12-1968

Relationship between change in condition of beef cows during the pasture season and performance of their calves to weaning

William Lester Sanders

To the Graduate Council:

I am submitting herewith a dissertation written by William Lester Sanders entitled "Relationship between change in condition of beef cows during the pasture season and performance of their calves to weaning." 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, Robert L. Murphree, Don O. Richardson, Charles C. Thigpen

Accepted for the Council:

Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

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

November 15, 1968

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R. L. Murphree

Accepted for the Council:

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Vice Chancellor for
Graduate Studies and Research

RELATIONSHIP BETWEEN CHANGE IN CONDITION OF BEEF COWS DURING THE PASTURE SEASON AND PERFORMANCE OF THEIR CALVES TO WEANING

A Dissertation

Presented to

the Graduate Council of

The University of Tennessee

In Partial Fulfillment

of the Requirements for the Degree

Doctor of Philosophy

---

by

William Lester Sanders

December 1968

ACKNOWLEDGEMENTS

The author wishes to express his most sincere appreciation and gratitude to the following persons who assisted in the preparation of this dissertation:

To Dr. Robert R. Shrode, major professor, for his critical review of the manuscript, and for his encouragement, wise counsel, and stimulating conversation.

To Dr. Charles S. Hobbs, for reviewing the manuscript, and for the original opportunity to do graduate work.

To Dr. Robert L. Murphree, for reviewing the manuscript, and for his guidance throughout the course of graduate study.

To Drs. Don O. Richardson and Charles C. Thigpen for serving on the graduate committee and for reviewing the manuscript.

To Dr. Will T. Butts for his assistance, encouragement, and motivating discussion.

And to his mother and father for their encouragement and many sacrifices that made college study possible.

ABSTRACT

One hundred and fifty-five Angus cows were measured ultrasonically for fat thickness using a Branson Model 12 Sonoray and visually scored for condition in April and October of 1966. Least-squares analyses of the data collected were conducted, using as a dependent variable in each analysis one of the three calf traits observed and recorded at weaning, viz., average daily gain, type score and condition score. The independent variables included in the model were age of dam, sex of calf, change in dam's fat thickness, squared change in dam's fat thickness, and age of calf. Change in fat thickness, as well as the squared change in dam's fat thickness, significantly affected weaning condition score but not weaning gain or weaning type score. The same analyses were conducted with change in dam's condition score substituted for change in fat thickness. Although cow condition score was highly correlated with each of the two ultrasonic estimates of fat thickness (r = 0.70 and 0.67 in spring and fall data, respectively), change in cow condition score did not affect weaning average daily gain, type or condition score of calf. A proposed explanation is that cow condition score may be influenced by cow size such that variation in condition score did not reflect differences in fatness as accurately as did the variation in ultrasonically measured fat thickness. The findings suggest that, under conditions similar to those in this study, change in fat thickness of the dam in conjunction with a measure of calf fatness might be useful in partitioning

increases in calf weight into gain due to growth and gain due to fattening.

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CHAPTER I

INTRODUCTION

The response of all living organisms to their environment is dictated by their respective genotypes. Therefore, the improvement of response through selection is a function of the precision of identifying the genetic and the environmental components of phenotypic variation.

Phenotypic selection even though based solely on subjective visual evaluation of phenotype, has been successful throughout the recorded history of cattle breeding. Selections based entirely on visually evaluated phenotypes have enabled breeders to successfully change ancient wild cattle into existing domestic breeds.

However, this change has taken centuries. Improvement of existing cattle will be made primarily through the development and application of more refined techniques to more accurately evaluate and adjust for the environmental forces which affect phenotypic variation. This in turn should enable the breeder to more precisely compare the genetic values of potential herd replacements.

Currently, most of the selection pressure available to the beef breeder is applied when calves are weaned from their dams. Generally, the traits receiving the most consideration are average daily gain from birth to weaning and type score, a subjective estimate of overall quality. It has been reported that average daily gain of calves from birth to weaning is greatly influenced by the milk production of their dams.

Therefore, variation due to differences in maternal abilities of dams tend to camouflage genetic ability and lower the precision of selection of individuals genetically superior with respect to life-time production of beef. Nelson (1967) states that milk production is apparently inversely related to the weight gain of the mature dam during lactation. Since weight change in mature cows is primarily a function of change in fatness, the present study was undertaken to assess the relationship between measures of the change in a cow's body composition during lactation and the performance of her calf to weaning. Reasoning from *a priori* knowledge concerning the influence of lactation on the fat reserves of cows made it seem logical that measurements reflecting the status of the dam's fat reserves would be useful in explaining statistically some of the environmental variation in the performance of calves from birth to weaning.

CHAPTER II

REVIEW OF LITERATURE

Some of the permanent environmental factors which affect calf weaning performance have been thoroughly investigated and reported. However, few attempts have been made to measure the effect of maternal ability on traits of weanling calves. No reports were found establishing the relationship between calf's performance to weaning and the change in dam's body composition. However, the relationship between live weight of the dam and calf performance has been reported.

Literature is readily available to indicate the relationship between ultrasonic estimates of fat thickness on the live animal and comparable measures made on the carcass.

I. EFFECTS OF CERTAIN PERMANENT ENVIRONMENTAL SOURCES OF VARIATION

Age of dam. The effect of age of dam on the variation in calf's performance to weaning has been demonstrated by numerous workers in varying locations. A review article by Petty and Cartwright (1966) summarizes these effects, and the means from their survey are presented in Table I. These average figures support the general recommendation that gain of calves from younger dams should be adjusted to a mature-cow basis. However, the evidence for the need of an adjustment for type is not so conclusive.

TABLE I

SUMMARY OF AVERAGE EFFECTS OF AGE OF DAM ON CERTAIN WEANING TRAITS

Trait	Age of dam, years							
	2	3	4	5	6	7	8	9
Av. daily gain, lb./day	-0.25	-0.16	-0.07	-0.03	0.00	0.02	0.03	0.00
Type grade	-0.8	-0.5	-0.3	-0.1	0.0	0.1	-0.2	-0.3

Sex. In the same review article by Petty and Cartwright (1966), average sex effects for gain and type at weaning were calculated. These average estimates indicate that male calves can be expected to gain approximately 0.15 pound per day more than females. Most reports indicate that sex has little effect on type score at weaning. However, Loganathan (1962) and Jamison (1966) found that male calves were given type scores slightly higher than those given heifers.

Loganathan (1962) and Butts (1966) indicated that females were scored significantly higher for condition at weaning than were males.

Age at weaning. Under most management regimes, age of calf at weaning is usually confounded with month of birth. Therefore, this effect may vary from location to location depending upon the average calving date in a given herd.

However, it is a possible source of environmental variation the magnitude of which has been estimated. Jamison (1966) found it to be a negligible source of variation in average daily gain to weaning. On the other hand, Barker (1964) found calves 120 to 177 days of age at weaning to have a higher average daily gain than those weaned from 180 to 300 days of age.

Marlowe, Mast, and Schalles (1965) reported a small positive relationship between type and age at weaning. This is in agreement with the findings of Koch and Clark (1955), Barker (1964), and Jamison (1966). In view of this, it appears that age at weaning is an effect which may not drastically affect the variation in performance to weaning but, depending on the situation, may have a consistent influence.

