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To the Graduate Council:

I am submitting herewith a thesis written by Robert Alexander Reynolds entitled "The Evaluation of Beef Sires on the Production of their Daughters". 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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THE EVALUATION OF BEEF SIRES ON THE PRODUCTION OF THEIR DAUGHTERS

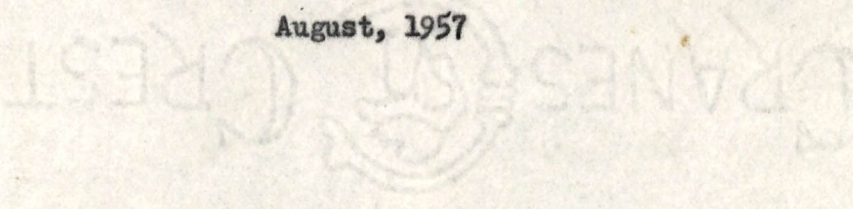
A THESIS

Submitted to
The Graduate Council
of
The University of Tennessee
in
Partial Fulfillment of the Requirements
for the degree of
Master of Science

by

Robert Alexander Reynolds

August, 1957



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INTRODUCTION

New production testing techniques are tools which may be used by the breeder as an aid in developing superior lines of beef cattle. They provide the breeder with some objective criteria to work with in addition to the visual type standards that have been widely used in the past. Management practices used by dairy farmers permits production records to be secured with very little additional labor and cost. In fact, it has been so easy that all the major breeds have incorporated performance records into the pedigrees of the animals and published lists of sires that have been proven on the performance of their progeny.

Much data have been accumulated at the various colleges and experiment stations on the performance of beef bulls. Most of the information, however, has been obtained in estimating the heritability of feed lot gains of beef sires. It is essential in the production of beef to have individuals that will make rapid economical gains on feed but it is also important in the future productivity of the cow herd to use sires whose daughters have good mothering ability. The problem of selecting beef sires based on the performance of their daughters is further complicated by the "yardstick" that is used to measure differences. In beef cattle, the growth of the calf is used to measure the milking ability of the cow, but the calf itself is not only affected by the environment, including milking ability, of the dam but by its' inherited ability to grow as transmitted by both its' dam and sire. The problem is complicated because of the factors mentioned above, and also by the time interval between generations, which is considered to be approximately

five years for beef cattle. Therefore, by the time a bull is proven superior or inferior on the basis of the performance of his progeny his period of usefulness is materially reduced.



LITERATURE REVIEW

Patterson et al. (1949) considered rate and efficiency of gain, along with reproductivity, the most important factors in economic beef production and found sire groups to have wide variability in rate of gain. Patterson reported a heritability estimate of 53 per cent for feed lot gain.

Koch and Clark (1955) in data from the Range Livestock Experiment Station, Miles City, Montana gave the following estimates for heritability and repeatability, respectively: birth weight, .35 and .26; weaning weight, .24 and .34; gain from birth to weaning, .18 and .22; and gain from weaning to yearling age, .39 and .09. They found a correlation of .46 between birth weight and gain to weaning, but found no correlation between gain to weaning and subsequent gains. They also concluded that maternal environment is quite important for birth weight, gain from birth to weaning and weaning score but was of little importance for yearling gain and score.

Warwick and Cartwright (1955) found heritability of rate of feed lot gain to be 54 per cent by the method of regression of parent on average offspring using gain ratio. They concluded that selection for rate of gain will be effective when the individual's own record is used.

Rollins and Guilbert (1954) studied the relationship between rate of growth from birth to four months and from birth to weaning. The results indicated that this method could be used satisfactorily to predict a cow's future production where it is used as a part of a system for se-

lecting replacement cows in the case of those cattlemen that veal a heifer's first calf.

Botkin and Whatley (1953) concluded that considerable progress could be made in the selection of cows on the basis of their first record, particularly by using weaning weights. Estimates of repeatability for weaning weights by two different methods were 0.43 and 0.49.

Knapp and Clark (1950) by sire-offspring regression methods gave estimates of heritability for final weight at 15 months of 92 per cent and concluded that heredity was very important in the determination of growth after weaning.

Dawson et al. (1954), in a study of selection for heavy six months' weight in herds in which the calves were sold at weaning for slaughter, obtained heritability estimates of six months' weight of zero from sire-offspring regressions and paternal half-sib correlations of immediate offspring and from 5-15 per cent based on dam-offspring regressions. Paternal half-sib correlations among daughters of the sires used and based on weights of calves raised by daughters gave a heritability estimate of 19 per cent. These figures indicate the importance of maternal ability in determining six months' weight of calves and suggest they are heritable traits. Their selection procedures were as follows: (1) retain a high percentage of heifers for one or two calf crops and retain those that demonstrate their ability to wean heavy calves; (2) select sires from among sons of cows which have repeatedly demonstrated their ability to wean heavy calves; and (3) where possible, use sires whose daughters have proven to have good maternal abilities.

Johnson (1945) found no justification for selecting proved sires on the uniformity of get in any character which depends upon several gene pairs and is not highly heritable.

Hazel and Lush (1942) found that the total score method was more efficient than independent culling levels or the tandem method of selection.

Gilmore (1952) in discussing indexes for dairy sires based on their progeny records gives several criteria that should apply to the daughters used in indexing bulls. There should be a random sample of the bulls daughters to prevent a distorted picture of the sires production ability that is transmitted to the daughters and at least five daughters should be tested for a preliminary index with ten being preferred.

