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To the Graduate Council:

I am submitting herewith a thesis written by Robert Cornwell McDaniel entitled "Factors Affecting Beef Bull Performance to Two-Years-of-Age." I recommend that it be accepted for nine quarter hours of credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Animal Husbandry.

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FACTORS AFFECTING BEEF BULL PERFORMANCE TO TWO-YEARS-OF-AGE

A Thesis

Presented to

the Graduate Council of

The University of Tennessee

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

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by

Robert Cornwell McDaniel

August 1965

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CRANES CREST

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CHAPTER I

INTRODUCTION

In order to make improvement in the beef cattle industry it is essential that fundamental information on traits affecting performance be established. An improved environment will definitely aid in this progress but animal genotype must also be considered. Increased interest and competition in the industry has accelerated research; however, much of this investigation has been concerned with pre-weaning and weaning traits. Since post-weaning traits are also involved in the final performance of a beef animal, these traits merit more emphasis.

Record of performance is an excellent means by which the genotypic and phenotypic worth of an animal may be evaluated. This becomes more important in the selection of herd sires because of the genetic influence which will be transmitted to the herd. Since the selection of a herd sire is one of the most profound decisions for the animal breeder, it is imperative that an estimate of the genetic potential of each sire be obtained before a final selection is determined. If a more basic understanding of the factors affecting beef bull development to two-years-of-age can be obtained, the accuracy of sire selection may be increased and improvement in progeny will result.

I. OBJECT OF STUDY

The purposes of this study in a sample of select bull calves were:

1. To determine the effect of age-of-dam on pre-weaning, weaning, and post-weaning traits.

2. To definitely determine if calf age is a source of significance or pre-weaning, weaning, and post-weaning traits.

3. To establish the association among all traits.

4. To determine if the present adjustment for age-of-dam on average daily gain at pre-weaning and weaning is appropriate for selected bull calves.

CHAPTER II

REVIEW OF LITERATURE

I. THE EFFECT OF AGE-OF-DAM

An abundance of research is available which supports the noticeable effect of age-of-dam on the performance traits of beef cattle.

Lasley et al. (1961) found that age-of-dam had a significant influence ($P < .01$) on birth and weaning weights.

Work done by Sawyer et al. (1948) demonstrated that two-year-old dams weaned calves that were 75 pounds lighter than calves of mature cows. The weaning weight of calves increased with increasing age-of-dam through eight years of age and then declined.

Rollins and Guilbert (1954) reported that dams in the age range of seven to ten years produced the calves that grew fastest to four months of age and were heaviest at weaning (240) days. However, from four months to eight months of age, the calves from first calf heifers and, to a lesser extent, from second calf cows grew faster than those from cows in the optimum age range. It was concluded that the lactating ability of a cow makes a major contribution to the growth of the calf throughout the entire sucking period.

Brinks et al. (1962) presented data on 1,029 bulls where age-of-dam was a significant source of variation for birth weight, 180-day pre-weaning gain, 180-day weaning weight, weaning score, and final

weight off test. However, the 196-day post-weaning gain was not significantly influenced by this factor.

In a study of 129 calves, Neville et al. (1962) found that an increase in the dam's 240-day milk production was positively associated with the progeny's stocker gains but negatively correlated, to a lesser extent, with fattening gains. Increases in weaning weight due to increases in milk production continue to be present, almost to the pound, at slaughter. Post-weaning performance was not significantly influenced by differences due to sires, age-of-dam or weight-of-dam.

In a test to evaluate the influence of sex, season of birth, and age-of-dam on birth weight, weaning weight, gain from birth to weaning, weaning score, yearling weight, and fall yearling score for Hereford range cattle; Koch and Clark (1955a) found that age-of-dam had a marked influence on all traits studied except fall yearling score. The cow's production with regard to birth weight, weaning weight, and weaning score increased steadily from three to six years of age and then declined. In another test on 4,553 calves, Koch and Clark (1955b) indicated that maternal environment is quite important for birth weight, gain from birth to weaning and weaning score. Maternal environment appeared to be of little importance for yearling gain and score or is even negatively related to the genes directly influencing these traits.

In an extensive study by Barker (1964) it was found that age-of-dam can contribute a difference of as much as 0.23 pounds per day in average daily gain of calves between two and ten-year-old dams. Age-of-dam had very little effect on average daily gain of calves out of

dams four through eleven years of age. Two, three, and twelve-year-old dams produced the lowest gaining calves. Age-of-dam had a small but significant effect on type score. The type score of calves out of cows three through six years of age were approximately the same. The mean type score by age-of-dam groups of creep-fed calves ranged from 12.20 to 12.47, and non-creep ranged from 11.58 to 11.70.

An investigation of the effects of sex, year, age-of-dam and age-of-calf at weaning on gain of Hereford bull and heifer calves, during different time periods up to one year of age, was conducted by Swiger (1961). The least squares constants for the effects of age-of-dam and weaning age indicate that age-of-dam and perhaps weaning age should be considered in evaluating calves for post-weaning gains.