II. EFFECT OF COW'S WEIGHT AND HER WEIGHT CHANGE ON CALF'S PERFORMANCE TO WEANING

Numerous studies have revealed a positive relationship between dam weight and calf's gain to weaning. Brinks et al. (1962), Fitzhugh (1965), Gregory et al. (1950), and Marchello et al. (1960), have all demonstrated a consistent relationship between dam weight and calf weaning weight. Nelson (1967) states that a curvilinear relationship generally exists between age of dam and progeny weaning weight, the peak weaning weight occurring about the same age that the dam reaches her mature weight. Gains (1942) stated that "as a cow grows older from the first calving to maturity, she gives more milk, not because she grows older but because she grows larger."

The objective of most of these studies was to measure the phenotypic relationship which exists between age of dam and calf's performance to weaning. However, there is a suggestion that within a cow age group there exists a positive genetic relationship between dam weight and calf weaning weight. However, the contribution of the genetic relationship to the overall phenotypic relationship is small, indicating that cow weight is primarily a function of cow age.

Another and probably a more important influence on calf weaning performance is the change in weight of the dam during lactation. Nelson (1967) states that milk production is apparently inversely related to the weight gain of the mature dam during lactation. Dawson *et al.* (1960), Neville (1962), Christian *et al.* (1965), and Melton *et al.* (1967) have reported that a highly significant relationship exists between milk production of the dam and calf gain from birth to weaning. This supports the results of Brinks *et al.* (1962), Gregory *et al.* (1950), and Hawkins *et al.* (1965), who found a negative correlation between calf weaning weight and weight gain of the dam, during the nursing period. However, Vaccaro and Dillard (1966) found that calf gain to 120 days was significantly influenced by weight change of dam only among cows more than five years of age.

Since the composition of weight change of younger dams may be reasoned to be primarily growth, and changes in weight of older dams a function of changes in fatness, change in weight may not be related to milk production *per se*, but only through its part-whole relationship with change in fatness. However, no reports were found of studies in which attempts were made to measure the relationship between change in fatness of the dam and either calf's performance to weaning or cow's milk production.

III. RELATIONSHIP BETWEEN ULTRASONIC ESTIMATES OF FAT THICKNESS ON LIVE ANIMALS AND CARCASS FAT THICKNESS

Ultrasonics has been demonstrated to be a reliable tool for estimating the fat covering of the live beef animal. Values of 0.11 to 0.90 have been calculated for the coefficient of correlation between an ultrasonic estimate of fat thickness and the value measured in the carcass, with most coefficients falling in the range of 0.60 to 0.80 (Hedrick et al. 1962; Stouffer et al. 1961; Sumption et al. 1964; Watkins et al. 1967; and Huff, 1967).

Based on unpublished data collected from 50 mature Hereford females culled from the Alcoa herd at The University of Tennessee, the simple coefficient of correlation between an ultrasonic estimate of fat thickness and carcass fat thickness was 0.82 (Ramsey, 1966). The possibility exists that an improvement of this relationship may not be dependent upon improvement of sonoray technique, but rather upon improvement of accuracy of measurement of fat thickness on the carcass. This opinion is based on the observation that automatic hide-pullers routinely used in packing plants tend to remove varying amounts of subcutaneous fat, the result being a biased estimate of fat thickness which tends to be smaller than the "true" fat thickness. The errors of estimation of ultrasonic fat thickness, however, should be random around the "true" fat thickness.

CHAPTER III

EXPERIMENTAL PROCEDURE

I. SOURCE OF DATA

The data used in this study were collected during the pasture season of 1966 from a herd of purebred Angus located at the Plateau Experiment Station, Crossville, Tennessee. This area is a high plateau (approximately 2,000 ft. elevation) and may be classified as having excellent conditions for cow-calf production. In general, the pastures at the Plateau Experiment Station consisted primarily of orchardgrass and clover. During the grazing season the calves remained with their dams and received only their mother's milk and pasture.

The herd was established in 1949 for the general purpose of studying the effects of inbreeding on calf performance to weaning. The herd may be classified into three groups. The first is a closed herd in which inbreeding has been allowed to increase. The second group is a closed herd, but deliberate attempts have been made to minimize inbreeding while the third group has been maintained as an outcross herd. Replacements from other sources have been selected to insure that inbreeding is nonexistent in the latter group.

Selections have been based primarily on average daily gain to weaning and type score at weaning. It may be stated that unitl 1960 very little selection pressure was exerted on females because the size of the herd was steadily being increased. Since that time, there has been some selection among females. Female replacements were subjected to a two-stage selection process. The first selection was at weaning followed by a second selection at the end of the winter feeding period, utilizing average daily gain as the primary selection criterion.

The bulls produced in the herd, after preliminary selection at weaning, were routinely compared on a feeding test. Selections from this test designated those bulls to be bred as yearlings to obtain a progeny test. Although not consistently adhered to, the intention was to select bulls entirely on the basis of progeny performance, and sires were to be kept in the breeding herd until younger bulls were deemed superior on the basis of the progeny test.

The cows in the herd were culled on the basis of both their productive and progeny performance. Usually, cows which were designated open as of a pregnancy check in the fall following a failure to calve the previous spring were culled. A cow's progeny record was considered to be the average performance of all her calves.

A portion of the cows in the herd (approximately 50) were used to determine how level of wintering of the dam affects calf performance. However, based on the results of this nutritional experiment and preliminary analysis from the current study, no carry-over effects of the different experimental treatments were indicated. Likewise, inbreeding of both cows and calves had no appreciable effect upon any of the relationships among variables which were measured in this study. Hence, inbreeding and previous treatment were ignored in the analyses.

II. DESCRIPTION OF DATA

Observations on the calves were weight at preweaning (approximately 120 days) and weaning as well as type and condition scores. Measurements on the dam were live weight, visual condition score, and an ultrasonic estimate of fat thickness. These observations were taken in April, 1966 and in October, 1966. The October measurements were made approximately one week after weaning, while the April measurements corresponded to the beginning of the pasture season. In addition, preweaning weights and grades were taken, but at this time no measurements on the cows were obtained.

Condition scoring was a subjective attempt to evaluate differences in fatness which exist among both cows and calves. The numerical condition grades were designed to depict degrees of apparent finish which would be comparable to the corresponding slaughter grades for steers and heifers. For example, 14, 13, 12 would be high, average and low choice, while 11, 10, 9 would represent high, average, and low good. Numberical type grades for calves had the same range; however, they differed in that the values for type corresponded instead to feeder calf grades (i.e., 17, 16, 15 Fancy; 14, 13, 12 Choice; 11, 10, 9 Good; 8, 7, 6 Medium; 5, 4, 3 Common; 2, 1, 0 Inferior).

Fat thickness of cows was measured using a Branson Model 12 Sonoray over the 12th rib, three-fourths of the distance from the backbone to the edge of the longissimus dorsi muscle. This position was located by palpation. On the same day that the cows were measured for fat thickness, they were weighed and visually scored for condition by a member of the Animal Husbandry-Veterinary Science Department.