Lush (1933) discussed indexes used by dairymen for the proving of dairy bulls and gave the advantages and disadvantages of each. The most commonly used are the daughter average and equal parent index. The daughter average, as he suggests, is slightly simpler, utilizes information of all the daughters, and will be less variable than the records of the dams; however, errors in environment are likely to be greater than with the equal parent index. The equal parent index is based on the assumption that the progeny inherits equally for production from its parents and, therefore, is between the two parents. The advantage over the daughter average is that it removes errors arising from differences in the productiveness of the cows to which each bull is bred, also the range is likely to be more nearly like that of the cows actual records. The main weakness is that it is easier to select records for this index

and there is more variation in the sires than is actually true of their genotype since the extremely low ones are probably better than they are shown and the extremely high ones are not likely to be this high.

Shrode and Lush (1947) proposed the method of regressing the bull index toward the breed average to be a better evaluation of the probable breeding value of the bull as compared to the equal parent index.

Rice (1944) suggested regressing indexes of dairy bulls one-half way back to the breed average when using the equal parent index:

$$\text{Sire Index} = \frac{\text{Equal Parent Index} + \text{Breed Average}}{2}$$

His reason for this regression is that in factors like milk production, which are subject to environmental changes, the phenotype does not truly represent the genotype of the individual and that animals producing toward the extremes are less likely to be mated to animals as extreme as themselves.

OBJECTIVE

The objective of this study was to evaluate the performance of a group of beef cattle sires used in the UT-AEC Agricultural Research Program by comparisons among sires of (1) the average production of their daughters and (2) equal parent indexes as determined by daughter-dam comparisons.

GENERAL

History of the Herd

The cow herd at the UT-AEC Agricultural Research Program originated from a group of forty-one grade Hereford cows that were accidentally exposed to radioactive fallout of the first atomic bomb explosion at Alamogordo, New Mexico in July 1945. Another group of seventy-four grade Hereford cows from the same general area were purchased in 1948 as a control herd to the original irradiated cows. Fifteen registered Polled Hereford cows and their sire were purchased in 1948 to be used in comparison studies. Since then some additional registered Hereford cows have been added to the herd. The replacement females have been produced from this group and the present cow herd consists of approximately three-hundred producing cows.

Herd Management

As far as practical all the cows were managed similarly. The pastures consisted largely of orchard grass-Ladino clover and fescue-Ladino clover with some native pasture for the summer grazing period.

The winter pastures consisted of either oats, Balbo rye, or rye grass and crimson clover but these were used almost entirely by the weaned steer and heifer calves. The winter ration for the cow herd consisted of silage and hay fed in the open. Corn silage made up the majority of silage with some Sudan, orchard grass and corn-soybean silage being used. The hay consisted mostly of orchard grass, clover and alfalfa.

Breeding

In the beginning, both grade and purebred bulls were used but by 1951 all of the grade bulls had been sold. All of the bulls considered in this study were either registered Hereford or Polled Hereford bulls. The cows were allotted uniformly to sire groups within years on the basis of sire and previous production history with the exception of the purebred cows. The cows were pasture bred and calved in the open. Both spring and fall calving have been practiced but due to pasture conditions and for comparative reasons all calves are now dropped in the spring.

Health

Because some of the original irradiated cows were positive to the test for Bangs disease, all the mature cows and heifers were vaccinated with strain 19 Brucella abortus. Since then all heifers have been calf-hood vaccinated. All the calves were vaccinated for blackleg, malignant edema and hemorrhagic septicemia prior to weaning.

Several of the original cows were disposed of after showing a positive reaction for anaplasmosis. In the fall of 1956 the herd was tested for anaplasmosis and no animals showed a positive reaction.

In the spring of 1954 a group of two-year-old heifers aborted and almost the entire calf crop from the two-year-olds was lost. Since that outbreak, no other major health problem has been encountered.

Calf Management

At birth calves were tattooed a herd number in both ears and ear tagged. In the fall after weaning the calves were branded on the right hip with a brand corresponding to the tattoo number. The calves were weighed at birth until 1954 after which the taking of birth weights was discontinued. The calves were weighed when the oldest ones became six months old and thereafter at monthly intervals until weaning. Individual grades for type and condition were made at weaning. All males, except some saved for bulls, were castrated about three months prior to weaning. Calves were not creep fed.

PROCEDURE

Animals

All of the daughters of a sire that were calved in the spring of 1952, 1953 or 1954 and had a production record in later years were used in the evaluation of the sire. Production records of daughters for the years 1955 and 1956 were available. Average daily gain was calculated by subtracting the birth weight from the weaning weight and dividing by the days of age at weaning. The daily gain from birth to weaning was then multiplied by the appropriate correction factor to adjust all daily gains to a mature dam and male calf equivalent. The correction

factors used were from an analysis of the weaning weights of calves by age of dam and sex of calf from the beef cattle records of the University of Tennessee Experiment Stations and were as follows:

Age of Dam	Correction Factor	
	Male	Female
2	1.28	1.42
3	1.19	1.31
4	1.10	1.20
5	1.05	1.14
6	1.02	1.11
7	1.00	1.08
8	1.00	1.08
9	1.02	1.11
10	1.03	1.12
11 +	1.14	1.24

Because birth weights were not taken after 1953 an average birth weight for calves was used to calculate the daily gain from birth to weaning. For cows calving the first time, 60 and 65 pounds were used for the birth weight of female and male calves, respectively. For all cows having calved at least once, 65 and 70 pounds were used as the birth weights for female and male calves, respectively.

Data on 94 daughters of 14 different sires were available for this study. For analysis of variance, 124 production records were available from the 94 daughters for the sires studied.