II. THE EFFECT OF AGE-OF-CALF

Rollins et al. (1962) reported that beef bulls can be effectively selected on the basis of weight-for-age at the end of a four-month period of post-weaning growth on an essentially roughage ration. The evidence suggests, that in selecting bulls, weight-for-age at the end of a testing period is a better criterion than daily gain over a period of four months.

Barker (1964) found that age-of-calf had a pronounced effect on average daily gain. Average daily gain was high during the early stages of growth, and gradually declined to 300 days of age. Age-of-calf also was an important source of variation in type score. Calves typed at

120 to 190 days of age were at a disadvantage. The relationship between score and age-of-calf was essentially linear.

In work described earlier by Swiger (1961) there are data which suggested that different regressions of weaning weight on age-of-calf should be used for bull and heifer calves to adjust weaning weight for age at weaning. Heritability was 0.25 for weaning weight, 0.40 for 140-day feedlot gain and 0.47 for weight at a year of age. These estimates agree reasonably well with previous estimates in the literature. They indicate that considerable progress should result from selection for rate of gain. If the relatively high heritabilities of early feedlot gains as compared with those made later during the post-weaning period should be verified in later studies, measurement of gaining ability can be made at relatively young ages. The large genetic correlation between gains made in different periods suggest that the same genes are largely responsible for gains made during the first year.

Koch and Clark (1955a) found the regressions of birth weight, gain from birth to weaning and weaning score on weaning age were -.08 pounds per day, -.04 pounds per day, and 0.1 unit per day, respectively. All regressions were considered to be too small for practical importance.

Marlowe (1962) reported a decrease in average daily gain with age from 60 to 300 days among a group of non-creep fed calves. Even within the recommended age range of 120 to 240 days, the difference between the extreme ages amounted to approximately one-tenth of a pound per day. It would appear then that some adjustment for age differences would be desirable. There was a slight increase in type

score with age; however, this difference appears to be too small to be of any practical significance.

III. CORRELATION AMONG TRAITS

Wilson et al. (1962) found a negative genetic correlation of -.39 between weaning weight and final conformation. Also the genetic and phenotypic correlation between weaning weight and daily gain and between final conformation and daily gain were small and positive.

Patterson et al. (1949) reported that the ability for rapid gain is highly heritable and selection based upon performance of the individual should thus prove the most effective in improving rate of gain in beef cattle. Practically no relationship exists between type score and gain (r -.041). The correlation between initial grade and initial weight was -.243, while initial grade and final grade are fairly highly correlated (r = 0.724). Patterson et al. (1955) summarized the results of twelve years of feed lot performance in which 1,053 bulls in 166 sire groups were studied. This work suggests that subsequent gain is little affected or associated with initial grade, initial weight, or initial age and subsequent performance records are apparently not greatly biased by these factors.

Lehmann et al. (1961) compared eight selection indexes for weaning beef calves. These were based on daily gain from birth to weaning, 203-day weight, and type score. Selection on the basis of an index combining daily gain and type or weaning weight and type in the best linear equation was concluded to be preferable to selection on the basis of either growth or type singly.

Blackwell et al. (1962) studied ten traits of beef cattle (weaning weight and grade, yearling weight, gain, and grade, daily gain in the feed lot, final feed lot weight, slaughter grade, carcass weight, dressing per cent and carcass grade) to obtain heritability estimates and estimates of the genetic, environmental, and phenotypic correlations among traits. Separate analysis of weaning and yearling data from steers and heifers under range conditions resulted in similar heritability estimates for most traits as well as comparable associations among traits. Individual differences in either gaining ability of young cattle or other traits which are a function of growth or size were found to be relatively highly heritable when the cattle received uniform treatment. Genetic correlations were relatively high among traits involving size and growth rate. Grades at different times were moderately to highly heritable and generally highly correlated genetically. Grades and gains or weights at different times tended to exhibit low to negative correlations.

In an experiment based on 613 steers from 83 Hereford sires, Knapp and Clark (1951) found a gross correlation of 0.0001 between score at weaning and gains in the feed lot. The variance and covariances of gains and weaning score were broken down into genetic and environmental influences. A genetic correlation of 0.3000 and an environmental correlation of -.304 were obtained. The heritability estimate for score was 31 per cent and for gains 70 per cent. The negative environmental correlation may be due to (1) compensatory gain in the feed lot resulting from the relatively poorer conditions of

environment before weaning, or (2) a negative correlation that may exist between milk production and post-weaning gains.

Knapp and Clark (1947) analyzed the gains of 422 steers from 43 different sires that were fed for at least 252 days. The feeding period was divided into three 84-day periods and the gross correlation between Periods 1 and 2 was 0.26; Periods 1 and 3, 0.18; and Periods 2 and 3, 0.39. All of these correlations were statistically significant ($P < .05$). The analysis indicates that there was little environmental correlation between the three periods and that the genetic influence became greater as the feeding period progressed. The correlation between the genetic influence for the entire period and the observed growth over the same period was 0.85. It was concluded that heredity plays a most important part in determining the gains of calves in the feed lot.