III. METHOD OF ANALYSIS

Selection of an appropriate mathematical model that adequately describes biological relationships is extremely important. The incorporation of certain factors into a model is determined by the judgement of the researcher. The mathematical model considered to be appropriate to determine the relationship between change in fat thickness of the dam and calf weaning gain, type, and condition was,

$$Y_{ijk} = \mu + A_i + S_j + b_1 (X_1 - \bar{X}_1) + b_2 (X_1^2 - \overline{X_1^2}) + b_3 (X_3 - \bar{X}_3) + e_{ijk}$$

where,

Y_{ijk} = observed value for the k^{th} calf in the i^{th} age of dam and the j^{th} sex

μ = population mean

A_i = effect of i^{th} age of dam

S_j = effect of j^{th} sex of calf

b_1 = partial regression of Y on change in fat thickness

X_1 = change in fat thickness of the dam of the ijk^{th} calf

b_2 = partial regression of Y on squared change in fat thickness

b_3 = partial regression of Y on age of calf

X_3 = age of ijk^{th} calf

e_{ijk} = random error portion of value of ijk^{th} calf.

The permanent environmental factors of age of dam, age of calf, and sex of calf were included because of abundant evidence of their effects on the variation in calf performance. The interaction between the discrete main effects (age of dam X sex of calf) was believed to be of no importance because Butts (1966) working with data from this same herd found this interaction to be non-significant. Since the relationship between change in fat thickness of the dam and calf weaning performance was the prime consideration of this study, preliminary analyses were conducted to insure that variation in change in fat thickness was not due merely to the manifestation of correlation with factors the effects of which have been previously reported.

The effect of age of dam was shown to be a non-significant source of variation in change in fat thickness when measured by an analysis of variance, giving basis for the belief that the pattern of change in fat thickness was not peculiar to a cow age group.

The model which has been presented contains the linear and quadratic forms of change in fat thickness measured ultrasonically. However, change in cow condition score is another estimate of the change in a cow's body composition which is less difficult to obtain than the ultrasonic estimate. Therefore, this measurement was substituted into the mathematical model for comparison with the ultrasonic estimate. Change in cow weight should be another variable which reflects changes in a cow's body composition. However, the preliminary analysis indicated that changes in cow weight were highly dependent on cow age. Therefore, cow weight change was not substituted into the model reasoning that the advantage of cow weight change for explaining variation in calf weaning performance would be slight in the presence of age of cow.

If change in cow's body composition may be reasoned to be associated with maternal factors, then its effect on performance from birth to preweaning is of interest, as well as on calf performance from preweaning to weaning. Therefore, the calf traits at preweaning were analyzed using the model previously presented.

CHAPTER IV

RESULTS AND DISCUSSION

Means and standard errors are presented in Table II. The mean average daily gain from birth to preweaning was less than the mean rate of gain from birth to weaning. This indicated a pattern of weight increase which has been observed to be characteristic of this herd, but not of all experimental herds across the state. That is, gain from preweaning to weaning tends to be higher than the rate of gain from birth to preweaning. This is believed to be due, partially, to cooler late summer temperatures and more available pasture to the cows during the summer months of July, August, and September on the Cumberland Plateau than is the case in other areas of the state.

Of interest also are the increase in average calf condition score from 8.6 at preweaning to 9.3 at weaning, and the increase in variation of calf condition score as reflected by the increase in the standard error from 0.072 to 0.115. The overall coefficients of simple correlation among all cow and calf traits are presented in Table III and will be referred to throughout the discussion.

I. DISTRIBUTION OF VARIABLES

The frequency plots of some of the variables are presented to indicate their distribution.

TABLE II

MEANS AND STANDARD ERRORS OF TRAITS STUDIED

Trait	Mean	Standard error
Calf preweaning		
Average daily gain, lb./day	1.68	0.025
Type	12.0	0.085
Condition	8.6	0.072
Calf weaning		
Average daily gain, lb./day	1.82	0.019
Type	12.2	0.096
Condition	9.3	0.115
Age, days	205.5	2.18

TABLE III

COEFFICIENTS OF CORRELATION AMONG CERTAIN TRAITS STUDIED[a]

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Calf preweaning															
1. ADG	1.000	.442	.531	.819	.363	.367	.117	.110	-.018	.179	.147	-.080	.253	.297	-.122
2. Type		1.000	.396	.429	.670	.144	.066	-.045	-.142	.102	.016	-.111	.165	.122	-.143
3. Condition			1.000	.375	.413	.576	.141	-.016	-.204	.092	.029	-.087	.149	.146	-.097
Calf weaning															
4. ADG				1.000	.363	.253	.249	.192	-.097	.231	.199	-.101	.383	.440	-.193
5. Type					1.000	.241	-.004	-.069	-.076	.036	.025	-.008	.070	.087	-.030
6. Condition						1.000	.223	.176	-.081	.128	.267	.103	.148	.226	-.026
Cow traits															
7. April fat thickness							1.000	.282	.505	.698	.596	-.307	.756	.552	-.663
8. October fat thickness								1.000	.282	.505	.673	.021	.579	.544	-.401
9. Change in fat									1.000	-.328	.008	.432	-.318	-.087	.407
10. April condition										1.000	.646	-.633	.745	.584	-.618
11. October condition											1.000	.177	.586	.615	-.349
12. Change in condition												1.000	-.378	-.142	.449
13. April weight													1.000	.780	-.833
14. October weight														1.000	-.304
15. Change in weight															1.000

[a]Coefficient of 0.159 and 0.208 required for significance ($P < .05$) and ($P < .01$), respectively.

The distribution of cow weight is presented in Figure 1. The percentage of cows weighing under 800 lb. was greatly reduced from April to October. This is primarily a function of cow age as may readily be seen in Figure 2. Two-, three-, and four-year-old cows gained more weight from April to October than did their more mature counterparts. This is supported by the preliminary analysis of variance which indicated that age of cow explained a significant amount of the variation in weight change. Younger cows could be expected to gain weight since they have not reached their mature weight and therefore weight change in cows of this age group is a function of both growth and change in fatness. This is contrasted to the weight change of older cows which is primarily a function of change in fatness. The values for cow weight were obtained by adding to the overall mean the least-squares constants which were obtained from the preliminary analysis (Harvey, 1960).

In Figure 3 is presented the frequency plot of change in fat thickness as measured ultrasonically. Again, the normal distribution is implied. Of equal importance is the non-significant relationship between this variable and age of cow. This result is graphically presented in Figure 4 which indicates that change in fat thickness is not consistently affected, either in magnitude or in direction, by age of cow.

In the preliminary analysis, age of dam was not a significant source of the variation in change in cow condition score. The distribution of change in cow condition is suggested to be normal by the frequency plot (Figure 5). The simple correlation coefficient measuring the relationship between an ultrasonic estimate of change in fat

