A STUDY OF GROWTH RATE AND TYPE SCORE OF OFFSPRING OF FOUR DIFFERENT SIRES IN HEREFORD CATTLE

by

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INTRODUCTION

The question of evaluating beef bulls has been studied for many generations. The evaluating methods, however, have been studied scientifically only during the past two or three decades. In dairy cattle and poultry the female produces products that can be measured easily. This simplifies the problem of accurately testing the progeny of a given sire. In beef cattle, the evaluation of a sire must rest on his own performance or the performance of his offspring. His performance can be measured either by the eye or by a feeding test, or by a slaughter test or some combination of these. The problem of setting up accurate testing methods for evaluating breeding animals used primarily for beef becomes complex; especially when it is desired to use the animal for breeding purposes after tests are made.

There were many reasons for undertaking this work. One of the most important was that cattle breeders seemed to need this kind of information. Very little information is available which provides the breeder with practical methods of measuring type and performance for evaluating replacement stock in breeding herds.

The principal characteristics that determine a meat animal's value are growth rate, condition and body conformation. Condition or fatness is determined largely by the environment, while growth and body conformation depend to some extent on heredity. It would be relatively easy for breeders to obtain weights and scores for body type on all their calves up to weaning and on many of them up to a year or more of age. Studies of weights and type scores of calves raised by breeders are needed to determine the usefulness of such observations in a breeding program.

OBJECTIVES

The objectives of this study were as follows:

1. To study the growth rate and body type of calves of different sexes sired by unrelated bulls in the same herd.

2. To obtain estimates of heritability of growth rate and body type in Hereford cattle.

3. To measure the effect of date of birth on growth rate.

REVIEW OF THE LITERATURE

Black and Knapp[1] in a study of methods of measuring performance in beef cattle reported simple correlations between birth to weaning and weaning to slaughter of -0.36 for average daily gain and 0.06 for economy of gain. Animals which gained faster while on milk tended to gain slower after weaning. No significant relation between economy of gain from birth to weaning and economy of gain from weaning to slaughter was found. They stated that gain from birth to weaning was highly correlated with pounds of milk received during that period. They proposed that the test period be limited to a weight constant period of 500 to 900 pounds in live weight and that the final evaluation be based on efficiency of gain from 500 to 900 pounds and the carcass grade.

Black and Knapp[2] made a study of the results of progeny testing by the three methods proposed by Winters, Sheets and themselves. They found that differences in the progeny of various sires could best be demonstrated by efficiency of gain from 500 to 900 pounds, whereas differences in weight at twelve months of age were not statistically significant.

Winters[10] in a review of records of performance for meat animals suggests that, in view of present knowledge of performance in beef cattle, testing should be based on (1) birth weights, (2) rate of gain during the suckling period, (3) rate of gain or efficiency of gain during a standard weight period of 500 to 900 pounds, and (4) the animal's slaughter value.

Kroger and Knox[7] found that over a period of eight years testing 443 steers and 411 heifers, using corrected weights, the steers weighed an average of thirty-two pounds more per head at weaning than the heifers.

The difference in weaning weights of steers and heifers in their study was large enough to necessitate correction for sex in evaluating the progeny of different animals if numbers of the two sexes are disproportionate. If the numbers of calves per progeny were small, the error introduced by not correcting for sex was found to be appreciable.

Knapp, Lambert and Black[3] in a study of beef and milking Shorthorn cattle found that a large proportion of the variation in birth weights and weaning weights could be attributed to the weight of the cow, calving sequence, length of gestation period, and pounds of milk the calf received during the suckling period.

Knapp and Nordskog[4] in a study of the records of 177 steers, from 23 sires reported heritability of weaning weight at 30 per cent. Weights of heifers at eighteen months of age at Miles City indicate 61 per cent heritability. Daily gain of steers on record of performance at Beltsville, Maryland and Tifton, Georgia indicated heritability in excess of 100 per cent. The authors stated that these estimates of heritability were higher than seemed reasonable and that the cause or causes of these high estimates are not known.