Even though all the daughters of a sire that were dropped in one year were retained and each was given a chance to have a production record, there may have been some bias in evaluation of sires due to the small number of daughters available with production records for some sires. The bulls were, therefore, evaluated not only on the average performance of their daughters but by equal parent indexes determined from daughter-dam comparisons. Equal parent indexes were calculated by two methods. The first was to take the production of the daughter within a single year and compare it to the dams total average production. The second was to compare the production of the daughter to that of the dam when both had records within the same year. The latter method, although it limited the number of records available for comparison, eliminated some environmental year differences.

The evaluation and ranking of the sires was then determined by calculating the equal parent index which is based on the generally accepted rule that offspring inherit about equally from both parents for production. Therefore, the following formula was used to compute equal parent indexes for the sires:

$$Y = \frac{X + Z}{2} \quad \text{or} \quad Z = 2Y - X$$

Where X represents the production of dam, Y is the production of the daughter and Z is the production of the sire. This method may rank a sire higher or lower than his true breeding value. If the index is regressed one-half the way toward the breed or herd average, this should

be more indicative of his true breeding value. Therefore, the following formula was used to compute the regressed equal parent index:

$$\text{Sire Index} = \frac{\text{Equal Parent Index} + \text{Breed Average}}{2}$$

Because there was no breed average available, the herd average for the year (Table XVIII) in which the production record was made was used to calculate the regressed equal parent index.

The index for the individual calf was constructed by converting the adjusted daily gain and type to points of index score from Table XVII and adding these points for an index for the weaned calf. This index gives equal emphasis to gain from birth to weaning and to feeder type.

The conversion table (Table XVII) was from an analysis of the weaning weights and type grades of the calves from the University of Tennessee Experiment Station's beef cattle herds. The mean adjusted daily gain, adjusted for sex of calf and age of dam, was 1.81 pounds and was assigned 50 points of index score. Each standard deviation from the mean calculated to be 0.25 pounds was given ten points of index score. The mean type grade was found to be low choice (12.0) and assigned 50 points of index score. Each standard deviation from the mean was calculated to be 1.40 and given ten points of index score.

The equal parent index will hereafter be referred to as the equal parent score so as not to confuse it with the weaning index described above.

Statistical Methods

Analysis of variance was made for the following three methods of comparison of sires; (1) the average production of daughters by sires within years; (2) the equal parent score and the regressed equal parent score by sires within years from a comparison of the dams and daughters total average production; (3) the equal parent score and the regressed equal parent score by sires and within years from a comparison of the records of dams and daughters calving in the same year. Analysis of variance techniques as described by Snedecor (1946) for data with subsamples of different numbers of individuals were used. An analysis was made for adjusted daily gain, type and index for each of the three methods of comparing the production of daughters by sires.

RESULTS AND DISCUSSION

The results of this study show considerable differences in the weaning performance of daughter progenies of different sires when analyzed both on a within year basis (Tables II, III) and when years were combined (Table IV). The average performance of offspring of daughters by different sires for adjusted daily gain for the years 1955 and 1956 (Tables II, III, IV) varied from 1.71 to 2.34 pounds and 1.44 to 2.00 pounds, respectively, and approached significance (Table V). When the years were combined the adjusted daily gain for daughter performance by the different sires varied from 1.61 to 2.06 pounds (Table IV) with a least significant mean difference of 0.22 and 0.29 pounds at the 0.05 and 0.01 levels of probability. Average type grades of the daughter progenies by the different sires ranged from 9.8 to 11.2, 9.4 to 12.0 and 9.4 to 11.1 for the years 1955, 1956 and for the combined years of 1955 and 1956, respectively. There were no significant differences in the type grades either within years or after the years were combined. However, the sires that tended to appear in the top one-half in adjusted daily gain or in the lower one-half appeared in similar positions on type score (Tables II, III, IV). This was probably due in part to the fact that sires whose daughter progenies had calves which gained faster, were fatter and tended to grade higher. The combined score for both adjusted daily gain and type (weaning index) also showed considerable difference in the average weaning performance of daughter progenies of different sires. On a within year basis the weaning index ranged from 82 to 115 and 68 to 100 for the years 1955 and 1956, respectively, and had a

range from 76 to 105 for the combined years 1955 and 1956 (Tables II, III, IV).

The rank of sires on the average offspring performance of daughter progenies for adjusted daily gain, type and weaning index on a within year and a combined years basis is given in Tables II, III, IV. Some sires were not included in the combined years table because they had not had at least two daughters in production for each of the years analyzed. This ranking of sires was based on a combined summary of daughter progeny performance for both 1955 and 1956, since herd averages were very similar for both years. Although there is some variation in the rank of sires for the various performance traits studied, it can be seen that the same sires are consistently found in either the top one-half or bottom one-half of the sires.

Similar results were obtained when equal parent scores or regressed equal parent scores were used to rank or evaluate the sires. There appeared to be little or no difference in the rank of the sire from the use of any of the methods to rank these sires on the performance of their progeny.

The equal parent score for the various sires for adjusted daily gain calculated from the production of the daughter in a single year as compared to the total production of the dam varied considerably between sires. These ranged from 1.37 to 2.52, 1.11 to 2.05 and 1.24 to 2.22 pounds for the years 1955, 1956 and combined 1955-1956 respectively. The ranking of the sires by this method (Tables VI, VII, VIII) ranked the sires in almost the same position as ranking the sires on the average

production of the daughters (Tables II, III, IV). The analysis of these data showed a highly significant difference between sires when the years were combined with a least significant mean difference of 0.36 pounds at the 0.01 level of probability. The equal parent scores for type and weaning index for the various sires calculated within year and for combined years, were similar to the values obtained from the average production of the daughters. The rank of the sires again did not change appreciably from the rank from average production of the daughters. Since the rank of the sires on adjusted daily gain, type and index did not change greatly when either average production of daughters or equal parent score were used, this would indicate that the average production of the dams of these daughters were quite similar for the various sires tested.