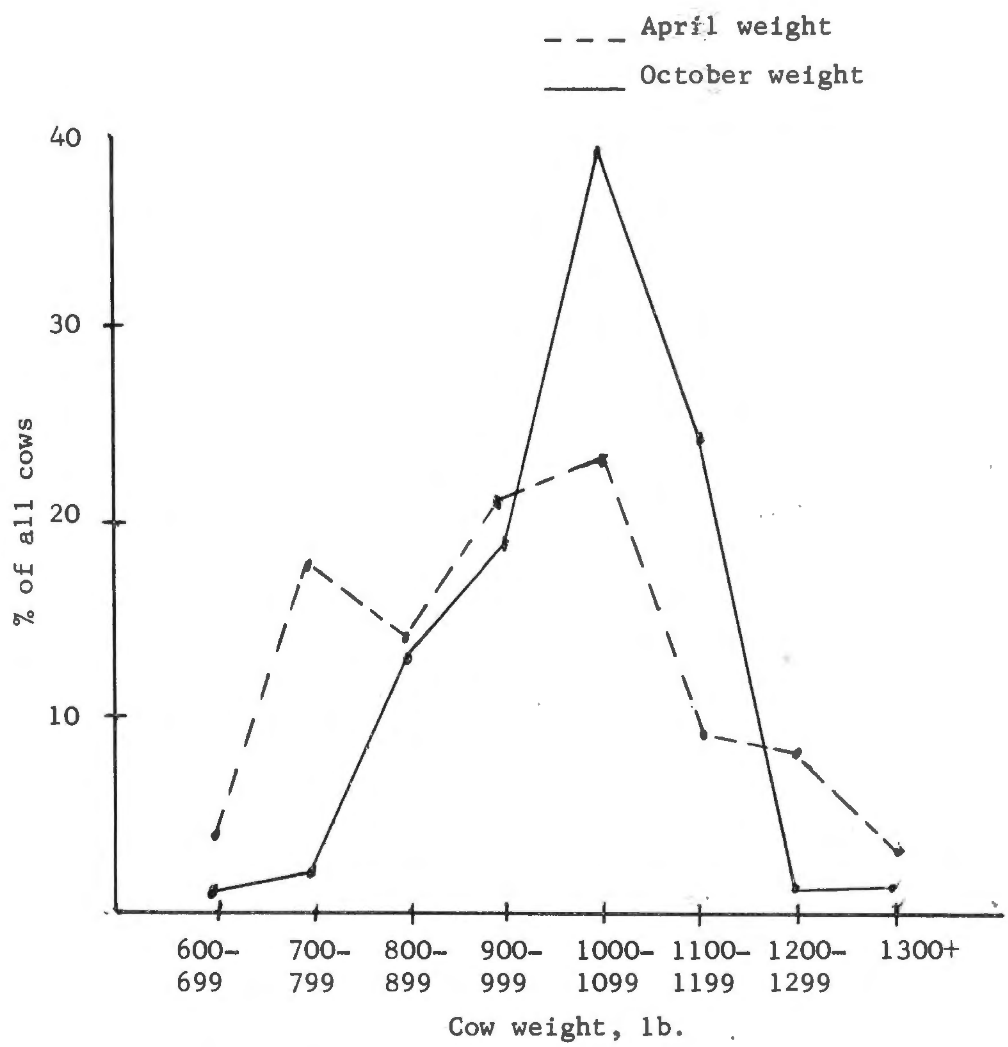

Figure 1. Frequency plot of April and October cow weight.

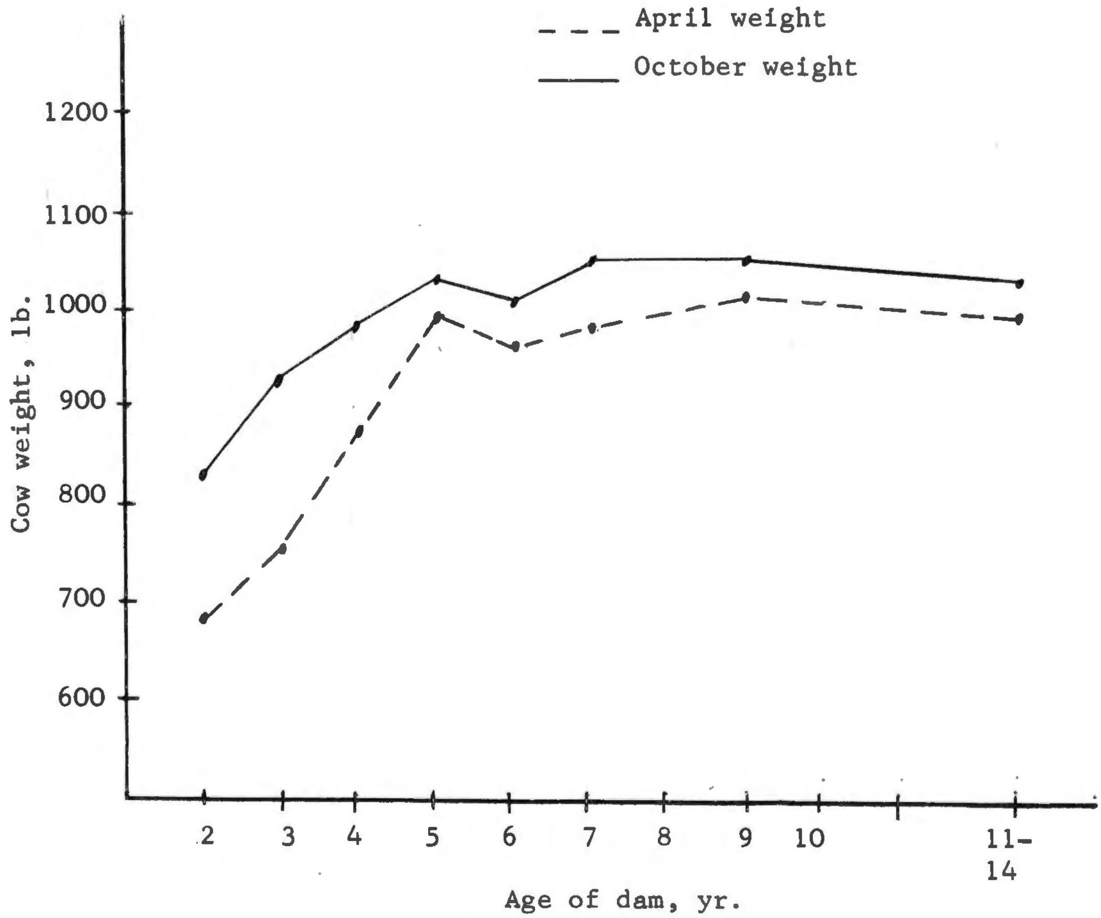

Figure 2. April and October mean weights for each cow age subgroup.