Knapp and Nordskog[5] found the correlation coefficient between weaning score and weaning weight in beef cattle to be 0.68. They estimated heritability of weaning scores to be 53 per cent.

Knapp, Baker, Quesenberry, and Clark[6] in a four-year study of record of performance in Hereford cattle reported differences between sire progenies for weaning weight corrected for age and for daily gain in the feed lot to be significant once in four years. Differences in gain from birth

to weaning, corrected for age, was highly significant once in three years and not significant in the other two years.

Correlation coefficients for steers studied by Knapp, Baker, Quesenberry and Clark[6] were as follows: weaning weight with daily gain in feed lot, - 0.059; score at weaning with daily gain in feed lot, 0.092; age at weaning with weaning weight, 0.652.

Ruby, Blunn, Brouse, and Baker[8] in a nineteen year study of relation of initial weights and subsequent gains of weaning calves during the winter reported correlation coefficients as follows: spring weight on initial weight, 0.480 and winter gain on initial weight, 0.232.

EXPERIMENTAL METHODS

Source of Data

The data were obtained from the Ivy Hill Farm purebred herd of Hereford cattle. The entire calf crop born in the spring of 1948, consisting of seventy-six calves, furnished the data. All calves were scored for type at birth and weaning and most of the heifers again at fifteen months, of age. Weights were taken at weaning on all calves and on the heifer calves again at fifteen months of age. Practically all of the bull calves were sold shortly after weaning. Weights and scores were not taken on the few remaining bull calves because of the small numbers available. All weights were adjusted by regression of weight on age to standard ages of 240 days for weaning and 395 days for yearlings.

The dams of the calves in this study represent several bloodlines common to the Virginia purebred herds. For the purpose of this study, it was assumed that the cows mated to each sire were random samples of the cows in the herd. However, the matings which produced the calves in this study were made before this study started and were not random. Actually, of course, matings were made on the basis of past experience with respect to "nicking" and other such considerations. This may mean that differences in type between sire progenies include some differences between dams, but it is not apt to influence differences in growth rate.

The number of calves and their sex studied for each sire are shown in Table 1.

Table 1. Distribution of Calves Studied by Sire and Sex

	Males	Females	Total Calves Studied Per Sire
Sire 1	15	23	38
Sire 2	9	8	17
Sire 3	6	7	13
Sire 4	5	3	8
Total	35	41	76

Method of Scoring

In this study the method of scoring calves as to body type was that of visual observation. The value or score given each calf was determined by its type, quality, conformation and condition. The standard calf grades of prime, choice, good, medium, and common were used as guides in scoring the calves at weaning and as yearlings. By placing a plus and minus value on those calves that were believed to be slightly above or below a standard grade, it was possible to make a scale of measurement that was divided into fifteen grades with scores ranging from 1 to 15. The scoring was done by the author.

The scores used at weaning and as yearlings are shown in Table 2.

Table 2. Description of Scores With Their Gradation and Numerical Values.

Grade	Description	Gradations	Numerical Value
Prime	Short legged, short bodied good head, very smooth finish, very fine quality.	P+	15
		P	14
		P-	13
Choice	Moderately short legged and short bodied, good head, smooth finish, fine quality.	C+	12
		C	11
		C-	10
Good	Medium length legs and body, medium head, fairly smooth, good quality.	G+	9
		G	8
		G-	7
Medium	Long legs, long body, plain head, moderately coarse, and medium quality.	M+	6
		M	5
		M-	4
Common	Very long legs, slim body, long plain coarse head, coarse, rough, poor quality.	Com+	3
		Com	2
		Com-	1

This study was started after the calves were born, but a type score had been given each calf at birth. These scores at birth were fine, good, fair and poor. By giving scores numerical values of 15, 11, 7, and 3, respectively, it was possible to have them in approximately the same numerical range as the scores at weaning and as yearlings.