Woodward and Clark (1950) in a Montana test found that calves from one station averaged significantly faster gains from birth to weaning than did the calves from another station. There was also a significant difference in average daily gains from birth to weaning between sire groups. Sires producing fast gaining calves at one station tended to do the same at the other station. There was no significant difference between station in average daily gains in the feed lot. There was, however, both a significant difference between sire groups and a sire x station interaction for feed lot gains.

Knapp and Clark (1950) presented data that indicate the important role of heredity on growth after weaning. Growth measures were

more highly influenced by heredity than were measures of quality and conformation.

Marlowe (1962) found the more important factors influencing post-weaning gains include: (1) age of calf at beginning of test; (2) pre-test treatment of calf; (3) length of test period; and (4) feed and management during the test period.

Marlowe et al. (1962) included data from 1,500 bulls of four breeds in a study to determine the influence of age, breed, flesh condition, nursing and season on weight and grade of beef cattle. The bulls ranged in age from 11 months to 11 years. At the outset the bulls were approximately equally divided between two age groups, 11-24 months and over 24 months. Age had the greatest single influence on weight among the younger animals, whereas the primary influence among the older animals was flesh condition.

Shelby et al. (1960) reported estimates of heritability for gain in the feed lot, final weight (thirteen months), adjusted final weight, and efficiency of feed utilization of 0.46, 0.77, 0.55 and 0.32, respectively. Differences between years was the most important source of variance. Weaning weight, gain in the feed lot, efficiency of feed utilization, and final weight varied importantly between lines. Weight at thirteen months appeared to be the most valuable criterion for selection.

In a Wisconsin study by Christian (1963) weaning weight was correlated significantly with average daily gain during the later stages of the post-weaning feeding period, and the proportion

of trimmed valuable cuts in the carcass, but not with the external fat thickness over the twelfth rib, or carcass and quality grade.

Knapp and Clark (1951) reported a possible negative correlation between milk production of the dam and gain in the feed lot.

Rome and Blackwell (1954) concluded that the genes which control growth at one period probably are the same, or include a portion of the same genes which influence growth at a later period.

Swiger et al. (1965) found high genetic relationships between weaning weight, post-weaning daily gain and final weight. The phenotypic associations between these variables were also positive but smaller in size. The environmental corrleation between weaning weight and post-weaning gain was -.17 but the environmental relationship of weaning weight with final weight and post-weaning daily gain and final weight were both positive.

CHAPTER III

EXPERIMENTAL PROCEDURE

I. NATURE OF DATA

These data were collected on 185 selected bulls from seven of the University of Tennessee Experiment Station herds. All were part of the Record of Performance Bull Test which has been in progress since 1958. The three breeds represented in the study were Angus, Hereford, and Polled Hereford. The herds are under a similar management program which does not include creep feeding.

This study included the years 1959-1963. Each year at approximately 110 days of age, the calves were weighed and scored for type and condition by a staff member of the University of Tennessee Animal Husbandry Department. Most all of the calves included in this study ranged between 65 and 155 days of age when pre-weaning information was obtained. The allowable range for type score was 3 to 17 with 17 corresponding to U. S. D. A. High Fancy, 14 to High Choice, 11 to High Good, 8 to High Medium, and 5 to High Common. A similar scale was used for condition score. The average daily gain was calculated by subtracting the birth weight from the pre-weaning weight and dividing by the days of age at pre-weaning. The average daily gain from birth to pre-weaning was then multipled by the appropriate correction factor to adjust all daily gains to a mature cow basis. The following

correction factors were used:

Age-of-dam (years)	Correction factor
2	1.15
3	1.10
4	1.06
5	1.03
6	1.00
7	1.00
8	1.00
9	1.00
10	1.00
11	1.02
12	1.05
13	1.08

Similar data was collected at weaning when the average calf age was approximately 220 days.

Bull calves were selected for this test almost entirely upon their type score and adjusted average daily gain to weaning. Only three bulls used in this investigation failed to possess a type grade of 12.0 or more and 23 failed to attain an adjusted average daily gain of 1.85 pounds per day at weaning.

The general management procedure was to move all bulls to the Knoxville station by approximately November 1 of each year. For about two weeks they were fed a pre-test ration of 40 per cent concentrates and 60 per cent ground hay. At the end of this pre-test period, the bulls were weighed on two consecutive days and divided into lots on the basis of weight, grade, source, and breed.

The three major phases during the testing period are listed below.

Winter Phase

Various feed treatments were used during this testing period which was in effect for approximately 140 days. Weights were recorded every 28 days. Lots of bulls were assigned to one of the following treatments:

AA-Full feed of grain and limited quantities of silage.

BA-Full feed of silage and four pounds of cracked corn with one and one-half pounds of cotton seed meal per head per day.

BB-Full feed of silage and four pounds of cracked corn with one and one-half pounds of cotton seed meal per head per day.

