9875	6	0.00	-.16	0.04	-.54	-.67	-.41
Age of Dam							
2	5	-.82	0.13	-.12	0.55	0.56	0.09
3	10	0.03	-.30	0.19	-.11	-.21	0.06
4	10	0.06	-.18	0.14	-.55	-.59	-.16
5	10	0.14	0.02	0.02	-.10	-.07	0.34
6	11	0.04	-.19	0.16	-.23	-.26	0.02
7	7	0.32	0.54	-.32	-.13	0.09	-.20
8	5	-.04	0.02	-.17	0.53	0.39	-.39
9	8	0.45	0.28	0.48	-.02	0.74	0.34
10 + over	8	-.17	-.33	-.39	0.06	-.66	-.43
Regression on Age		0.002	-.004	0.005	-.014[a]	-.014	0.002
Regression on Wt		0.032**	0.008**	0.004*	0.006**	0.018**	0.010**

[a](.05 < P < .10).

*(.01 < P < .05).

**(P < .01).

VITA

William Lester Brown, son of John Lester Brown and Ina Mae (Parker) Brown, was born in McKenzie, Alabama, on December 23, 1943. He was graduated from McKenzie High School in May of 1961 and entered Vanderbilt University in September of the same year. The following year he transferred to Auburn University where he received the degree of Bachelor of Science in June, 1965. His major was Animal Science. He received the Master of Science degree from Auburn University in March, 1967, and the Doctor of Philosophy degree from The University of Tennessee in December, 1969. His major areas of study were population genetics and statistics.