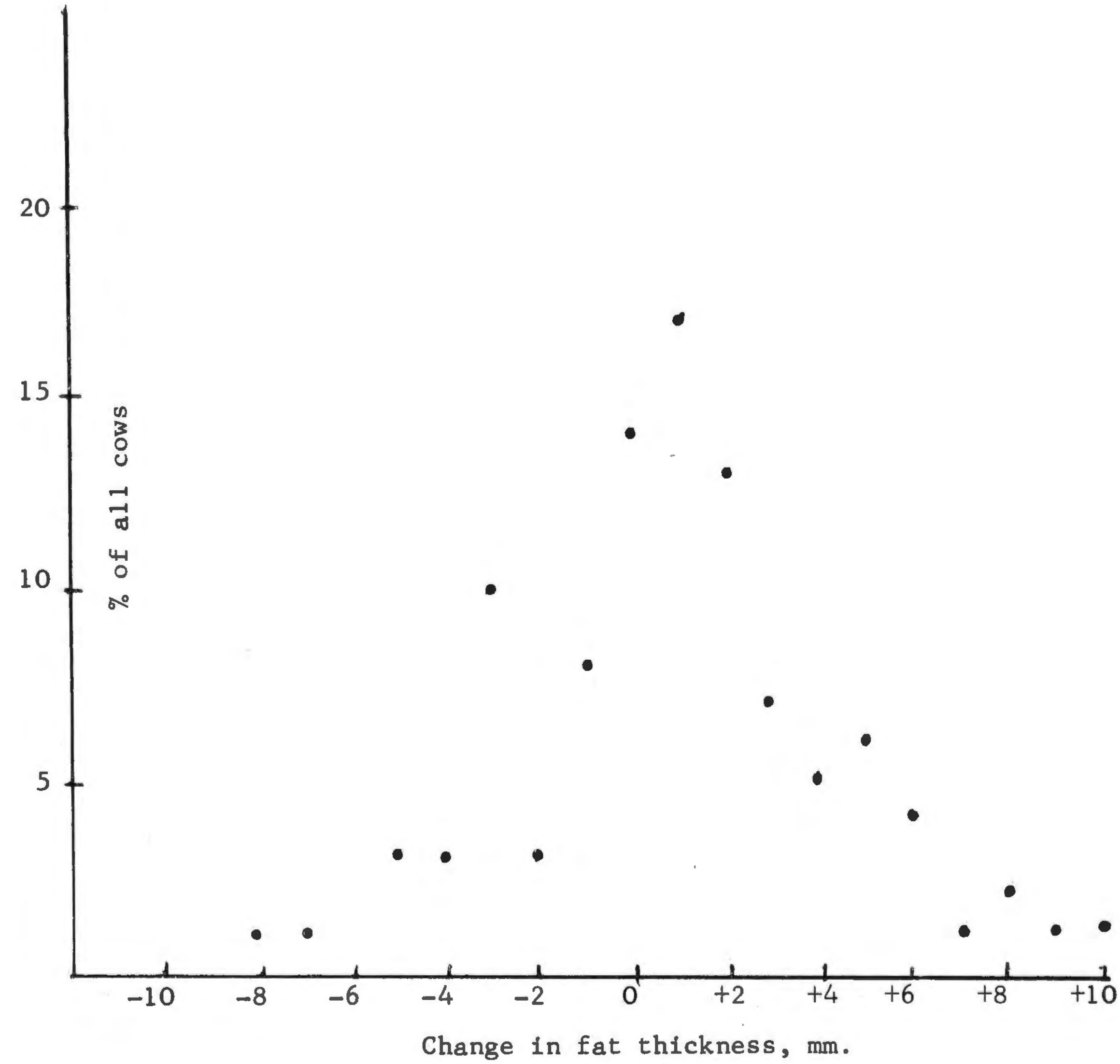

Figure 3. Frequency plot of change in fat thickness.

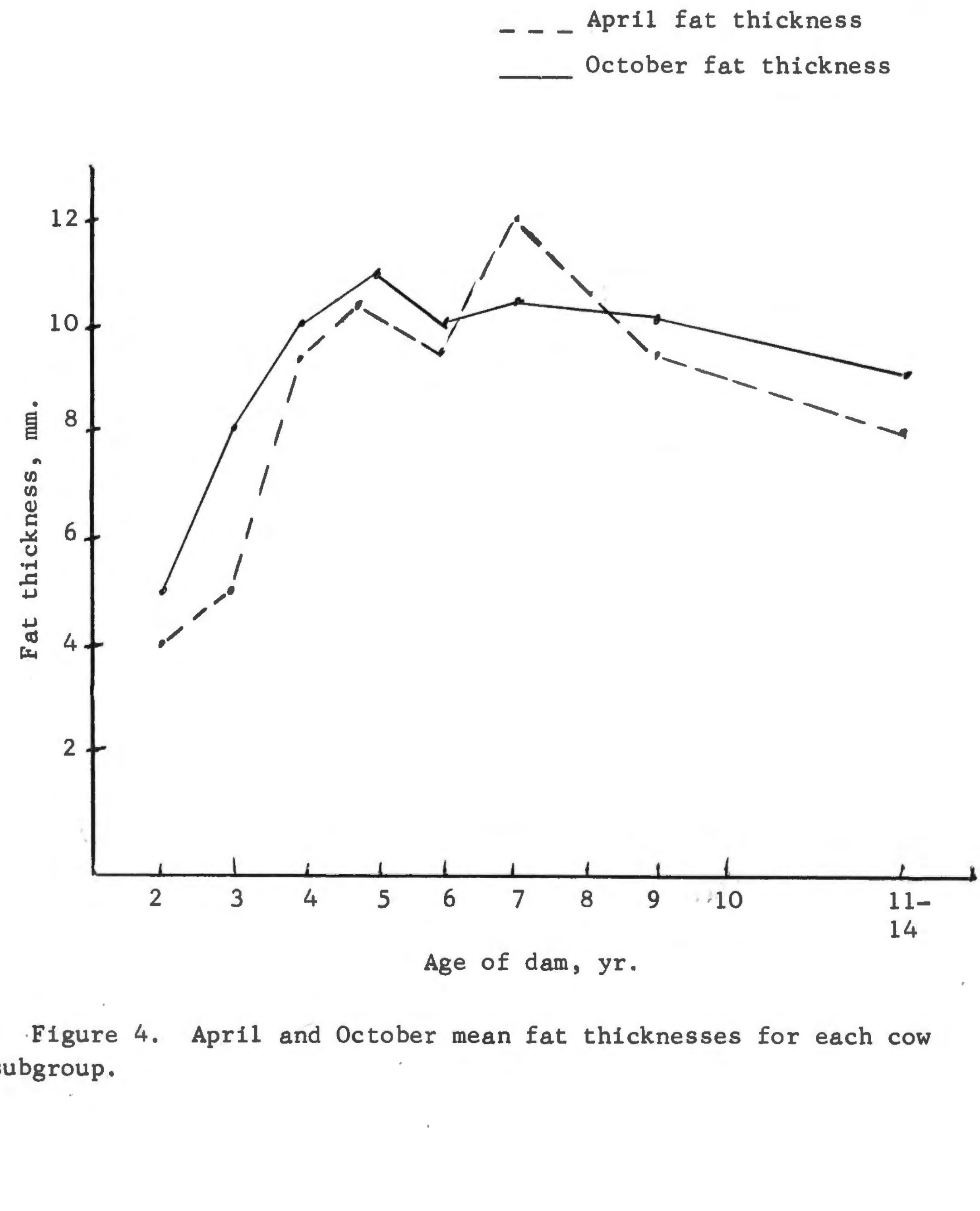

Figure 4. April and October mean fat thicknesses for each cow age subgroup.