CA-Full feed of silage and only one and one-half pounds of cotton seed meal per head per day.

DA-Full feed of silage and four pounds of cracked corn with one and one-half pounds of cotton seed meal per head per day for approximately 80 days followed by 60 days of full feed. This treatment did not provide for a pasture phase.

At the conclusion of this phase the bulls were graded for type and condition.

Pasture Phase

During this 122-day period, all bulls except those wintered on the DA and BB system and a few bulls which were used for breeding, received approximately one pound of concentrate per head per day while grazing orchardgrass-ladino clover pasture. Bulls on the BB system received no grain.

Feed Lot Phase

At the termination of the pasture phase all bulls except those on the DA system were full fed for 98 days. Each treatment group was fed separately so feed consumption could be measured.

Anderson (1962) has outlined more completely the feeding regimes and management practices governing the Record of Performance Bull Test.

II. METHOD OF ANALYSIS

Because of differences resulting from geographical location, all station effects were absorbed in these analyses. Breed effects were also absorbed since variation was certain to exist by reason of this factor. An additive model was considered appropriate for these analyses. Interaction among main effects was not thought to be of major importance. Constants were fitted for the effects of year, treatment and age-of-dam.

Age-of-dam was divided into ten groups since no dams were less than two years of age and only a few were more than eleven years old. Thus, dams in excess of eleven years were classified as age eleven.

Since all traits were not available on all bulls, two analyses were necessary. One analysis included all bulls and only seventeen traits, and the other analysis embraced fewer bulls with twenty-two variables for consideration.

The method of least squares (Harvey, 1960) was used because of the unequal subclass numbers. When significant differences due to a class of effects were detected, Duncan's Multiple Range Test (1955), as modified by Kramer (1957), was used for mean separation.

CHAPTER IV

RESULTS AND DISCUSSION

I. THE EFFECT OF AGE-OF-DAM

The analysis of variance (Table I) indicates the influence of age-of-dam on birth weight. Two- and three-year-old dams produced calves that were significantly ($P < .05$) lighter at birth than did dams ranging in age from four through eleven. There were no significant differences in the birth weight of calves from dams four through eleven years of age.

The least squares constants for age-of-dam effects (Table II) are negative for two, three, and four-year-old dams. There was no decline in birth weight for calves until the dams were eleven years of age. These results are in general agreement with those found in the literature; however, Marlowe (1958) reported a decline in birth weight of calves from dams over seven years old.

From this study the arithmetic mean of birth weight was 68.1 pounds. Four- and five-year-old cows produced calves that more closely approached the mean than did any other age-of-dam group.

Reference to Table I will reveal that age-of-dam did not have a significant bearing on average daily gain at pre-weaning. This finding does not agree with Brinks et al. (1962) where age-of-dam was a significant source of variation at pre-weaning. This may be explained by the fact that this study is based upon a sample of

TABLE I

ANALYSIS OF VARIANCE FOR AGE-OF-DAM AND AGE-OF-CALF EFFECTS ON PRE-WEANING TRAITS

		Mean square				
Source	d.f.	Birth weight	Average daily gain	Adjusted average daily gain	Type	Condition
Age-of-dam	9	157.43**	0.0623	0.0300	0.4889	0.4018
Age-of-calf	1	55.26	0.0134	0.0270	4.39**	1.48*
Residual	161[a]	54.31	0.0407	0.0435	0.5143	0.3050

[a]Residual degrees of freedom for type and condition = 74.

*$P < .05$.

**$P < .01$.

TABLE II

LEAST SQUARES CONSTANTS[a] FOR THE EFFECTS OF AGE-OF-DAM ON PRE-WEANING TRAITS

Age-of-dam (years)	Birth[b] weight	Average daily gain	Adjusted average daily gain	Type	Condition
2	-7.30	-.094	0.079	0.03	-.13
3	-5.74	-.097	0.010	0.06	-.16
4	-.97	-.014	0.041	-.10	0.26
5	1.42	-.014	-.027	-.19	-.20
6	1.49	0.078	0.018	-.25	0.05
7	2.16	0.037	-.033	0.42	0.18
8	2.23	0.011	-.059	-.23	-.16
9	2.01	0.005	-.065	-.22	-.05
10	3.33	0.127	0.062	0.54	0.44
11 and over	1.37	-.039	-.026	-.06	-.23
Arithmetic mean	68.1	1.91	1.98	12.68	8.78

[a]Constants are deviations from the overall mean.

[b]Two and three year old age-of-dam constants for birth weight differ significantly from all others ($P < .05$). All other differences are not significant.

highly selected bull calves. Although the differences were not significant, two through five and eleven-year-old dams (Table II, page 18) raised calves that had lower gains at pre-weaning than did six through ten-year-old cows. Ten-year-old cows nursed calves that were higher in average daily gain at pre-weaning than did cows in any other age classification. The overall mean was 1.91 pounds per day.