The regressed equal parent score for the sires did not change the rank of any of the sires from that of the equal parent score either on adjusted daily gain, type or weaning index (Tables VI, VII, VIII). Since the regressed equal parent score did not change the rank of the sires and gave approximately the same significance as the equal parent score, it appears that it should be a better estimate of the real breeding value of the sire by preventing extreme variations from the mean.

The evaluation of the sires by constructing equal parent scores for adjusted daily gain, type and weaning index from the records of dams and daughters calving in the same year (Tables XI, XII, XIII) agreed generally with the other methods of sire evaluation. The rank

of sires by this method was not altered appreciably as compared to ranking by the other methods of evaluation. Analysis of variance showed a highly significant difference between sires for adjusted daily gain and weaning index when the years were combined. This method of evaluation, although it agreed generally with the other methods of evaluation, had several disadvantages. The main disadvantage would seem to be the small number of records that could be used to evaluate the sire. In many instances the dams have been discarded for old age, health or other reasons before many of their daughters are in production. Another factor that would make this method unsatisfactory is that environmental differences are likely to be greater between an aged beef cow and a heifer in a single year than the effects of environment over several years on the production of the dam and the production of the daughter in a single year.

Evaluation of sires based on the productivity of their daughters in this study does not reveal a very high relationship between ranking on this basis and a rank of sires based on the average weaning performance of the sire progenies. The evaluation and subsequent rank of sires on weaning performance of progenies (Table I) show that several of the higher ranking sires on this basis are the lower ranking sires on the basis of daughter productivity. This agrees with Koch and Clark (1955) and Dawson (1954) in that the gain from birth to weaning and consequently weaning index are more dependent on the maternal environment of the dam than on the sire. Therefore a sire mated to a group of high producing females would rank very high on the weaning

performance of his progeny. If he did not transmit the ability for high production to his daughters he might be ranked very low when these daughters came into production, especially if he were ranked on an equal parent score using the production of the dam and the production of the daughter as a basis for constructing the equal parent score.

The results of this study of the performance of daughters by sires indicate that for the group of sires studied certain sires were consistently either in the top one-half or the lower one-half of the sires for adjusted daily gain, type and weaning index based on the progeny of their daughters. Sires remained in about the same relative rank when they were compared within years or when the years were combined and when compared by the different methods of evaluation. The statistical treatment of these data showed that there were real differences in the productivity between the daughters of different sires. This would indicate that these traits for production are heritable and should be considered in the selection of a herd sire if the productivity of the herd is to be maintained or improved.

The results of this study indicate that for the production traits studied sires -14 and -40 were superior to the other sires studied and that sires 346, 246 and 347 were inferior in these traits of production to the other sires.

The use of average performance of offspring of the daughters by sires gave as good results in ranking the sires as any of the three methods used. The use of the equal parent score with dams and daughters calving in the same year was the least desirable of the three methods

used. In small herds where only one or two sires are used at a single time and the females are not randomly allotted to the sires being used the method of using the total average dam production in comparison to the daughters of a sire to construct an equal parent score would be valuable in establishing the breeding value of a sire.

The regression of the equal parent score did not change the rank of the sires but gave a more accurate evaluation of the sire for the points being considered. If only the equal parent score were used to evaluate a sire, many sires would be appraised too high and others unnecessarily low. For the conditions under which the herds are managed at the UT-AEC Agricultural Research Program with females being randomly assigned to sires before each breeding season starts, the comparison of the production of daughters of sires within years is as practical as the other methods.

SUMMARY AND CONCLUSIONS

Forty-two daughters by eleven sires and eighty-two daughters by thirteen sires for the years 1955 and 1956, respectively, were compared on the basis of the adjusted daily gain, type and weaning index within years and with years combined on the performance of their progeny within sire groups. These daughters were from the spring calf crops of 1952, 1953 and 1954. The numbers used were limited according to the requirements of the analysis, deaths and other factors. The evaluation and ranking of the sires was accomplished by comparisons among sires of (1) the average production of the daughters, (2) equal parent scores using the total average production of the daughters' dams and (3) equal parent scores from the records of dams and daughters made in the same year.

The results showed that there were considerable differences in the weaning performance of daughter progenies by the different sires when analyzed both on a within year basis and when the years were combined. Ranking the sires by three different methods on the performance of their daughter's progeny ranked these sires in approximately the same order.

The rank of the sires based on the performance of their progeny was not consistent with the rank made by the performance of the daughter progenies by the different sires.

Certain sires (-14 and -40) were consistently ranked in the top one-half of the sires based on the production of the progeny of their

daughters. Other sires (346, 246 and 3147) were consistently in the lower one-half of the sires ranked.

The results indicate that there are considerable differences in breeding worth between sires as measured by the productivity of their daughters. Selection of the daughters of high producing sires and extensive use of their sires would increase the productivity of a herd of beef cattle. The results also show that some sires should be eliminated because of their lowering the future productivity of the herd. However, by the time a sire is proven by this method his productive life has been materially reduced. Nevertheless, bulls proven to be superior by this method should be used to the maximum.

