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The influence of date of birth and calving season on preweaning growth rate, type score, condition score, and weanling index of beef calves

Wallace Aaron Griffey

To the Graduate Council:

I am submitting herewith a thesis written by Wallace Aaron Griffey entitled "The influence of date of birth and calving season on preweaning growth rate, type score, condition score, and weanling index of beef calves." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Animal Husbandry.

C. S. Hobbs, Major Professor

We have read this thesis and recommend its acceptance:

Harold J. Smith, O. G. Hall, L. N. Skold

Accepted for the Council:
Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

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

March 16, 1959

To the Graduate Council:

I am submitting herewith a thesis written by Wallace Aaron Griffey entitled "The Influence of Date of Birth and Calving Season on Preweaning Growth Rate, Type Score, Condition Score, and Weanling Index of Beef Calves". 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.

Charles V. Hobbs
Major Professor

We have read this thesis
and recommend its acceptance:

Harold J. Smith

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Accepted for the Council:

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Dean of the Graduate School

THE INFLUENCE OF DATE OF BIRTH AND CALVING SEASON ON PREWEANING GROWTH RATE, TYPE SCORE, CONDITION SCORE, AND WEANLING INDEX OF BEEF CALVES

A THESIS

Submitted to
The Graduate Council
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Master of Science

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by

Wallace Aaron Griffey

March 1959

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CHAPTER I

INTRODUCTION

There are many environmental factors including sex of calf, age of dam, and season of birth, in addition to actual heredity, that affect preweaning performance in beef calves. One of these on which the least information is available is the influence of season of birth within the year or the numerical day of birth within a season. A knowledge of the influence of numerical day in year calved on performance is extremely important in planning a beef production program. A breeder must have his calves born at the time of the year that will result in maximum performance with lowest costs of production. The climatic conditions prevailing during various seasons of the year will affect pasture growth and feed supply of both the dam and calf. Extremes in either cold or hot weather may hamper the growth of the calf. Cold and damp weather in certain seasons would be favorable to disease resulting in a lowered performance of calves born within that season.

A knowledge of the influence of season of birth on preweaning performance is also important from the standpoint of effective selection for improvement of producing ability. If season of birth significantly affects performance, corrections can be made that will enable the breeder to measure genetic differences between calves with a higher degree of accuracy.

The purpose of this study was to determine the influence of season of birth (numerical day in year calved) upon preweaning gain,

weanling type score, condition score and index.

CHAPTER II

LITERATURE REVIEW

There is considerable information available on the influence of such factors as sex, age of dam and birth weight of the calf on preweaning growth rate, type score and weanling index. However, there is very little information available on the influence of season of birth of the calf or numerical day of birth within season on preweaning growth rate, type score and weanling index.

In a comparison of early and late calves, Duncan (1951) reported that calves born in March and April gained faster from birth to weaning than did calves born in January and February. The early calves made an average daily gain of 1.63 pounds and weighed an average of 531 pounds per calf on the first of November compared to an average daily gain of 1.72 pounds and an average weight of 462 pounds per calf for the late calves. The early calves were appraised at an average price of $182.10 compared to $156.81 for the late calves. The cost per calf raised was $105.55 for the early calves and $93.45 for the late calves. Under these conditions the early calves were $13.19 more profitable than the late calves.

Koch, et al. (1955), using data from 5,952 calves, studied the influence of season of birth and other factors on some traits in beef cattle, including birth weight, daily gain and type score. The influence of season of birth was studied by regressing the various traits on age at weaning, since all the calves were weaned at the same time. They

obtained a figure of -.04 pound per day for the regression of gain from birth to weaning on weaning age. This was not statistically significant. The regression of weaning score on weaning age was .01 unit per day (± .005), indicating that early calves tend to score a little better than those born later in the season. They considered all the regressions to be too small for practical importance.