The age-of-dam effect was not significant for adjusted average daily gain at pre-weaning (Table I, page 17). Least squares constants for the effect of age-of-dam on adjusted gain (Table II, page 18) were negative for five, seven, eight, nine, and eleven-year-old dams. Two-year-old dams had the highest constant which might suggest an over adjustment for this age group.

Differences in pre-weaning type also failed to be significant (Table I, page 17) among ages-of-dam. Barker (1964) found a small but significant influence of age-of-dam on this factor. Seven and ten-year-old dams (Table II, page 18) produced calves that graded the highest in type at this relatively early stage of growth.

Condition at pre-weaning was not influenced (Table I, page 17) by age-of-dam. The arithmetic mean for condition at pre-weaning was 8.78.

Age-of-dam was a highly significant ($P < .01$) source of variation (Table III) for average daily gain at weaning. Two-year-old dams nursed calves that were significantly ($P < .05$) lower in average daily gain at weaning than did dams of other ages. Three, four, five, and eleven-year-old dams did not differ in this respect but were

TABLE III

ANALYSIS OF VARIANCE FOR AGE-OF-DAM AND AGE-OF-CALF EFFECTS ON WEANING TRAITS

Source	d.f.	Mean square			
		Average daily gain	Adjusted average daily gain	Type	Condition
Age-of-dam	9	0.0543**	0.0190	0.6882	0.5311
Age-of-calf	1	0.0262	0.0451	3.89*	0.7525
Residual	161[a]	0.0185	0.0204	0.5996	0.3292

[a]Residual degrees of freedom for condition = 74.

*P $<.05$.

**P $<.01$.

significantly ($P < .05$) different from other age groups. Four through eleven-year-old dams were similar in this factor and raised calves to weaning with a higher average daily gain than did two and three-year-old dams. These findings are in close agreement with results of previous investigations (Lasley et al., 1961; Sawyer et al., 1948; Brinks et al.; 1962) and further focus upon the importance of the dam's lactating ability.

Adjusted average daily gain at weaning (Table III, page 20) was not significantly influenced by age-of-dam. Least squares constants (Table IV) were negative for two and six through ten-year-old dams. Five-year-old cows produced calves that more closely approached the mean of 2.03 pounds per day than did any other age-of-dam group. Therefore if an adjustment to a common base is desired, a five-year-old basis seems practical. It must be noted from the foregoing that in this select group of bulls, the adjustment factors used tended to overestimate the average daily gain of calves from young dams.

Both type and condition at weaning were not affected significantly by age-of-dam (Table III, page 20). This lack of influence of age-of-dam on weaning type and condition is not in agreement with the work enumerated by Koch and Clark (1955a) where age-of-dam had a marked influence on weaning score. Barker (1964) also found that age-of-dam significantly affected type score. The constants (Table II, page 18) follow an irregular pattern.

The average daily gain from pre-weaning to weaning (Table V) was significantly ($P < .05$) influenced by age-of-dam. Two-year-old dams

TABLE IV

LEAST SQUARES CONSTANTS[a] FOR THE EFFECTS OF AGE-OF-DAM ON WEANING TRAITS

Age-of-dam (years)	Average[b] daily gain	Adjusted average[c] daily gain	Type[c]	Condition[c]
2	-.184	-.015	-.18	-.18
3	-.067[d]	0.049	0.21	-.02
4	-.015[de]	0.040	-.08	-.34
5	0.014	0.002	-.23	-.01
6	0.049[e]	-.012	0.05	0.22
7	0.030[e]	-.044	0.41	0.54
8	0.031[e]	-.040	-.07	-.33
9	0.069[e]	-.003	-.11	0.04
10	0.060[e]	-.007	0.13	0.09
11 and over	0.013[de]	0.030	-.13	-.01
Arithmetic mean	1.96	2.03	13.14	9.49

[a]Constants are deviations from the overall mean.

[b]Age-of-dam significantly ($P < .05$) influenced average daily gain. Constants not superscripted with the same letter are significantly different ($P < .05$).

[c]Age-of-dam did not significantly affect these traits.

TABLE V

ANALYSIS OF VARIANCE FOR AGE-OF-DAM AND AGE-OF-CALF EFFECTS ON INTERIM GAINS

Source	d.f.	Mean square	
		Average daily gain pre-weaning to weaning	Average daily gain weaning to start of test
Age-of-dam	9	0.1050*	0.3459
Age-of-calf	1	0.0004	1.906
Residual	161	0.0522	0.5836

*$P < .05$.

were significantly ($P < .05$) different from all other ages-of-dam in average daily gain of calves from pre-weaning to weaning. Other ages-of-dam were not significantly different. Least squares constants listed in Table VI for average daily gain from pre-weaning to weaning indicate that in this sample nine-year-old dams produced the superior calves.

The analysis of variance (Table V, page 23) indicates age-of-dam had no effect on average daily gain from weaning to the onset of testing. This observation is not surprising because of the short duration of this period and the multitude of extraneous factors which undoubtedly influence this trait.