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APPENDIX



TABLE I

RELATIVE RANK OF SIRES BY YEARS BASED ON WEANING PERFORMANCE
OF THEIR PROGENY

Sire	Number of Calves	Adjusted Daily Gain	Sire	Type	Sire	Weaning Index
1952						
-3	16	2.31	238	12.0	246	121
246	16	2.29	246	11.9	-3	118
238	12	2.20	-3	11.3	238	118
226	5	1.98	226	10.4	226	97
Total	50	2.24		11.6		117
1953						
246	5	2.24	117	12.6	117	108
-58	10	2.02	3147	12.4	246	108
-40	7	2.01	369	11.4	3147	105
346	12	2.00	-14	11.3	-58	104
-13	10	2.00	-58	11.2	-14	103
-14	14	1.98	-38	11.2	-40	103
369	5	1.98	-40	11.1	369	103
611	14	1.90	611	11.0	611	97
117	12	1.88	246	10.4	-38	95
3147	10	1.86	-13	10.2	-13	95
-38	14	1.77	346	9.9	346	94
Total	113	1.94		11.2		101

TABLE I (Continued)

RELATIVE RANK OF SIRES BY YEARS BASED ON WEANING PERFORMANCE
OF THEIR PROGENY

Sire	Number of Calves	Adjusted Daily Gain	Sire	Type	Sire	Weaning Index
1954						
-3	26	1.93	-40	11.5	-40	96
369	24	1.82	246	11.1	-3	93
238	19	1.82	514	11.1	369	92
346	28	1.80	369	10.7	514	92
-40	21	1.79	238	10.6	238	91
514	10	1.76	-3	10.2	246	90
246	19	1.74	346	10.0	346	85
Total	147	1.82		10.7		91
1955						
688	16	2.06	-58	11.2	-58	103
-58	16	2.01	246	10.9	688	103
369	14	1.96	688	10.9	369	100
529	29	1.92	369	10.9	592	97
592	6	1.92	592	10.8	586	95
-3	25	1.89	586	10.7	246	95
586	22	1.89	-3	10.6	-3	94
246	19	1.88	-40	10.5	529	93
238	16	1.76	238	10.4	238	88
-40	17	1.59	529	10.3	-40	79
$\overline{92}$	10	1.46	$\overline{92}$	10.0	$\overline{92}$	70
Total	190	1.87		10.6		93

TABLE I (Continued)

RELATIVE RANK OF SIRES BY YEARS BASED ON WEANING PERFORMANCE
OF THEIR PROGENY

Sire	Number of Calves	Adjusted Daily Gain	Sire	Type	Sire	Weaning Index
1956						
-3	21	2.03	688	11.5	688	106
369	21	2.03	-14	11.5	369	104
688	22	2.02	<u>213</u>	11.4	-3	103
246	20	1.89	-40	11.2	-40	97
529	20	1.87	369	11.1	246	96
-40	20	1.86	-3	11.0	-14	94
346	18	1.84	246	10.9	<u>213</u>	94
11	23	1.80	11	10.7	529	92
-13	22	1.80	-13	10.7	11	90
<u>173</u>	6	1.79	529	10.5	-13	90
<u>213</u>	18	1.77	586	10.5	586	86
-14	27	1.75	238	10.2	346	84
238	11	1.75	<u>173</u>	10.0	238	84
586	18	1.74	346	9.6	<u>173</u>	84
864	13	1.66	864	9.3	864	75
865	14	1.65	865	9.0	865	72
Others ^a	37	1.55	Others	10.5	Others	80
Total	330	1.81		10.7		91

^a Includes calves with sires unknown and calves from dwarf carrier cows.

TABLE II

RANK OF SIRES ON THE AVERAGE PERFORMANCE OF THE PROGENY OF THEIR
DAUGHTERS FOR 1955

Sire	Number of Calves	Adjusted Daily Gain	Sire	Type	Sire	Weaning Index
-58	2	2.34	-40	11.2	-58	115
-13	2	2.26	-58	10.8	-40	114
-40	6	2.23	369	10.5	-13	106
-14	3	2.18	238	10.4	-14	103
369	2	2.07	-3	10.3	369	102
238	4	1.92	246	10.2	238	94
-3	3	1.86	117	10.1	-3	91
117	6	1.85	-14	10.1	117	89
346	2	1.84	3147	10.0	346	85
3147	3	1.77	-13	10.0	3147	84
246	9	1.71	346	9.8	246	82
Total	42	1.95		10.3		95

TABLE III

RANK OF SIRE ON THE AVERAGE PERFORMANCE OF THE PROGENY OF THEIR
DAUGHTERS FOR 1956

Sire	Number of Calves	Adjusted Daily Gain	Sire	Type	Sire	Weaning Index
-14	5	2.00	-38	12.0	-38	100
-40	7	1.91	-40	10.9	-14	97
514	2	1.88	238	10.8	-40	96
117	5	1.84	117	10.6	117	91
611	5	1.84	611	10.6	611	91
-38	4	1.80	-14	10.3	514	90
369	9	1.77	-3	10.0	238	86
-13	3	1.71	514	10.0	-3	81
238	6	1.70	3147	9.9	369	81
-3	12	1.69	-13	9.8	-13	80
346	12	1.69	369	9.5	346	76
246	9	1.59	346	9.4	246	71
3147	3	1.44	246	9.4	3147	68
Total	82	1.75		10.1		84