Nelms, et al. (1956) obtained results somewhat at variance with those of Koch, et al. (1955). Their data were taken from 103 animals over a two-year period, 1953 and 1954. The calves were born over a 90-day calving season from March through May. The season was divided into 20-day periods beginning March 1. The early calves gained at a considerably higher rate than did the calves born late. With the exception of the period from March 1 to March 20, the calves born in the first part of the season gained 0.20 pound more daily than the mean, or 0.38 pound more daily than those born in the last part of the season.

McCormick, et al. (1956) obtained regression coefficients of +.0004 pound and -.0012 pound for regression of average daily gain from birth to weaning on day in year calved for male and female Polled Herefords calves, respectively. The calves included in this study were born principally in February and March with extreme dates of calving ranging from January 3 to June 11. The calves were creep-fed during the suckling period and weaned in late September and October at an average age of about 210 days.

Marlowe, et al. (1957) reported that season of birth was an important source of variation in both preweaning growth rate and type score. In this study the year was divided into the following seasons: December 16th

through March 15th, March 16th through May 31st, June 1st through August 31st, and September 1st through December 15th. Estimated season means were 1.65, 1.69, 1.56 and 1.53 for growth rate and 11.7, 11.6, 10.7 and 11.6 for type score, respectively. Marlowe, et al. (1958a) reported on further studies, including data from earlier work, and stated that it was quite evident that calves born during the period of June 1st through August 31st graded almost one point lower than calves born during the other three seasons. Upon breaking down the seasons by months, they found that calves born during February, March, April and May had the highest growth rates followed by calves born during January, June and July. Calves born during December grew about .02 of a pound per day slower than those born during February through May. There was very little difference in the average type score of the calves born during the period of November 1st through March 31st. There was a slight decrease in type score of calves born during April and May. Calves born during June through October, graded approximately one grade point lower than calves born during November through March.

Marlowe, et al. (1958b) analyzed the records of 2,007 creep-fed and 4,166 non-creep-fed calves obtained in the Virginia performance testing program over a four-year period, 1953-56, inclusive. The years were broken down into the same seasons as described in previous work (Marlowe and Gaines, 1957; Marlowe, et al., 1958a). Season of birth of calf appeared to be of statistical and practical significance for growth rate of non-creep-fed calves, but of little practical importance for growth rate of creep-fed calves or type score in either group. They found that non-

creep-fed calves born during June through December grew about 0.1 pound per day slower than those born during February through May. Season of birth influenced type score in the non-creep-fed calves only in the calves born between June first and September first. These calves scored approximately one-third of a grade lower than the calves born during the other seasons. Creep feeding appeared to have an important influence in equalizing type scores over all seasons.

CHAPTER III

PROCEDURE

Source of Data

The data used in this study were the weanling performance records of 2,443 beef calves from beef cattle herds maintained at four locations of the Tennessee Agricultural Experiment Station for the years 1952-57, inclusive. These four locations were Alcoa, Oak Ridge, Crossville and Springfield. The cattle consisted primarily of purebred cattle, but some high grades were included at Alcoa and Oak Ridge. The cattle at Springfield were all purebred Hereford, and the cattle at Alcoa and Oak Ridge included both purebred and grade Herefords. The cattle at Crossville were purebred Angus. Alcoa and Oak Ridge are located in East Tennessee; Crossville on the Cumberland Plateau and Springfield in Middle Tennessee.

Herd Management

Although the beef cattle herds used in this study are located in different geographical areas of the state, the management and breeding practices at each of the locations were similar for the years included in the study. The cattle were maintained on Orchardgrass-Ladino clover-Alfalfa, Tall Fescue or Bluegrass pastures during the summer and parts of other seasons. Some supplemental summer and winter pasture was available but most of it was used by younger animals and not by the breeding herd. Winter feeding consisted of hay and silage. The hay was mostly Orchardgrass-Ladino clover-Alfalfa or other grass-

legume mixtures. The silage was mostly from the same source, however, corn silage, sorghum silage and Sudangrass silage were fed in limited quantities at some locations. The cattle had access to adequate water and mineral mixtures at all times. At most locations the breeding stock was maintained on permanent sod at all times, and no grain was fed to the cow herd.