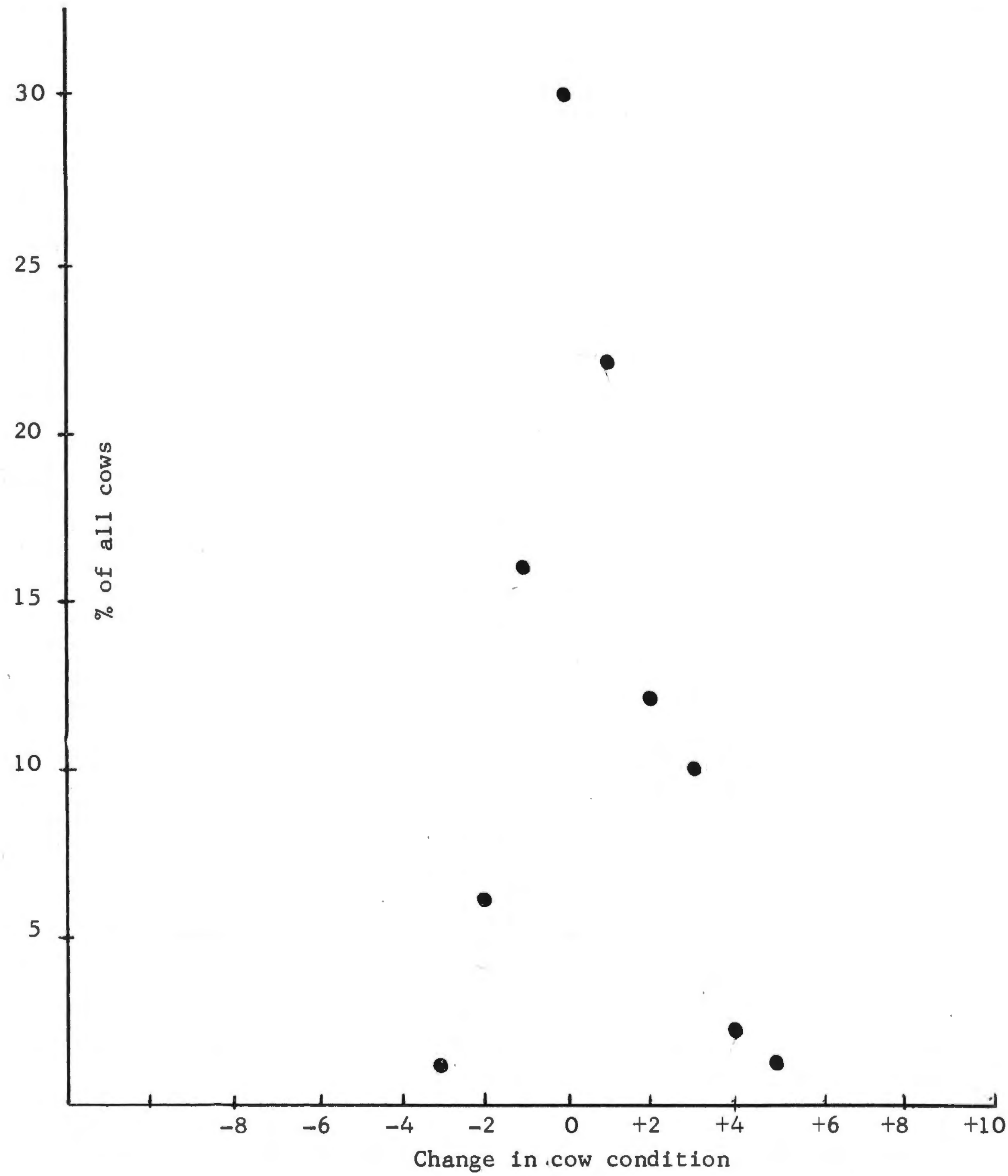

Figure 5. Frequency plot of change in condition of cows from April to October.

thickness and change in cow condition was 0.432. Even though scoring of cows visually was an attempt to subjectively evaluate differences in fatness, the magnitude of the coefficient of correlation indicates that agreement between these two estimates is far from perfect. However, the coefficient of simple correlation between ultrasonic fat thickness estimate and the visual condition score was 0.698 and 0.673 for the April and October estimates, respectively.

II. ANALYSIS OF CALF PREWEANING TRAITS

An analysis of variance of the preweaning traits is presented in Table IV. The ultrasonic estimate of change in cow fat thickness was included in the model for the first analysis presented.

As would be expected, age of dam and sex of calf were significant sources of variation in average daily gain of calves. These two independent variables were also significant sources of variation in preweaning type score. However, sex of calf was the only significant factor affecting calf condition score.

Standardized least-squares constants indicating the sex of calf effect on preweaning average daily gain, type, and condition are presented in Figure 6. The magnitude of these constants suggests that females possess more external fat but weigh less than males. However, the fact that male calves were deemed typier by the judges implies that variation in type score is not merely a reflection of condition even though these two variables are correlated ($r = 0.396$).

TABLE IV

ANALYSIS OF VARIANCE OF PREWEANING TRAITS STUDIED

		Mean Squares		
	d.f.	Average daily gain of calves	Calf type	Calf condition
Age of dam	12	0.18134*	2.10827*	.44431
Change in fat thickness	1	0.21768	.38817	.25958
$(\text{Change in fat thickness})^2$	1	0.22239	1.13720	.00548
Age of calf	1	0.11132	.07435	.13521
Sex	1	0.62746**	4.50389*	8.05558**
Residual	138	0.08395	.98038	.77249
R^2		0.225	.210	.146

*$P < .05$.

**$P < .01$.

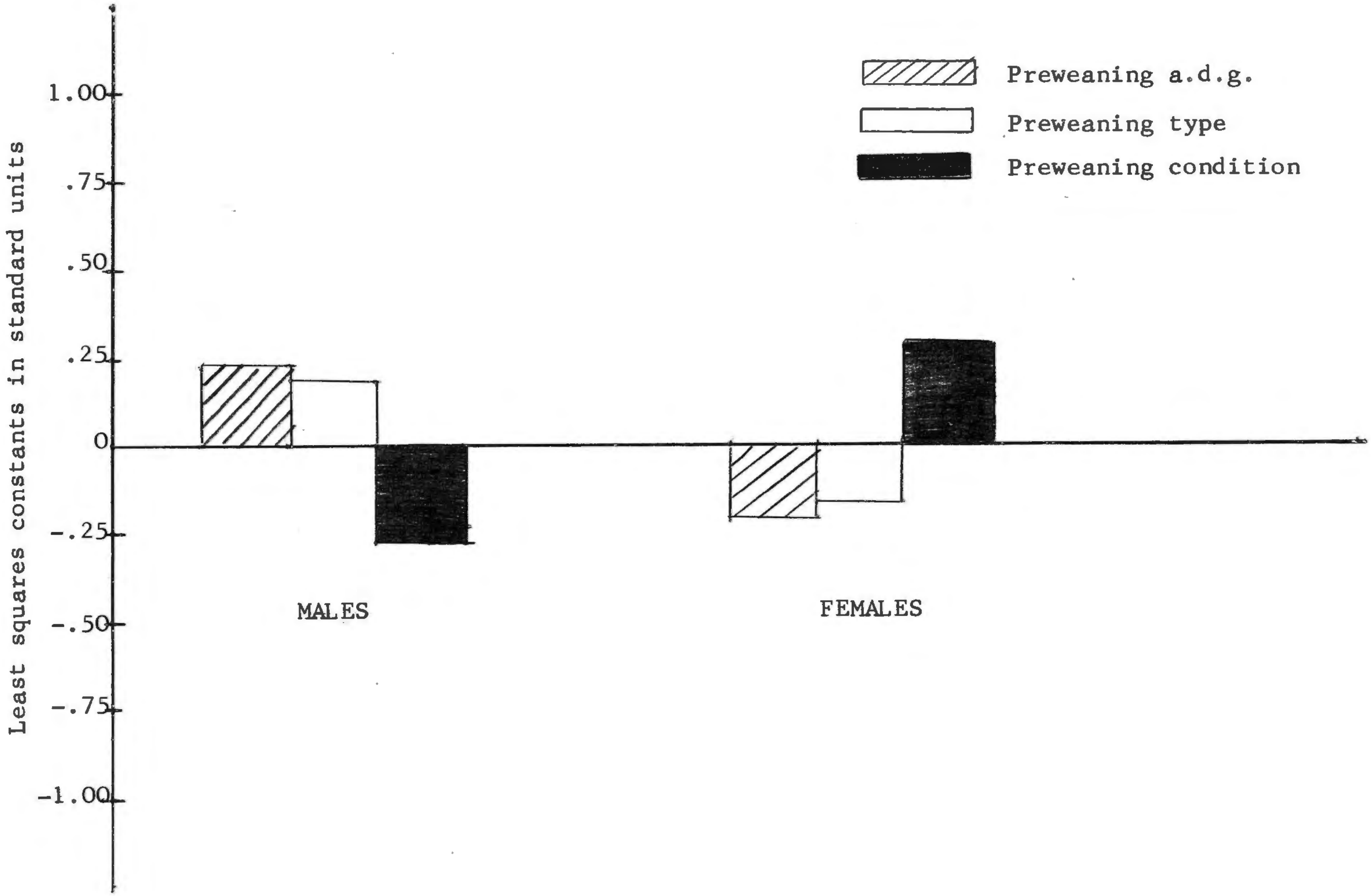

Figure 6. Least squares constants in standard deviation units for sex of calf effect on calf preweaning performance.