Method of Weighing

The heifer calves were weaned and weighed on November 9, 1948. They were weighed individually starting at 1 p.m. and finishing around 3:30 p.m. The tattoo number, weight, and score of each calf was recorded. The sire, dam, date of birth and sex of each calf was taken from the herd production books.

The bull calves were weaned and weighed November 13, 1948 with the same records kept as with the heifers.

After the heifer calves were weaned they were fed four pounds of grain per day until April 19, 1949 when the last observations were taken. Their roughage during the fall and winter was ladino pasture from weaning to January 10 and from February 20 to April 19. During the period from January 11 to February 19 they received corn silage and lespedeza hay in addition to the regular daily grain ration of four pounds per head.

ANALYSIS OF DATA

The analysis of variance, regression and correlation as outlined by Snedecor[9] was used in analyzing and interpreting the data. The linear regression of weight on age for heifers and steers was computed and used to adjust all calves to a standard weaning age of 240 days. An estimated weight at 395 days was obtained by adding the winter gain to the adjusted 240 day weight. The average linear regression for steers and heifers amounted to 1.67 and 1.57 pounds per day, respectively.

Heritability was estimated from intra-class correlation with the mean squares in the analysis of variance interpreted as follows:

Mean Square	Interpretation of Mean Square
Between Sires	$R + \bar{k}S$
Within Sires	R

$R = E + 3/4G$

$\bar{k}$ = Average number of calves per sire

$S = 1/4G$

E = Environmental variance

G = Genetic variance

Heritability = $H = \frac{G}{E + G}$

In this study the five per cent level of probability was considered significant and the one per cent level as highly significant.

RESULTS

Body Type

The average type scores in Table 3a show differences between bulls that tend to hold somewhat the same relative position at all three ages with the exception of Sire 3 whose heifers scored much lower at the end of the winter feeding period than at the other ages. This suggests that some bulls may sire calves whose type changes with age, while others sire calves that hold about the same type at the three ages studied here. If this is the true picture, then more accurate data would be obtained by scoring calves at different ages.

This view is supported by the following correlation coefficients:

Correlation between score at birth and weaning = 0.73

Correlation between score at birth and fifteen months = 0.12

Correlation between score at weaning and fifteen months = 0.62

These correlations show a fair degree of relationship between scores approximately six months apart, but very little relationship when they were as much as twelve months apart. Therefore, it appears that the two scores of these three which would be more valuable are those taken at birth and at one year of age.

Table 3a. Average Score for Body Type by Sire and Sex at Three Ages

	Birth		Weaning		Fifteen Months
	Males	Females	Males	Females	Females
Sire 1	12.21	12.72	10.80	11.34	11.7
Sire 2	10.56	11.44	8.00	10.87	10.3
Sire 3	11.58	12.54	8.16	11.14	8.8
Sire 4	10.26	11.00	7.80	9.00	9.3

Measureable differences between sire progenies seem to be greatest at birth and to decrease with age. The analysis of variance (Table 3b) shows bull differences to be highly significant at birth, significant at weaning and non-significant at fifteen months of age.

Table 3b. The Analysis of Variance of Score for Body Type at Birth, Weaning and Fifteen Months of Age.

Source of Variance	Birth		Weaning		Fifteen Months	
	Degrees of Freedom	Mean Square	Degrees of Freedom	Mean Square	Degrees of Freedom	Mean Square
Between Sires	3	15.7**	3	10.3*	3	4.0
Between Sex	1	17.0*	1	7.0	0	--
Sire X Sex Interaction	3	0.66	3	4.0	0	--
Residual	68	2.46	59	3.5	34	4.2

** Highly Significant
* Significant

Estimates of heritability of type based on scores at birth and at weaning were 88 per cent and 40 per cent, respectively. The latter estimate is in general agreement with Knapp and Nordskog's[5] estimate of 53 per cent for score at weaning.