In the first years included in the study, some calves were born in about all periods throughout the year, with most of the calves coming in the first four months. In the later years of the period under study, the calves at all locations were born from approximately January 10th to April 30th.

All of the calves used in the study were weighed at birth with the exception of Oak Ridge calves, and again at weaning. Calves at Crossville and Springfield were weighed at 28-day intervals from birth to weaning. The calves were scored for type and condition at weaning and at some locations between birth and weaning. Numerical scores were used as described by Malliah (1958).

The calves were all raised on their dams' milk, grass and other roughages, with no creep feeding. The calves were tattooed at birth for identification and branded after weaning. Calves born in the first half of the year (spring calves) were weaned about November 1st when they were approximately 210 to 220 days of age. Those born in the last half of the year (fall calves) were weaned about May of the following year.

Methods of Analysis

In the analysis of data included in this study, each year was arbitrarily divided into two equal calving seasons of about the same number of days--January 1 through July 8 and July 9 through December 31. Each half of the year was then further subdivided into ten-day calving periods (Table X). The first half of the year included periods 1-19 and the second half of the year included periods 20-37. The data were assembled and classified by locations, years and calving periods.

The performance traits included in the study were adjusted daily gain from birth to weaning, type score, condition score and weanling index. Actual daily gains of calves from birth to weaning were adjusted for the influences of sex of calf and age of dam on daily gain. Type and condition scores were not adjusted since previous studies have shown that sex of calf and age of dam do not significantly affect these traits, except in the case of type score for calves out of two-year old cows and cows ten years of age and older. The weanling selection index for each calf was constructed by using adjusted daily gain and type score. Equal emphasis was placed on each of these traits in the construction of the index. In the first phase of the study, average values were calculated for each of the four performance characteristics for periods within locations, combining all years (Tables I-IV). An analysis of variance was calculated using periods 4-19 for each of the traits. Data for the first three periods were omitted from the analysis because of the limited number of calves in some periods and the complete lack of data for these periods at one location.

In the second phase of the study the influence of season of birth (numerical day in year calved) was studied by regressing adjusted daily gain, type and condition scores and weanling index on the numerical day in year calved. Regression coefficients were first calculated on a within year and location basis. Separate regression coefficients were computed for calves born in the first half of the year and calves born in the second half. A common regression coefficient was obtained for each station by pooling the data for all years. Over-all regressions were calculated for different breeds (Hereford and Angus) and for all cattle. The correlation between performance and numerical day in year calved was determined by locations for all characteristics, combining data from all years. Over-all correlations were determined for breeds (Angus and Hereford) and for all cattle. Regression, correlation and analysis of variance techniques were those described by Snedecor (1956).

CHAPTER IV

RESULTS AND DISCUSSION

Adjusted Daily Gain

The average adjusted daily gains by location and periods for all years are shown in Table I. For periods 1-19 there was a range in adjusted daily gain of 1.41 to 1.83 pounds for Alcoa, 1.62 to 1.90 pounds for Oak Ridge, 1.71 to 2.05 pounds for Crossville, 1.53 to 2.10 pounds for Springfield. With the exception of the first two or three periods where the number of calves was small, the average adjusted daily gains for the remainder of the periods (4-19) during the first half of the year were very similar and no consistent increase or decrease in daily gain with age of calf was observed (Table I). On a weighted average basis, the averages for periods 1-19 for the different locations were 1.69, 1.81, 1.84 and 1.80 respectively. An analysis of variance (Table V), using average daily gains for periods 4-19 at all locations, revealed that there were no significant differences among periods. There were, however, significant differences among locations. Data for the first three periods were omitted from this analysis because of the limited numbers of calves in some periods at three locations and the complete lack of data at one location. This indicates that the numerical day of birth would have relatively little influence on the rate of gain of a calf born during the first 19 periods.