Average daily gain and type during the winter testing period (Table VII) were not significantly changed by the effect of age-of-dam. Constants (Table VIII) are very irregular for these two traits and indicate no consistent relationship between age-of-dam and winter traits. Swiger (1961), however, found age-of-dam to exert a significant influence on post-weaning gains.

Age-of-dam did not significantly affect pasture traits (Table VII) in this study of select bull calves. This is borne out further by the least squares constants in Table VIII. However, average daily gain was superior for calves from two, four, six, and eleven-year-old dams and pasture type was best for calves from two, seven, and nine-year-old dams.

Age-of-dam was not a significant source of variation for full feed average daily gain or type but had a highly significant ($P < .01$)

TABLE VI

LEAST SQUARES CONSTANTS[a] FOR THE EFFECTS OF AGE-OF-DAM ON INTERIM GAINS

Age-of-dam (years)	Average daily gain[b] pre-weaning to weaning	Average daily gain weaning to start of test
2	-.271	0.102
3	-.038	-.176
4	0.008	0.134
5	0.054	-.148
6	-.020	0.054
7	-.009	0.136
8	0.067	-.216
9	0.145	-.047
10	-.001	0.082
11 and over	0.065	0.079
Arithmetic mean	2.02	1.35

[a]Constants are deviations from the overall mean.

[b]The constant for two-year-old dams differed significantly ($P < .05$) from all other constants.

TABLE VII

ANALYSIS OF VARIANCE FOR AGE-OF-DAM AND AGE-OF-CALF EFFECTS ON POST-WEANING TRAITS

		Mean square						
		Winter		Pasture		Full feed		
Source	d.f.	Average daily gain	Type	Average daily gain	Type	Average daily gain	Type	Condition
Age-of-dam	9	0.0236	0.5696	0.2896	0.8504	0.1674	0.8120	1.5492**
Age-of-calf	1	0.0452	2.2782	0.0004	3.541**	0.0265	1.8029	4.9249**
Residual	141[a]	0.0832	0.9564	0.1642	0.4716	0.1415	0.6852	0.5669

[a]Residual degrees of freedom for pasture and full feed traits = 71.

**P < .01.

TABLE VIII

LEAST SQUARES CONSTANTS[a] FOR THE EFFECTS OF AGE-OF-DAM ON POST-WEANING TRAITS

Age-of-dam (years)	Winter		Pasture		Full feed		
	Average daily gain[c]	Type[c]	Average daily gain[c]	Type[c]	Average daily gain[c]	Type[c]	Condition[b]
2	0.002	-.43	0.166	0.83	-.130	0.40	1.10[d]
3	-.002	0.23	-.059	-.21	-.060	0.44	-.08[ef]
4	-.071	-.10	0.294	-.33	0.179	-.16	0.19[ef]
5	-.032	-.08	-.222	-.34	0.106	-.22	-.35[f]
6	0.016	-.06	0.207	-.09	-.083	-.10	0.12[ef]
7	-.013	0.30	-.047	0.47	0.083	0.16	0.52[de]
8	0.042	-.01	-.300	-.08	-.026	-.18	-.37[f]
9	-.008	0.23	-.059	-.16	-.176	-.30	-.33[f]
10	0.068	-.17	-.085	-.22	0.120	-.28	-.63[f]
11 and over	-.002	0.09	0.105	-.19	-.013	0.24	-.17[ef]
Arithmetic mean	2.14	12.87	1.21	12.65	2.85	13.20	10.29

[a]Constants are deviations from the overall mean.

[b]Age-of-dam significantly ($P < .05$) influenced full feed condition. Constants not superscripted with the same letter are significantly different ($P < .05$).

[c]Age-of-dam did not significantly affect these traits.

influence on condition score at the end of the full feed test. Age-of-dam constants for full feed performance traits are presented in Table VII, page 26. Two and seven-year-old dams produced calves with the highest condition scores at the end of the full feed phase of testing. Calves from three, four, six, seven, and eleven-year-old cows were alike on this regard and dissimilar from the other ages.

The analysis of variance (Table IX) indicates little influence of age-of-dam on lifetime traits at approximately twenty-four months of age. This affirms the fact that average daily gain at two years of age does not include the previous marked effect of age-of-dam. Least squares constants (Table X) reveal no regular relationship between age-of-dam and average daily gain from weaning to termination of the testing period. Constants for lifetime average daily gains were negative for two through five and eight and nine-year-old dams. Eleven-year-old dams produced calves with superior lifetime average daily gains followed closely by seven, six, and ten-year-old dams.