Growth Rate

The average weights (Table 4a) show the same sires to be high and low for both sexes, but with the difference much greater for the males (59 pounds) than for the females (11 pounds). Considering the information on average weights at standard ages the sires line up as to growth rate of calves from highest to lowest as 4, 1, 3, 2. The mean square between sires (Table 4b) is not significant and indicates that sire differences for weaning weight may have been due to chance.

Table 4a. Average Adjusted Weights and Gain of Calves by Different Sires

	Average Weight 240 Days		Average Weight 395 Days	Gain
	Males	Females	Females	Females
Sire 1	524.8	452.8	601	148
Sire 2	501.8	450.6	597	146
Sire 3	524.8	454.4	590	136
Sire 4	559.8	461.6	601	140
Averages	523.8	453.2	598	145

The mean square (Table 4b) between sex showed sex differences to be highly significant. This was somewhat higher than Kroger, Marvin and Knox[7] found. Studying a total of 850 calves, using corrected weights, they reported the bulls averaged thirty-two pounds more than heifers.

The negative mean square for sire by sex interaction was unusual and seems due to the unequal number of calves in the sire-sex subclasses. An examination of this interaction based on subclass averages indicated that

the sire-sex interaction was insignificant.

The differences in gain the heifers made during the winter feeding period was not significant. This was thought to be due to feeding a limited ration, thereby not allowing the individual genetic abilities to show up.

The results of correlation of two items during the feeding period were as follows:

1. Weaning weight and daily gain during the winter feeding period -0.39
2. Score at weaning and total gain during winter feeding period -0.40

Table 4b. The Analysis of Variance of Adjusted Weaning Weights

Source of Variation	Degrees of Freedom	Mean Square
Between Sires	3	4,436
Between Sex	1	91,125**
Sire X Sex	3	- 782
Residual	67	3,193

** Highly Significant

Although the mean square for differences between sires in the analysis of variance was not significant and may have been due to chance variations, it does offer a basis for estimating heritability of weaning weight. This estimate was as follows:

Mean Square Between Sires $4436 = E + 3/4G + 18.7(1/4G)$

Mean Square Within Sires $3193 = E + 3/4G$

$1243 = 18.7\ (1/4G)$

$G = \frac{4(1243)}{18.7} = 266$

$E + 3/4G = E + 200$

$E = 3193 - 200 = 2993$

$H = \frac{266}{2993 + 266} = \frac{266}{3259} = .08$ or 8 per cent

This estimate of heritability of weaning weight is similar to that of Knapp, Lambert and Black[3], who estimated heritability for weaning weight in calves at twelve per cent; but is much smaller than that of Knapp and Nordskog[4] who estimated heritability of weaning weight at thirty per cent.