A relatively small number of calf records were available for

some periods during the last half of the year at Alcoa and Oak Ridge (Table I). Although these data do not present a complete picture of the effect of date of birth during the second half of the year on daily gain, they do provide some basis for a comparison of daily gains during the first and second halves of the year. The weighted average daily gains of all calves born during the second half of the year at Alcoa and Oak Ridge were 1.51 and 1.48 pounds, respectively. Differences between averages for the first and second halves of the year for the various locations indicate a considerable advantage in favor of the calves born in the first 19 periods of the year. Calves born in the first half of the year gained an average of 0.18 to 0.33 pound per day more than the calves born in the second half of the year.

The regression of adjusted daily gain on the numerical day in year calved by years within locations is shown in Table VI for the calves born in the first 19 periods. There was no consistent trend in the regressions for all locations. However, with the exception of the regressions for Springfield, regressions for individual years within each location were generally in the same direction and similar in value. Yearly regressions for Alcoa and Crossville generally were positive but low in value. At Springfield the yearly regression coefficients showed considerable variation and ranged from .0030 to a -.0016. At Oak Ridge, negative regression coefficients were obtained for all years, indicating that the earlier calves gained slightly faster than the calves born later in the season. The reasons for the differences among locations are not apparent from the data. The quantity, quality and distribution

of pasture during the year may have been a contributing factor. If there was a pasture shortage in the late summer months, this would cause a decrease in both the dams' milk and the grass available to the calf, thereby causing the later born calves to have a slower rate of growth up to weaning. On the other hand, if pasture conditions were more favorable during the latter part of the grazing season, dams of later born calves would continue to milk at a high level of production, thereby causing these calves to have a faster rate of growth up to weaning. Observations indicated that pasture was not as abundant at Oak Ridge during the latter part of the grazing season as it was at other locations over these years. When the data for all years were pooled for each location, (Table VIII) regression coefficients of .0003, .0004 and .0010 pound were obtained for Alcoa, Springfield and Crossville, respectively. The regression of .0010 pound for Crossville was significant ($P < .05$). The regression of adjusted daily gain on day in year calved was -.0018 pound for Oak Ridge. The positive regressions indicate a slight advantage for daily gain in favor of the calves born later in the first half of the year, while the negative regression indicates an advantage for calves born earlier in the first half of the year. When the data from the three locations involving Hereford calves were pooled, a significant regression of -.0009 was obtained. This, however, was due mostly to the influence of the data from Oak Ridge on the over-all regression. Positive but non-significant regression coefficients were obtained for periods 20-37 for both Alcoa and Oak Ridge. This might be expected since the calves born later in the fall

would gain faster than late summer calves because of feed supply and temperature differences.

The results obtained in this study indicate the difference between the growth rates of early and late calves, particularly within restricted calving seasons of two to three months, is not of much practical importance. However, calves born in the second half of the year tend to gain at a somewhat slower rate as compared with calves born during the first half of the year. At Oak Ridge there was a slight advantage in favor of earlier born calves over those born in May, June and July.

Correlations between day of birth and adjusted daily gain are shown in Table IX. For periods 1-19, statistically significant correlation coefficients of -.31 and .39 were obtained for Oak Ridge and Crossville, respectively. These correlations, however, do not appear to be of practical importance. Coefficients of determination (r^2) indicate that only 9.6 to 16.0 percent of the variation in adjusted daily gain of calves could be accounted for by differences in day of birth.

Type Score

The average type scores by locations and calving periods are shown in Table II. For periods 1-19, there was a range in type score of 10.0 to 12.3 for Alcoa, 10.1 to 13.5 for Oak Ridge, 10.4 to 12.8 for Crossville and 10.1 to 13.8 for Springfield. On a weighted average basis, the average type scores for all periods, 1-19, for the various locations were 11.8, 10.8, 12.1 and 12.0 respectively. An analysis of

variance of type scores for periods 4-19 (Table V) showed significant differences among periods and locations. Although the trend was slight, there was a decrease in type score with an increase in the numerical day of birth of the calf for the first half of the year. Calves born in February scored an average of about one-third of a grade higher than those born in June. The average type scores for periods 20-37 were 11.7 for Alcoa and 10.6 for Oak Ridge. Type score tended to increase with an increase in numerical day of birth of the calf during periods 20-37. Calves born in late summer scored an average of two-thirds of a grade lower than those born in the late fall months.