II. THE EFFECT OF AGE-OF-CALF

Indications are that the linear effect of age-of-calf (Table I, page 17) was not a significant source of variation for birth weight, average daily gain, or adjusted average daily gain at pre-weaning. (Technically, all calves are zero days of age at birth; therefore, an effect of calf age on birth weight would be interpreted as the effect of day of the year born on birth weight.) Age-of-calf was a highly significant ($P < .01$) source of variation for pre-weaning type and

TABLE IX

ANALYSIS OF VARIANCE FOR AGE-OF-DAM AND AGE-OF-CALF EFFECTS ON LIFETIME TRAITS

Source	d.f.	Mean square	
		Average daily gain weaning to end of test	Lifetime average daily gain
Age-of-dam	9	0.0268	0.0180
Age-of-calf	1	0.0386	0.0080
Residual	71	0.0266	0.0143

TABLE X

LEAST SQUARES CONSTANTS[a] FOR THE EFFECTS OF AGE-OF-DAM ON LIFETIME TRAITS

Age-of-dam (years)	Average daily gain weaning to end of test	Lifetime average daily gain
2	0.045	-.042
3	-.046	-.045
4	0.016	-.005
5	-.022	-.013
6	0.015	0.028
7	0.037	0.037
8	-.064	-.019
9	-.047	-.012
10	0.004	0.026
11 and over	0.062	0.045
Arithmetic mean	1.95	1.95

[a]Constants are deviations from the overall mean.

significant ($P < .05$) for condition. The partial regressions of pre-weaning traits on age are given in Table XI.

The analysis of variance (Table III, page 20) demonstrates the lack of a linear influence of calf age on weaning average daily gain, adjusted average daily gain, and condition. However, the age-of-calf was a significant ($P < .05$) source of variation for weaning type. A ten day increase of calf weaning age was predictive of approximately a tenth of a unit increase in type score. This result is in keeping with work by Barker (1964) where the relationship between type score and age-of-calf was essentially linear. Partial regressions of the effects of calf age on these traits are given in Table XI.

The interim gains were not changed by age-of-calf as can be observed in Table V, page 23. Partial regressions for the effect of calf age on these traits may be seen in Table XI.

In Table VII, page 26, may be found the analysis of variance for the linear effects of age-of-calf on post-weaning traits. The average daily gain and type during the winter phase of testing was not altered by the age-of-calf. Neither was pasture average daily gain affected by age. The influence of age-of-calf on type during the pasture phase was highly significant ($P < .01$). Calves ten days older at weaning were on the average one tenth of a unit higher in grade at this stage. Full feed average daily gain and type were not significantly influenced by age in this study; however, the effect on full feed condition was highly significant ($P < .01$).

It seems evident in this study that the only two traits affected

TABLE XI

LINEAR PARTIAL REGRESSIONS OF PRE-WEANING, WEANING AND POST-WEANING TRAITS ON AGE AT WEANING OR AT THE TERMINATION OF THE TEST PERIOD

Traits	Age at weaning	Age at end of test
Birth weight	-.0240	- -
Pre-weaning		
Average daily gain	-.0004	- -
Adjusted average daily gain	-.0005	- -
Type	0.0100**	- -
Condition	0.0060*	- -
Weaning		
Average daily gain	-.0005	- -
Adjusted average daily gain	-.0010	- -
Type	0.0060*	- -
Condition	-.0040	- -
Average daily gain		
Pre-weaning to weaning	-.0001	- -
Average daily gain		
Weaning to start of test	-.0040	- -
Winter		
Average daily gain	0.0010	- -
Type	0.0050	- -
Pasture		
Average daily gain	-.0001	- -
Type	0.0090**	- -
Full feed		
Average daily gain	- -	0.0005
Type	- -	0.0050
Condition	- -	0.0110**
Average daily gain		
Weaning to end of test	- -	-.0005
Lifetime		
Average daily gain	- -	-.0005

*P <.05.

**P <.01.

by age-of-calf are type and condition. This would appear to be compatible with the finding of Barker (1964) that older or more mature animals tend to receive higher grades than younger animals. A complete listing of the effects of age-of-calf on performance traits may be appraised in Table XI, page 32.

III. CORRELATION AMONG TRAITS

The relationships among all traits studied are given in Table XII.

Birth weight was highly correlated with average daily gain at weaning, during the winter and to two-years-of-age. Pre-weaning average daily gain was associated in a positive manner with gain to weaning, during full feed and to two-years-of-age. Type and condition were positively correlated with each other during various periods throughout the two years of testing, and in most cases the associations were highly significant. However, high condition and type scores at pre-weaning were generally indicative of calves which made slower post-weaning gains and lifetime gains.

Weaning age was negatively correlated with average daily gain at the same period of growth as well as at the termination of testing. Average daily gain at weaning had a positive and highly significant association with gain during full feed and at the end, but was negatively related to full feed condition and lifetime age. The gain from pre-weaning to weaning was found to have a negative association with average daily gain on pasture but positive and highly significantly related