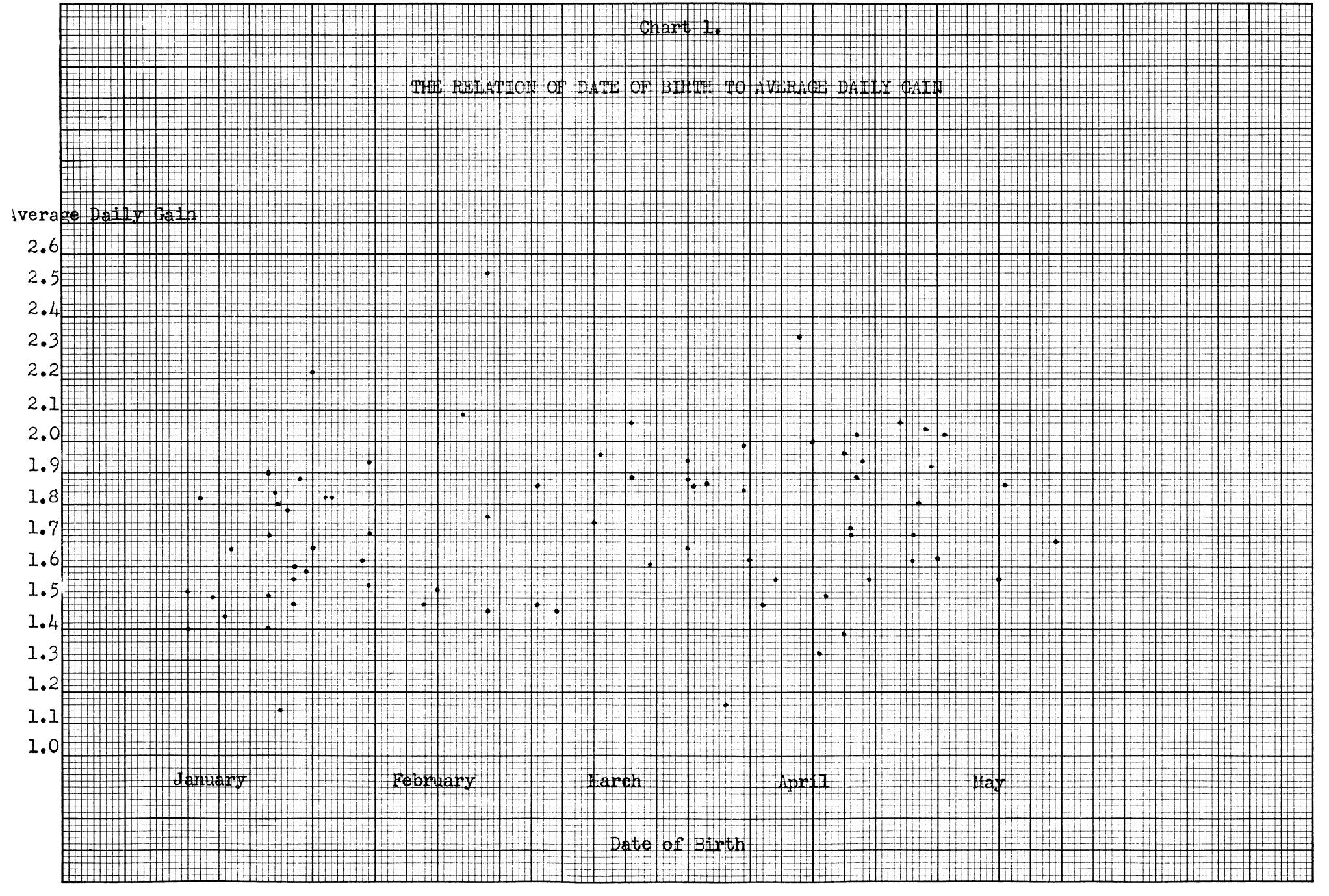
The Effect of Season of Birth on Growth Rate

The theory that the earlier calves are born, the faster they gain, is prevalent among many cattle growers. Working with several calf crops, the author of this study observed that calves born in late spring and early summer months seemed to start growth quicker and gain faster than calves born in the winter months. It was, therefore, one of the aims of this worker to examine the data on the group of calves being studied in the light of the above theory and observations.

The average daily gain of all calves, disregarding sire and sex, plotted against date of birth is shown in Chart 1.

Chart 1.

THE RELATION OF DATE OF BIRTH TO AVERAGE DAILY GAIN



The linear regression of average daily gain on date of birth within sire and sex was 0.00075 ± 0.00062 pounds per day. This regression is not significantly larger than its error term, but it does suggest that January and February calves may grow slower than April and May calves. A comparison on average daily gains of early, intermediate, and late calves showed differences similar to the regression. If the regression found in these data are used, the expected average daily gain and differences in weight at 240 days for calves born on certain selected dates is as follows:

Date Born	Expected Average Daily Gain	Expected Difference in Weight at 240 Days of Age
January 10	1.67	0
March 14	1.72	12
May 29	1.78	26

It is pointed out that the above comparisons are on the basis of a standard weaning age of 240 days. In actual practice, weaning is usually done by date rather than by age of calf, provided the calf is old enough to wean. Even though a January calf gains slower than a May calf, the January calf will be heavier and perhaps more profitable than a May calf when both are weaned and sold, say October 15.