The regression of type score on numerical day of birth is shown in Tables VI and VII. Yearly regression coefficients were consistently negative, with few exceptions, at Alcoa, Springfield, Crossville and Oak Ridge. When the data for all years at each location were pooled and analyzed (Table VIII), regression coefficients of -.0055, -.0258 and -.0049 were obtained for type score on day in year calved for Alcoa, Oak Ridge and Springfield. Crossville had a positive coefficient for type score of .0011 but this was not significant. When the data from the locations involving Hereford calves were pooled, a highly significant regression of -.0186 was obtained for type score. These results indicate an advantage in favor of calves born early in the first half of the year and are in agreement with results reported by Marlowe, et al. (1958a) and Koch, et al. (1955). This might be due to the earlier calves being heavier and more mature at weaning, thus scoring higher than the later born calves.

The correlation between type scores and birth dates of calves are given in Table IX. For periods 1-19, significant negative correlations were obtained for Alcoa, Oak Ridge, for all Herefords and for all locations. Coefficients of determination indicate only about 4 to 25 percent of the variation in type scores could be accounted for by variation in calving dates. Thus, date of calving would not have a high predictive value with respect to type grade at weaning.

Condition Score

The average condition scores are shown in Table III. For periods 1-19, there was a range in condition scores of 7.5 to 11.2 for Alcoa, 7.1 to 10.9 for Oak Ridge, 9.5 to 11.9 for Crossville and 7.7 to 11.0 for Springfield. On a weighted average basis, the average condition scores for the various locations for all periods, 1-19, were 9.9, 9.2, 10.8 and 9.5, respectively. Analysis of variance for periods 4-19 showed significant differences among periods and locations. Calves born in February graded as much as two-thirds of a grade higher than calves born in June. This clearly indicates an advantage in condition score for calves born early in the first half of the year as compared with calves born later in the first half of the year. In periods 20-37, the average condition scores for the second half of the year were as high or higher than for the first half of the year.

Regression coefficients for regression of condition score on numerical day in year calved are given in Table VI, VII and VIII. With the exception of one year (1956) at Crossville, all regression coefficients

for years within locations (periods 1-19) were negative, indicating that early calves graded higher on condition socre than late calves. When data for all years were pooled and analyzed by locations, highly significant regression coefficients of -.0103, -.0116, -.0170 and -.0166 were obtained for Alcoa, Oak Ridge, Springfield and Crossville, respectively. Regressions for breeds and the average regression for all locations also were highly significant ($P < .01$). Based on the average regression for all locations, 30 days difference in day of birth would mean a difference of about .35 of a unit in condition score; ninety days difference in birth dates would make a difference in condition score of calves of about one unit (one-third of a grade).

In periods 20-37, positive regression coefficients for regression of condition score on numerical day in year calved were obtained for Alcoa and Oak Ridge. This suggests that calves born in the late fall would score higher than late summer and early fall calves. Generally, calves born in the first three and the last two months of the year scored higher for condition than calves born in the late spring, summer and early fall months.

Correlations between day of birth and condition score were significant but relatively small in value. They ranged from .2457 to .3630, for the various locations and coefficients of determination indicate that about 5.8 to 13.0 percent of the total variation in condition scores can be accounted for by variation in birth dates of calves.

Weanling Index

The average weanling indexes, for periods 1-19, are shown in

Table IV. The range of weanling index was 100 to 113 for Alcoa, 101 to 120 for Oak Ridge, 109 to 122 for Crossville and 104 to 135 for Springfield. Average weaning indexes on a weighted basis for all periods within locations were 109, 108, 116 and 114, respectively. Analysis of variance of weanling indexes, periods 4-19 (Table V), showed no significant differences among periods. There were, however, significant differences among locations. There was no definite trend in size of index with age of calf. Considerable variation was noted from period to period and a high index and a low index could be found in adjacent periods. Averages indexes for periods 20-37 were somewhat lower than averages for the first 19 periods. The average index was 101 for Alcoa and 95 for Oak Ridge. These results suggest that caution should be used in comparing weanling indexes of calves born in the first half of the year with calves born in the last half of the year unless corrections are made for the influence of season of birth.