TABLE IV

RANK OF SIRES ON THE AVERAGE PERFORMANCE OF THE PROGENY OF THEIR
DAUGHTERS FOR 1955 AND 1956

Sire	Number of Calves	Adjusted Daily Gain	Sire	Type	Sire	Weaning Index
-40	13	2.06	-40	11.1	-40	105
-14	8	2.06	238	10.6	-14	99
-13	5	1.93	117	10.3	-13	91
117	11	1.85	-14	10.2	117	90
369	11	1.83	-3	10.1	238	90
238	10	1.79	3147	10.0	369	85
-3	15	1.72	-13	9.9	-3	83
346	14	1.71	246	9.8	246	77
246	18	1.65	369	9.7	346	77
3147	6	1.61	346	9.4	3147	76
Total	111	1.80		10.0		86

L.S.M.D. - Adjusted Daily Gain 0.05 = 0.22, 0.01 = 2.29

L.S.M.D. - Weaning Index 0.05 = 14.8, 0.01 = 19.6

TABLE V

ANALYSIS OF VARIANCE OF THE PERFORMANCE OF THE PROGENY OF
DAUGHTERS BY THEIR SIRES

Source	Degrees of Freedom	Mean Squares		
		Adjusted Daily Gain	Type	Index
1955				
Total	41			
Between Sires	10	.1884	.755	591
Within Sires	31	.0971	.931	334
1956				
Total	81			
Between Sires	12	.1021	3.21	577*
Within Sires	69	.0561	1.89	302
1955-1956				
Total	110			
Between Years	1	1.0344**	3.52	3704
Between Sires	9	.2630**	2.89	1089
Within Sires	100	.0692	1.57	305

* $P = < .05 > .01$

** $P = < .01$

TABLE VI

RANK OF SIRES ON EQUAL PARENT SCORE AND REGRESSED EQUAL PARENT SCORE
FOR ADJUSTED DAILY GAIN, TYPE AND WEANING INDEX CALCULATED FROM DAMS
TOTAL AVERAGE PRODUCTION AND 1955 DAUGHTER RECORDS

Number of		Adjusted Daily Gain		Type			Weaning Index		
Sire	Calves	E.P.S. ^a	R.E.P.S. ^b	Sire	E.P.S.	R.E.P.S.	Sire	E.P.S.	R.E.P.S.
-13	2	2.52	2.20	-40	11.8	11.2	-40	130	112
-14	3	2.49	2.18	369	10.9	10.8	-58	119	106
-40	3	2.48	2.18	-58	10.4	10.5	-14	117	105
-58	2	2.48	2.18	-14	10.0	10.3	-13	116	104
238	4	1.88	1.37	246	9.6	10.1	369	94	94
369	2	1.83	1.85	-13	9.5	10.0	238	85	89
117	6	1.80	1.84	238	9.4	10.0	117	78	85
346	2	1.73	1.80	-3	9.3	10.0	-3	75	84
-3	3	1.70	1.78	117	8.8	9.7	346	72	82
3147	3	1.49	1.68	346	8.8	9.7	246	63	78
246	9	1.37	1.62	3147	8.1	9.3	3147	59	76
Total 42		1.90	1.88		9.9	10.2		88	90

^a Equal Parent Score

^b Regressed Equal Parent Score

TABLE VII

RANK OF SIRES ON EQUAL PARENT SCORE AND REGRESSED EQUAL PARENT SCORE
FOR ADJUSTED DAILY GAIN, TYPE AND WEANING INDEX CALCULATED FROM DAMS
TOTAL AVERAGE PRODUCTION AND 1956 DAUGHTER RECORDS

Number of		Adjusted Daily Gain		Type			Weaning Index		
Sire	Calves	E.P.S. ^a	R.E.P.S. ^b	Sire	E.P.S.	R.E.P.S.	Sire	E.P.S.	R.E.P.S.
-14	5	2.05	1.93	-38	13.8	12.3	-38	118	104
-38	4	1.92	1.86	-40	11.1	10.9	-14	98	95
117	5	1.90	1.85	238	11.0	10.8	-40	93	92
514	2	1.88	1.85	611	10.7	10.7	117	87	89
-40	7	1.81	1.81	-14	10.2	10.4	611	87	89
-13	3	1.73	1.79	117	9.6	10.2	514	84	87
611	5	1.72	1.77	-3	9.2	9.9	-13	78	85
369	9	1.57	1.69	-13	9.2	10.0	238	75	83
238	6	1.44	1.63	514	9.1	9.9	369	66	78
346	12	1.43	1.62	3147	8.9	9.8	-3	62	76
-3	12	1.41	1.61	369	8.6	9.6	346	55	73
3147	3	1.14	1.48	346	8.2	9.4	3147	47	69
246	9	1.11	1.46	246	7.6	9.1	246	36	63
Total	82	1.56	1.68		9.5	10.1		71	81

^a Equal Parent Score

^b Regressed Equal Parent Score

TABLE VIII

RANK OF SIRES ON EQUAL PARENT SCORE AND REGRESSED EQUAL PARENT SCORE
FOR ADJUSTED DAILY GAIN, TYPE AND WEANING INDEX CALCULATED FROM DAMS
TOTAL AVERAGE PRODUCTION AND 1955-1956 DAUGHTER RECORDS

Sire	Number of Calves	Adjusted Daily Gain		Sire	Type		Sire	Weaning Index	
		E.P.S. ^a	R.E.P.S. ^b		E.P.S.	R.E.P.S.		E.P.S.	R.E.P.S.
-14	8	2.22	2.03	-40	11.4	11.0	-40	110	101
-40	13	2.12	1.98	238	10.4	10.5	-14	105	98
-13	5	2.05	1.94	-14	10.1	10.4	-13	93	92
117	11	1.84	1.84	-13	9.3	10.0	117	82	87
369	11	1.62	1.72	-3	9.2	9.9	238	79	86
238	10	1.62	1.73	117	9.2	9.9	369	71	81
346	14	1.47	1.64	369	9.0	9.8	-3	65	78
-3	15	1.46	1.65	246	8.6	9.6	346	57	74
3147	6	1.32	1.58	3147	8.5	9.6	3147	53	72
246	18	1.24	1.54	346	8.2	9.6	246	49	71
Total	111	1.64	1.74		9.4	10.0		74	83