DISCUSSION

The type scores for the calves taken at birth were highly significant. The author believes that this particular time in a calf's life may be very important in determining the sire differences between bulls. Knapp, Lambert and Black[3] concluded that there was little or no variation in birth weight due to environmental differences among dams. If this is true, then calves are likely to have been nourished near optimum during the gestation period and, therefore, carry somewhat the same amount of flesh at birth. These differences in type would be due mostly to differences in conformation rather than differences in fatness.

At weaning there will be much variation in fatness due to differences in milking abilities of the dams and other environmental influences. These views are supported by the heritability estimates for type scores at birth and at weaning. It seems from this study that rather accurate selections for type can be made at early ages.

Growth rate as measured in this study was based on weight of all calves taken at weaning and a second weight on heifers taken approximately six months after weaning. Weaning weights were corrected to a standard age on the basis of regression of weaning weight on age. If correction factors similar to those available for swine[(1)] which could be used to correct weights to a standard age were available, it is believed that growth rate would have been measured more precisely. It is recommended that future studies on growth rate give consideration to the development of age correction factors for calves at weaning. If such factors were available to

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(1) Whatley, J. A., Jr., and Quaife, E. L., "Adjusting Weights of Pigs to a Standard Age of 56 Days", Iowa Agr. Expt. Sta. Journal Paper No. J-509, Project No. 32.

breeders, the use of weaning weights in a selection program would be simplified.

The regression of rate of gain on date of birth for calves born at different dates in the spring calving season was not significantly different from zero. However, it is believed that the trend was sufficient to warrant further study.

It is believed that further investigations of the values of type scores at birth and at other ages is needed. If it should be studied further, it is suggested that a committee of scorers be used rather than only one scorer as was used in this study and that scores be obtained on the animals at ages beyond one year.

CONCLUSIONS

1. Weaning weights of calves in the same herd sired by four unrelated bulls were not significantly different.

2. Heritability of weaning weight was estimated at 8 per cent.

3. Calves born in late spring and early summer tended to gain faster than calves born during the winter months. The regression of average daily gain on date of birth was 0.00075 ± 0.00062 pounds per day.

4. Male calves were heavier at weaning than females. The average differences in this study was 70 pounds.

5. Differences in type scores of calves in the same herd sired by four unrelated bulls was highly significant at birth, significant at weaning, and not significant at approximately fifteen months of age.

6. Estimates of heritability of type scores at birth, at weaning and at approximately fifteen months of age were 88, 40 and 14 per cent, respectively. It appears that type scores taken at birth offer distinct possibilities for the measurement of genetic differences among animals with regard to body conformation.

7. On the average, heifer calves scored higher than bull calves at bith and at weaning, but the difference was not significant.

SUMMARY

A study of growth rate and body type of calves of both sexes; estimates of heritability of growth rate and body type; and the effect of date of birth on growth rate was made on 76 calves in the same herd sired by four unrelated bulls. The calves were scored for body type at birth, weaning and the females at approximately fifteen months of age. All calves were weighed at weaning and the females at approximately fifteen months of age. The females were fed a limited ration from weaning until the fifteen month weight was taken. The weights of the calves were adjusted by regression to 240 days at weaning and 395 days as yearlings.

The analysis of variance, regression, and correlation were used in the analysis and interpretation of the data. Heritability of weaning weight and type score was estimated from intra-class correlations obtained from the analysis of variance.