Regression coefficients (Tables VI, VII) followed the same general pattern observed for type and adjusted daily gain. Yearly regression coefficients at Crossville were positive with the exception of those for 1955 and 1957. A regression coefficient os .0312 was obtained when the data from all years were pooled but this regression was not significant. At Alcoa and Springfield there was considerable variation in regressions from year to year. At Oak Ridge the regression of weanling index on numerical day in year calved was consistently negative from one year to another. The average regressions over all years were -.0216 for Alcoa, -.0084 for Springfield, and -.0926 for Oak Ridge; only the regression

at Oak Ridge was significant ($P < .01$). The regressions of -.0669 for all Hereford and -.0602 for all locations were highly significant. These regression coefficients indicate that 30 days earlier in date of birth during periods 1-19 would result in about 2.0 units decrease in index at weaning. Regression for periods 20-37 were positive for both locations, indicating, as in the other traits, an advantage for the late-fall, early-winter calves over the late-summer, early-fall calves.

Correlations of weanling index with day in year calved ranged from -.0227 to -.3057 for the different locations for periods 1-19 (Table IX). Coefficients of determination indicate that 0.05 to 9.40 percent of the variance in weanling indexes of calves could be accounted for by variation of date within year of calving.

Application of Results

These results indicate that the use of performance records that are uncorrected for day of birth within restricted calving seasons of two to three months would not seriously affect the evaluation of possible genetic differences between individuals and subsequent selection as potential breeding stock. This would be applicable to the Tennessee beef cattle production program where spring (mid-January, February and March) calves are desired. Adjustment of performance data should be kept to a minimum and used only for major effects, since from a practical breeding standpoint more risk is involved in over-adjusting than under-adjusting. However, caution should be used in comparing records of calves born in different seasons of the year (i.e., in the first or second half of the year) and subjected to different environmental and management

conditions during the suckling period. This would be particularly applicable for comparisons involving rate of gain and condition scores and, to a lesser extent, comparisons involving type score. The most logical plan would be to limit the evaluation and comparison of the records of calves to within season comparisons after adjusting for the affects of sex and age of dam on performance. If direct comparisons are made between the records of calves born in different seasons, then such records should be adjusted for season of birth or serious errors could be made in selection.

CHAPTER V

SUMMARY AND CONCLUSIONS

Weanling performance data from 2,443 calves at four locations were studied to determine the influence of numerical day of birth in the calving season on adjusted daily gain, type score, condition score and weanling index. Average values for each of these traits were calculated for successive 10-day periods within locations, combining all years. The influence of birth date on performances also was studied by regressing the various traits on numerical day in year calved within seasons. Regression coefficients were first calculated for years within locations. A common regression was obtained for each location by pooling the data for all years. Average regression coefficients were determined for Hereford, Angus, and all cattle. Data from calves born from January 1st to July 8th were analyzed separately from data for calves born July 9th to December 31st. Correlations were also determined between performance in each of the traits and day in year calved.

Differences among average adjusted daily gains for 10-day calving periods in both the first and second half of the year were not significant, indicating that day calved within season of birth would have relatively little influence on the growth rate of calves born over a limited period of time. Considerable differences were found in the adjusted daily gain of calves born in the first half of the year as compared with the second half of the year. Calves born in the first half of the year gained an average of 0.18 to 0.33 pound per day more

than calves born in the last half of the year. Regression coefficients for adjusted daily gain on numerical day in season calved were variable and not consistent for all locations. The average regression, of adjusted daily gain on day in season calved for Alcoa, Springfield, Crossville and Oak Ridge was .0003, .0004, .0010 and -.0018, respectively. The positive regressions indicate that calves born later in the season gained more rapidly than those born earlier and the negative regression indicates that calves born earlier in the season gained slightly faster than the calves born later. Even though there is a statistically significant difference in some of these regressions, they do not appear to be of much practical importance.