^a Equal Parent Score L.S.M.D. - Adjusted daily gain 0.28,
Weaning index

^b Regressed Equal Parent Score L.S.M.D. - Adjusted daily gain 0.24,
Weaning index 16

TABLE IX

ANALYSIS OF VARIANCE OF SIRES EQUAL PARENT SCORE CALCULATED FROM DAMS
TOTAL AVERAGE PRODUCTION AND DAUGHTERS 1955 AND 1956 RECORDS

Source	Degrees of Freedom	Mean Squares		
		Adjusted Daily Gain	Type	Weaning Index
1955				
Total	41			
Between Sires	10	.8049	4.77	2633
Within Sires	31	.4441	5.52	1791
1956				
Total	81			
Between Sires	12	.5087	14.99	2190
Within Sires	69	.2702	7.97	1609
1955-1956				
Total	110			
Between Years	1	24.1714**	221.67**	10479**
Between Sires	9	1.2637**	11.62	5141**
Within Sires	100	.1061	5.20	1518

** P = < .01

TABLE X

ANALYSIS OF VARIANCE OF SIRES REGRESSED EQUAL PARENT SCORE CALCULATED FROM DAMS TOTAL AVERAGE PRODUCTION AND DAUGHTERS 1955 AND 1956 RECORDS

Source	Degrees of Freedom	Mean Squares		
		Adjusted Daily Gain	Type	Weaning Index
1955				
Total	41			
Between Sires	10	.1966	1.177	626
Within Sires	31	.3500	1.378	445
1956				
Total	81			
Between Sires	12	.1266	3.75	766*
Within Sires	69	.0682	2.00	365
1955-1956				
Total	110			
Between Years	1	1.0655**	1.28	3188**
Between Sires	9	.3183**	2.71	1308**
Within Sires	100	.0794	1.85	378

* $P = < .05$

** $P = < .01$

TABLE XI

RANK OF SIRES ON EQUAL PARENT SCORE AND REGRESSED EQUAL PARENT SCORE FOR ADJUSTED DAILY GAIN, TYPE AND WEANING INDEX FROM RECORDS OF DAUGHTER AND DAM CALVING IN 1955

Sire	Number of Calves	Adjusted Daily Gain		Sire	Type		Sire	Weaning Index	
		E.P.S. ^a	R.E.P.S. ^b		E.P.S.	R.E.P.S.		E.P.S.	R.E.P.S.
-14	3	2.73	2.31	238	12.3	11.5	238	142	118
238	2	2.66	2.26	-40	11.8	11.2	-14	134	113
-40	5	2.57	2.22	-14	10.7	10.6	-40	133	113
3147	2	2.24	2.06	3147	9.2	10.0	3147	100	97
-3	2	2.23	2.05	-3	8.8	9.7	-3	98	96
117	2	1.74	1.80	246	8.7	9.6	117	68	80
246	5	1.46	1.63	117	7.9	9.2	246	57	75
Total	21	2.18	2.02		10.0	10.3		103	98

^a Equal Parent Score

^b Regressed Equal Parent Score

TABLE XII

RANK OF SIRES ON EQUAL PARENT SCORE AND REGRESSED EQUAL PARENT SCORE FOR ADJUSTED DAILY GAIN, TYPE AND WEANING INDEX FROM RECORDS OF DAUGHTER AND DAM CALVING IN 1956

Number of Sire Calves		Adjusted Daily Gain		Type			Weaning Index		
		E.P.S. ^a	R.E.P.S. ^b	Sire	E.P.S.	R.E.P.S.	Sire	E.P.S.	R.E.P.S.
-14	4	2.08	1.95	-38	15.7	13.2	-38	157	114
-38	2	2.05	1.93	3147	12.2	11.4	-40	97	94
-40	7	1.89	1.85	-40	11.1	10.9	-14	93	92
369	5	1.70	1.76	611	10.8	10.8	3147	82	86
611	2	1.53	1.68	238	9.9	10.3	611	80	86
346	5	1.47	1.64	-14	9.1	10.0	369	69	80
3147	2	1.42	1.62	117	9.1	9.9	238	63	77
238	3	1.35	1.58	-3	8.7	9.7	117	56	74
117	2	1.31	1.56	369	8.3	9.5	-3	50	71
-3	7	1.21	1.51	246	7.1	8.8	346	46	69
246	5	1.11	1.46	346	6.5	8.6	246	33	62
Total	44	1.55	1.68		9.3	10.0		69	80

^a Equal Parent Score

^b Regressed Equal Parent Score

TABLE XIII

RANK OF SIRES ON EQUAL PARENT SCORE AND REGRESSED EQUAL PARENT SCORE FOR ADJUSTED DAILY GAIN, TYPE AND WEANING INDEX FROM RECORDS OF DAUGHTER AND DAM CALVING IN 1955 AND 1956