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APPENDIX

Complete Data as Collected in the Field

Sire 1 — Heifers

Calf Number	Date Born	Weaning		Yearling		Score		
		Age	Weight	Age	Weight	Birth	Weaning	Fifteen Months
3	1/10	293	480	454	690	11	13	14
4	1/10	293	515	454	640	11	13	13
5	1/12	291	600	452	725	11	13	12
8	1/16	287	495	448	690	11	11	14
15	1/24	279	580	440	855	15	14	14
17	1/25	278	350	449	530	11	10	10
20	1/27	276	490	428	610	15	12	10
24	1/30	273	520	434	665	11	13	12
26	2/3	269	560	—	—	11	12	—
30	2/9	263	520	424	610	15	12	10
33	2/9	263	580	424	680	11	12	11
40	3/6	238	420	—	—	11	11	—
43	3/9	235	410	—	—	15	9	—
52	4/6	207	320	368	540	7	8	10
55	4/10	203	405	364	510	15	13	12
59	4/12	201	370	—	—	11	10	—
60	4/21	192	325	353	490	15	9	13
62	4/25	188	330	—	—	15	11	—
64	4/26	187	390	348	550	11	10	9
65	4/26	187	400	348	555	11	11	11
66	4/27	186	450	—	—	11	12	—
68	4/28	185	430	—	—	15	10	—
73	5/6	177	370	338	495	11	12	12

Sire 1 - Bulls

1	1/10	308	660			11	7
6	1/12	306	780			15	13
9	1/17	301	570			15	12
10	1/23	295	515			11	12
18	1/26	292	590			11	11
44	3/16	243	540			15	12
45	3/21	238	560			15	11
46	3/21	238	520			11	9
48	3/30	229	500			11	9
50	4/1	227	510			11	8
53	4/9	218	500			11	11
70	5/4	194	470			11	7
74	5/8	190	460			11	8
76	5/10	188	375			11	10
79	5/21	177	400			11	6

Sire 2 - Heifers

Calf Number	Date Born	Weaning Age	Weaning Weight	Yearling Age	Yearling Weight	Score Birth	Score Weaning	Score Fifteen Months
12	1/23	280	465	441	650	11	8	9
23	1/29	273	505	434	595	11	12	10
34	2/18	254	435	415	600	11	11	11
35	2/20	252	455	—	—	11	11	—
57	4/14	199	380	—	—	11	11	—
61	4/22	191	370	352	550	15	11	11
63	4/25	188	440	349	585	11	11	11
67	4/27	186	420	347	530	11	12	10

Sire 2 - Bulls

16	1/24	294	600			11	8	
47	3/30	229	500			11	11	
49	3/30	229	450			11	8	
54	4/9	219	475			11	11	
56	4/20	208	485			7	7	
71	5/6	192	390			7	7	
75	5/9	189	425			11	7	
77	5/11	187	450			11	8	
78	5/20	178	350			7	5	

Sire 3 - Heifers

19	1/27	276	480	437	650	15	12	10
21	1/27	276	505	437	615	15	13	10
27	2/3	269	560	430	710	11	12	8
29	2/8	264	500	—	—	15	14	—
37	2/28	244	425	405	540	15	13	8
69	4/25	184	360	345	510	11	7	8
82	5/29	154	330	315	450	7	7	9

Sire 3 - Bulls

7	1/14	304	515			11	11	
13	1/23	295	570			11	6	
14	1/23	295	635			11	7	
22	1/28	290	610			11	6	
36	2/24	263	620			15	11	
58	4/18	210	560			11	8	

Sire A - Heifers

Calf Number	Date Born	Weaning Age	Weaning Weight	Yearling Age	Yearling Weight	Score Birth	Score Weaning	Score Fifteen Months
32	2/9	263	475	424	595	11	9	11
41	3/6	238	495	399	620	11	11	11
80	5/24	159	325	320	500	11	7	7

Sire A - Bulls

25	1/31	287	705			11	10	
38	2/28	259	730			11	7	
39	2/28	259	530			11	7	
51	4/1	258	530			7	8	
72	5/6	222	450			11	7	