	2	3	4	17	18	19	20	21	22
1 Birth weight	0.17*	0.05	0.04	0.14	0.19**	0.06	0.22**	0.01	0.28**
Pre-weaning									
2 Average daily gain		0.94**	0.21**	0.20**	-.01	0.02	0.08	-.01	0.38**
3 Adjusted average daily gain			0.18*	0.17*	0.02	0.10	0.11	-.08	0.36**
4 Type				-.01	0.30**	0.24**	-.16*	0.14	-.11
5 Condition				0.03	0.13	0.21**	-.02	0.26**	0.02
Weaning									
6 Age				0.11	0.12	0.23**	-.09	0.64**	-.15*
7 Average daily gain				0.29**	0.06	-.04	0.06	-.05	0.48**
8 Adjusted average daily gain				0.25**	0.11	0.06	0.10	-.15*	0.46**
9 Type				0.16*	0.41**	0.28**	-.13	0.20**	-.03
10 Condition				-.24**	0.06	-.00	-.21**	-.12	-.17*
11 Average daily gain Pre-weaning to weaning				0.22**	0.07	-.02	-.05	0.02	0.24**
12 Average daily gain Weaning to start of test				-.06	0.20**	0.11	0.17*	0.02	0.10
Winter									
13 Average daily gain				0.20**	0.13	0.17*	0.37**	-.05	0.38**
14 Type				0.23**	0.50**	0.28**	0.07	0.06	0.14
Pasture									
15 Average daily gain				-.10	0.12	0.18*	0.25**	-.04	0.11
16 Type				-.02	0.56**	0.51**	0.29**	0.25**	0.25**
Full feed									
17 Average daily gain					0.24**	0.19**	0.31**	0.20**	0.40**
18 Type						0.58**	0.25**	0.14	0.24**
19 Condition							0.40**	0.23**	0.31**
20 Average daily gain Weaning to end of test								-.34**	0.90**
Lifetime									
21 Age									-.30**
22 Average daily gain									

*P < .05

**P < .01

with full feed and lifetime average daily gains. Winter average daily gain was negatively related to pasture gains, but positively associated with full feed and lifetime gains.

Pasture type was associated positively with all traits studied except full feed average daily gain. Full feed average daily gain was correlated in a positive and highly significant manner with all post-weaning traits considered. The gain from weaning to the completion of testing was negatively correlated with lifetime age; however, it was significantly associated with lifetime average daily gain. The relationship between lifetime age and average daily gain was highly significant and negative.

CHAPTER V

CONCLUSIONS

This investigation has suggested that the following inferences are warranted:

1. Age-of-dam exerts a significant influence on the birth weight of bull calves. Two and three-year-old dams produce calves that are approximately six to seven pounds lighter at birth than dams four through eleven years-of-age.

2. Age-of-dam is a highly significant source of variation in average daily gains at weaning. Weaned bull calves from two-year-old dams approach two-tenths of a pound less in average daily gain than do calves from other age dams. Three, four, five, and eleven age dams are alike in this factor, and are dissimilar from all other age dams.

3. Differences in age-of-dam is responsible for variation in average daily gain of calves from pre-weaning to weaning in evaluation of select bull calves. Two-year-old dams differ significantly from other age dams in this respect.

4. The only post-weaning trait significantly influenced by age-of-dam is full feed condition. Two and seven-year-old dams are alike and differ from all other age groups in this comparison.

5. The marked effect of age-of-dam on pre-weaning and weaning traits of bull calves seem to disappear during post-weaning performance.

6. Calf age significantly influences pre-weaning type and condition.

7. Calf type at weaning and during the pasture phase is affected by differences in age.

8. At the termination of testing, calf age seems to have a bearing on condition score.

9. Birth weight is highly and positively correlated with average daily gain at weaning, during the winter phase and to two years of age.

10. The relationship between pre-weaning average daily gain and this same trait at weaning, full feed, and lifetime is positive and highly significant.

11. The relationship between weaning average daily gain and lifetime average daily gain is positive and highly significant.

12. Weaning type and condition is negatively associated with lifetime average daily gain.

13. It appears that the presently used correction factors over-adjust pre-weaning average daily gain of calves from dams under four years-of-age.

14. Adjustment of average daily gain of bull calves to a five-year-old dam basis seems advisable since this age-of-dam group most closely approaches the average unadjusted gain of all calves.

CHAPTER VI

SUMMARY

Twenty-two performance traits of 185 selected bull calves, representing three breeds, were analyzed to determine (1) the effect of age-of-dam on pre-weaning, weaning, and post-weaning traits, (2) the influence of calf age on pre-weaning, weaning, and post-weaning traits, (3) the linear association among all traits, (4) and if the presently used adjustments for age-of-dam effects on average daily gain at pre-weaning and weaning are appropriate for selected bull calves.

The effects of age-of-dam upon birth weight and average daily gain at weaning was highly significant ($P < .01$). Age-of-dam was also a significant source of variation on average daily gain from pre-weaning to weaning. It appears, however, that the presently used correction factors tend to over adjust gain of calves from younger age cows. The only post-weaning trait significantly influenced by age-of-dam was full feed condition. In this study, lifetime average daily gain was not influenced by age-of-dam.

Age-of-calf variation was responsible for pronounced differences in pre-weaning type and condition and weaning type.

Post-weaning traits significantly influenced by age-of-calf were pasture type and full feed condition. It seems that average daily gain of bulls to two years of age is independent of age-of-calf.

The relationship between weaning average daily gain and lifetime average daily gain was positive and highly significant ($P < .01$).

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