Adjusted Daily Gain				Type			Weaning Index		
Sire	Calves	E.P.S. ^a	R.E.P.S. ^b	Sire	E.P.S.	R.E.P.S.	Sire	E.P.S.	R.E.P.S.
-14	7	2.36	2.10	-40	11.4	11.0	-40	112	102
-40	12	2.17	2.00	238	10.9	10.8	-14	110	101
238	5	1.87	1.85	3147	10.7	10.7	238	95	93
3147	4	1.83	1.84	-14	9.8	10.2	3147	92	92
117	4	1.52	1.68	-3	8.7	9.7	117	62	77
-3	9	1.44	1.63	117	8.5	9.6	-3	61	76
246	10	1.25	1.55	246	7.9	9.2	246	45	68
Total	51	1.78	1.81		9.7	10.2		82	86

^a Equal Parent Score L.S.M.D. - Adjusted daily gain, 0.57,
Weaning index 40

^b Regressed Equal Parent Score L.S.M.D. - Adjusted daily gain 0.28,
Weaning index 20

TABLE XIV

ANALYSIS OF VARIANCE OF SIRES EQUAL PARENT SCORE CALCULATED FROM
RECORDS OF DAM AND DAUGHTER CALVING IN SAME YEAR

Source	Degrees of Freedom	Mean Squares		
		Adjusted Daily Gain	Type	Weaning Index
1955				
Total	20			
Between Sires	6	.9286	8.17	3862
Within Sires	14	.4161	4.81	1494
1956				
Total	43			
Between Sires	10	.4636	19.86*	2048
Within Sires	14	.3018	8.96	1866
1955-1956				
Total	50			
Between Years	1	5.6211**	4.51	15418**
Between Sires	6	1.3901**	15.47	6096**
Within Sires	43	.2792	8.31	1420

* $P = < .05$

** $P = < .01$

TABLE XV

ANALYSIS OF VARIANCE OF SIRES REGRESSED EQUAL PARENT SCORE CALCULATED
FROM RECORDS OF DAM AND DAUGHTER CALVING IN SAME YEAR

Source	Degrees of Freedom	Mean Squares		
		Adjusted Daily Gain	Type	Weaning Index
1955				
Total	20			
Between Sires	6	.2339	2.07	967
Within Sires	14	.1038	1.20	372
1956				
Total	43			
Between Sires	10	.1152	4.027	733
Within Sires	33	.0757	2.554	397
1955-1956				
Total	50			
Between Years	1	1.6573**	0.84	4355**
Between Sires	6	.3497**	3.98	1521**
Within Sires	43	.0690	2.08	353

**p = < .01

TABLE XVI

METHOD OF SCORING FOR TYPE^a

Type			Legend
Symbol	Number		
HF	17		F = Fancy
F	16		C = Choice
LF	15		G = Good
HC	14		M = Medium
C	13		Co = Common
LC	12		H = High
HG	11		L = Low
G	10		
LG	9		
HM	8		
M	7		
LM	6		
HCO	5		
Co	4		
LCO	3		

^a System of scoring for type as used in the Southern Regional Beef Cattle Breeding Project, S-10

TABLE XVII

CONVERSION TABLE FOR TYPE AND ADJUSTED DAILY GAIN TO WEANING
INDEX SCORE

Type Score	Points in Index for Score	Adjusted Daily Gain	Type Score	Points in Index for Score	Adjusted Daily Gain
16.20	80	2.47	13.54	61	2.05
16.06	79	2.45	13.40	60	2.03
15.92	78	2.43	13.26	59	2.01
15.78	77	2.41	13.12	58	1.99
15.64	76	2.38	12.98	57	1.97
15.50	75	2.36	12.84	56	1.94
15.36	74	2.34	12.70	55	1.92
15.22	73	2.32	12.56	54	1.90
15.08	72	2.30	12.42	53	1.88
14.94	71	2.27	12.28	52	1.86
14.80	70	2.25	12.14	51	1.84
14.66	69	2.23	12.00	50	1.81
14.52	68	2.21	11.86	49	1.79
14.38	67	2.19	11.72	48	1.77
14.24	66	2.16	11.58	47	1.75
14.10	65	2.14	11.44	46	1.73
13.96	64	2.12	11.30	45	1.70
13.82	63	2.10	11.16	44	1.68
13.68	62	2.08	11.02	43	1.66

TABLE XVII (Continued)

CONVERSION TABLE FOR TYPE AND ADJUSTED DAILY GAIN TO WEANING
INDEX SCORE

Type Score	Points in Index for Score	Adjusted Daily Gain	Type Score	Points in Index for Score	Adjusted Daily Gain
10.88	42	1.64	8.50	25	1.26
10.74	41	1.62	8.36	24	1.24
10.60	40	1.59	8.22	23	1.22
10.46	39	1.57	8.08	22	1.20
10.32	38	1.55	7.94	21	1.18
10.18	37	1.53	7.80	20	1.15
10.04	36	1.51	7.66	19	1.13
9.90	35	1.48	7.52	18	1.11
9.76	34	1.46	7.38	17	1.09
9.62	33	1.44	7.24	16	1.07
9.48	32	1.42	7.10	15	1.04
9.34	31	1.40	6.96	14	1.02
9.20	30	1.37	6.82	13	1.00
9.06	29	1.35	6.68	12	.98
8.92	28	1.33	6.54	11	.96
8.78	27	1.31	6.40	10	.93
8.64	26	1.29			

TABLE XVIII

MEAN HERD ADJUSTED DAILY GAIN, TYPE, AND WEANING INDEX FOR
SPRING CALVES BY YEARS

Year	Number of Calves	Adjusted Daily Gain	Type	Index
1952	50	2.24	11.6	117
1953	113	1.94	11.2	101
1954	147	1.82	10.7	91
1955	190	1.87	10.6	93
1956	330	1.81	10.7	91