III. ANALYSIS OF CALF WEANING TRAITS

An analysis of variance for the weaning traits which were studied are presented in Table V. Again, age of dam and sex of calf were significant sources of the variation in average daily gain and condition score. The standardized constants for sex of calf are presented in Figure 7 and are in close agreement with the analogous constants for the preweaning traits.

However, change in fat thickness and squared change in fat thickness of the dam were declared significant sources of the variation in calf weaning condition score--the subjective estimate of overall fatness. The graph representing the calculated regression equation is presented in Figure 8. The minimum point of the curve is at 3.4 mm. of fat thickness change. Thus, cows which gained less than 3.4 mm. or lost external fat from April to October tended to wean fatter calves. Likewise, cows which gained in excess of 3.4 mm. would appear to have higher conditioned calves. However, there is no biological explanation for this latter assessment of calf condition, but is more probably an artifact resulting from the characteristics of a second degree polynomial.

Neither change in fat thickness nor its squared form significantly affected average daily gain of calves to weaning. On first inspection, there appears to be a contradiction because the arguments supporting the relationship between change in fat thickness of cows and their maternal ability should imply a relationship between change in cow fat

TABLE V

ANALYSIS OF VARIANCE OF WEANING TRAITS STUDIED

		Mean Squares		
	d.f.	Average daily gain of calves	Calf type	Calf condition
Age of dam	12	0.02936*	1.66930	1.11270
Change in fat thickness	1	0.00260	0.95383	10.03446**
(Change in fat thickness)^2	1	0.00357	1.27146	9.51520**
Age of calf	1	0.00101	0.15487	4.09896
Sex	1	0.27181**	0.13460	77.97740**
Residual	138	0.00769	1.42900	1.43390
R^2		0.390	0.107	0.376

*$P < .05$.

**$P < .01$.

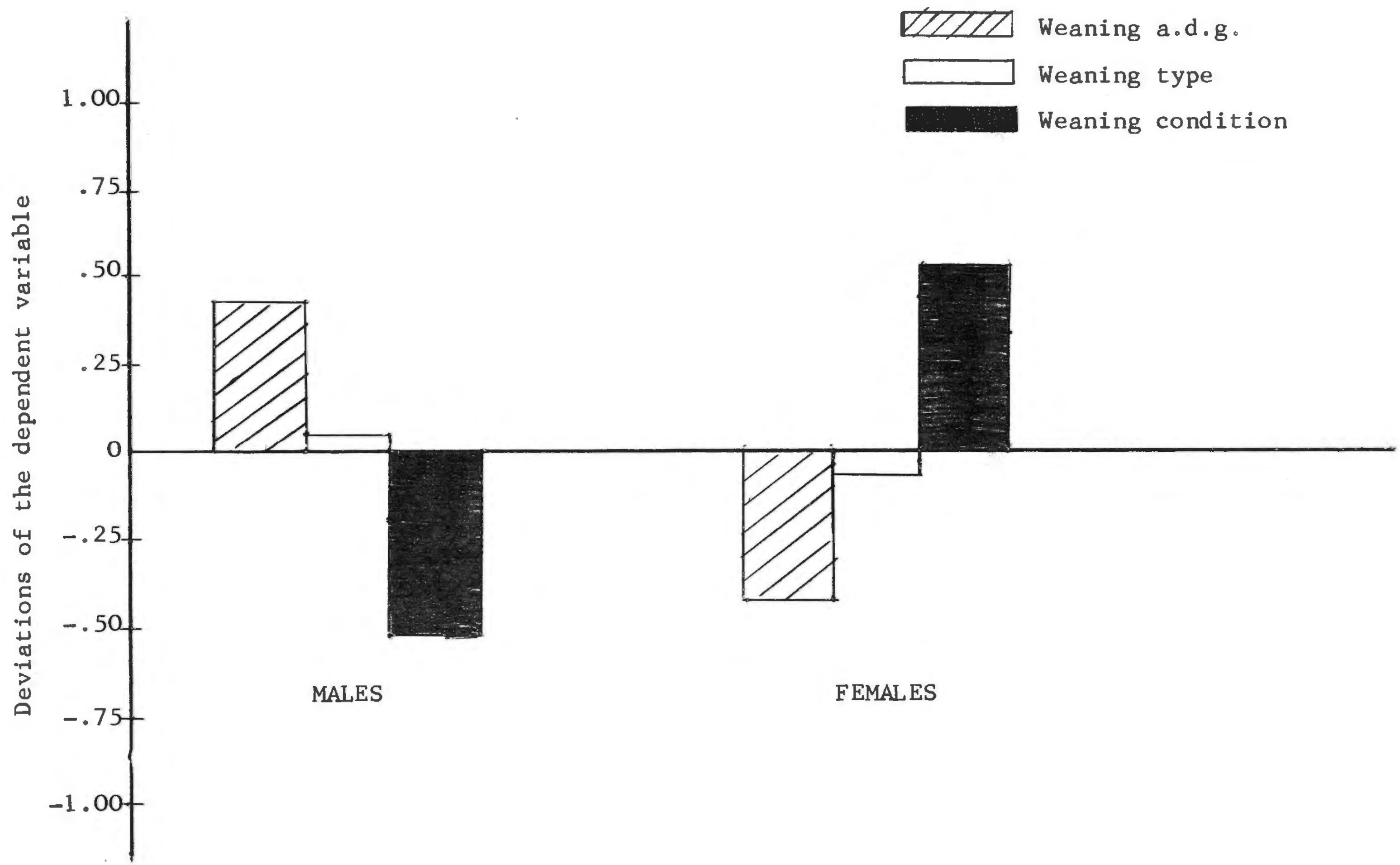

Figure 7. Least squares constants in standard deviation units for sex of calf effect on calf weaning performance.

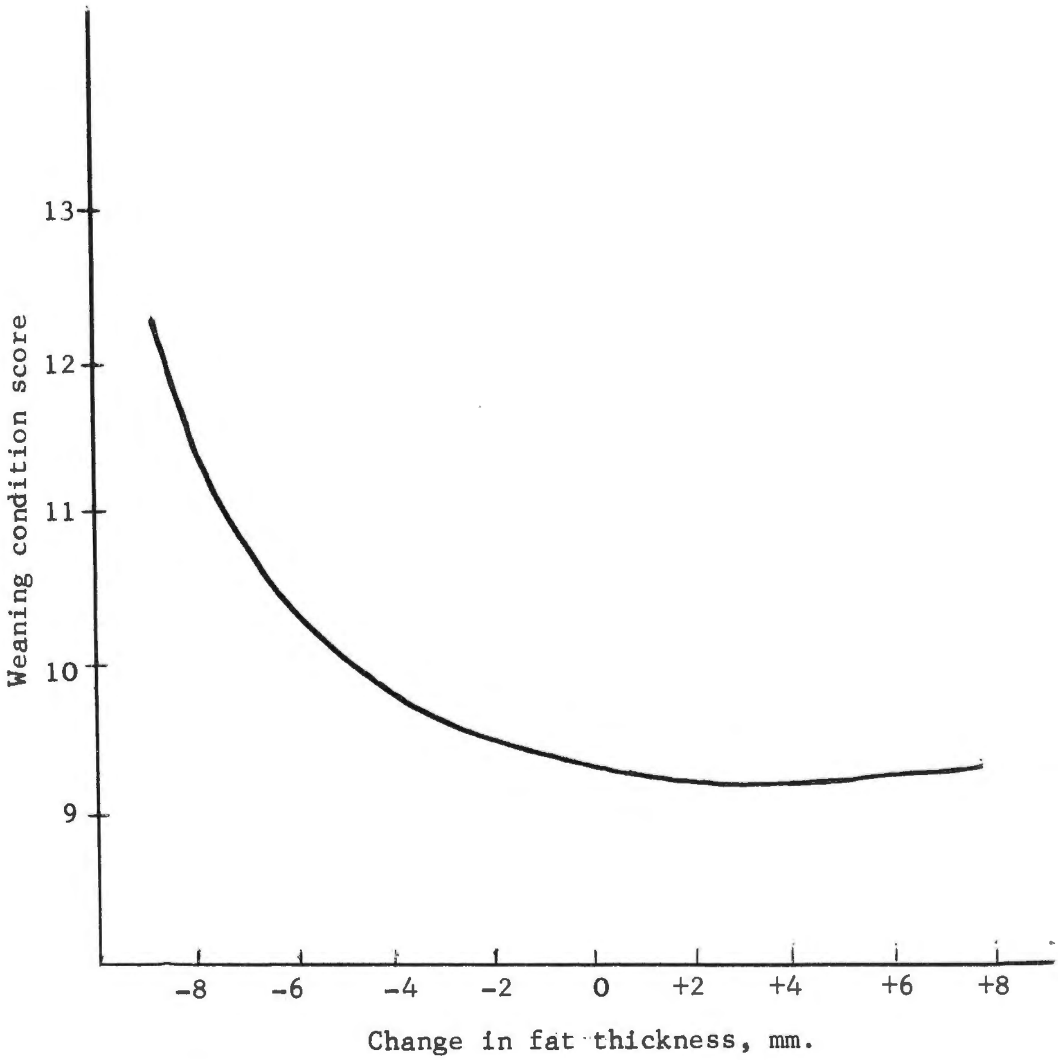

Figure 8. Relationship between change in fat thickness of the dam and calf condition score.

thickness and both calf gain and calf condition. On the other hand, if one accepts the theory that within the animal there exists an ordered demand for nutrients which is expressed through segregated rates of tissue deposition, such that nutrients are first available for growth and later available for fattening, then it would appear logical to assume that variation in average daily gain would not be influenced by differences in maternal ability except through the contribution of weight of fat to overall live weight. Butts (1966) working with data from this same herd found the heritability of weaning condition score to be near zero (0.02). He also stated that the maternal effect on variation in weaning average daily gain of calves was reduced by adjusting gain for its covariance with calf weaning condition score. After this adjustment, the heritability of average daily gain was increased from 0.31 to 0.44. He concluded that weaning condition score reflected more maternal environmental than genetic forces. Since change in fat thickness was deemed a significant source of the variation in weaning condition score, change in fat thickness of the cow promises to be a useful variable to define a portion of the environmental variation in calf gain caused by maternal differences. Of course, this reasoning is dependent upon the accessibility of pastures comparable to those at the Plateau station. For if the plane of nutrition available to the cow is so low that milk production is curtailed below the minimum amount necessary for maximum calf growth, then her change in fat thickness would probably be neither normally distributed nor a function of the cow's individuality but instead would become dependent upon the level of nutrition available to her. Even though change in fat thickness significantly affected weaning condition score, the percent of variation which change in fat thickness explained was not large enough to be immediately applicable to a practical breeding program. However, this relationship may be improved if condition of the calf at weaning also was measured objectively instead of subjectively. The possibility exists that an objective measure of calf condition coupled with a measure of the change in cow condition might be used to accurately partition increase in calf weight into gain due to growth and gain due to fat deposition. This should increase the precision of selection for growth at weaning.

The results of substituting change in cow condition score and its quadratic form for the linear and non-linear representation of change in ultrasonic fat thickness estimate in the mathematical model are presented in Table VI. The results are the same for weaning average daily gain and type score with age of dam and sex of calf significantly affecting daily gain and with none of the classes of effects affecting type score.

Although the ultrasonic estimate of fat thickness and condition score of the dam were highly correlated (r = 0.698 and 0.673 for the April and October estimates, respectively), change in condition score of the dam did not significantly affect weaning condition of the calf as did change in ultrasonic fat thickness. Possible explanation for this is that the error of estimate of visually estimated condition could have been relatively greater than the error of estimate for the

TABLE VI

ANALYSIS OF VARIANCE OF WEANING TRAITS STUDIED WITH CHANGE IN COW CONDITION SCORE SUBSTITUTED IN THE MATHEMATICAL MODEL

		Mean Squares		
	d.f.	Average daily gain of calves	Calf type	Calf condition
Age of dam	12	0.03202*	1.72836	1.84635
Change in condition score	1	0.02599	1.68898	1.73554
(Change in condition score)^2	1	0.02734	1.72113	2.15463
Age of calf	1	0.00072	0.05484	0.61501
Sex	1	0.26198**	0.14830	79.15257**
Residual	138	0.00762	1.43398	1.42510
R^2		0.406	0.104	0.379

*P < .05.

**P < .01.

sonoray readings, or that variation in cow condition score is composed of factors other than fat thickness. For the latter case, it is felt that the visual estimate of cow condition was biased by overall size of the cow such that a large-framed, mature cow tended to receive a higher condition score than a small-framed, younger cow of equal fat thickness. The ensuing result would be a proportionate increase in the mean square for age of dam in the second analysis over the first. However, even with this increased mean square, age of dam did not approach significance in the second analysis.

At the present time, the taking of ultrasonic measurements on an entire breeding herd, both cows and calves, presents certain problems--such as, training of the operator, cost of machine, and time required per measurement. However, it may be that systematic efforts to use ultrasonic measurements to train the eyes of observers to see more precisely the existing differences in fatness would result in a subjective scoring system which would be sufficiently improved in accuracy to be of practical value.

Since the cows represented in the current study were monitored for fat thickness only in April and October, a description of change in fat thickness within the pasture season is unattainable from these data. Reasoning from the fact that the standard deviation in calf condition score was increased from preweaning to weaning as well as knowledge of differences that exist in individual lactation curves, the possibility exists that fat thickness change within a specific portion of the grazing period may be more descriptive of maternal differences than the fat thickness change over the whole period.

thickness of the dam may be useful in explaining maternal variation which exists in beef cows. Thus, consideration of dam's change in fat thickness while selecting for increased growth rate may improve the precision of selection of individuals which are truly genetically superior.

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