Type scores were significantly influenced by the period of calving in both the first and second half of the year. During the first half of the year type scores were highest during the first nine ten-day periods (January, February and March). During the last half of the year, type score tended to increase with an increase in numerical day of birth of the calf. The regressions of type score on day in season calved indicated an advantage in type score for calves born early in the first half of the year. Although the trend was slight, there was a decrease in type score with an increase in numerical day of birth of the calf. In the last half of the year, type score tended to increase with an increase in numerical day of birth of the calf.

Condition scores were also significantly affected by numerical day of birth within seasons. The condition scores of calves born early in the first half of the year were significantly higher than condition scores

of calves born later. Regression coefficients for condition score on day in season calved were consistently negative for all locations included in the study, indicating that early calves scored higher than late calves. Condition scores were highest for calves born in January, February and March.

The influence of numerical day of birth within season on the performance of the calf was not consistent for all locations. Differences among averages by 10-day periods for both the second half of the year were not significant.

The average weanling index for calves born during the last half of the year were considerably smaller than the index for calves born in the first half of the year for locations where such comparisons could be made. Regression coefficients for weanling index on day in season calved were positive at one location and negative at the other location involved in the study. Although some of these regressions within seasons were statistically significant for some locations, they do not appear to be of practical significance from the standpoint of over-all evaluation and selection.

These results indicate that the use of performance records that are uncorrected for numerical day of birth within restricted calving seasons of two to three months would not seriously affect the evaluation of possible genetic differences between individuals and subsequent selection as potential breeding stock. However, caution should be used in comparing records of calves born in different seasons of the year (i.e., in the first or second half of the year) and subjected to different

environmental and management conditions during the suckling period. This would be particularly applicable for comparisons involving rate of gain and condition scores and, to a lesser extent, comparisons involving type score. The most logical plan would be limit the evaluation and comparison of the records of calves to within season comparisons after adjusting for the affects of sex and age of dam on performance. If direct comparisons are made between the records of calves born in different seasons, then such records should be adjusted for season of birth or serious errors could be made in selection.

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APPENDIX

TABLE I

AVERAGE ADJUSTED DAILY GAIN OF CALVES BY LOCATION AND CALVING PERIODS

Periods	Alcoa		Oak Ridge		Crossville		Springfield		Total
	No. of calves	Adj. daily gain	No. of calves	Adj. daily gain	No. of calves	Adj. daily gain	No. of calves	Adj. daily gain	no. of calves
		pounds		pounds		pounds		pounds	
1	3	1.41	1	1.82	0	-	2	1.62	6
2	6	1.70	2	1.62	0	-	2	1.76	10
3	42	1.63	34	1.86	0	-	3	1.70	79
4	147	1.65	24	1.90	3	1.93	4	1.53	178
5	134	1.68	185	1.81	31	1.80	9	1.75	359
6	87	1.71	175	1.84	66	1.86	2	1.93	330
7	74	1.67	130	1.76	85	1.78	13	1.79	302
8	58	1.77	97	1.81	46	1.87	9	1.79	210
9	43	1.72	85	1.78	31	1.86	8	1.68	167
10	42	1.76	65	1.84	30	1.86	9	1.76	146
11	34	1.66	48	1.72	24	1.85	6	2.06	112
12	41	1.71	34	1.78	18	1.84	2	1.99	95
13	25	1.73	38	1.86	15	1.86	11	1.85	89
14	26	1.77	22	1.69	10	1.71	12	1.84	70
15	14	1.67	12	1.85	8	2.04	8	1.79	42
16	15	1.71	9	1.86	5	1.91	5	2.10	34
17	4	1.57	7	1.69	6	2.05	6	1.55	23
18	9	1.57	6	1.96	6	2.00	2	1.83	23
19	8	1.83	6	1.71	4	1.87	1	2.06	19
Total	812		980		388		114		2294
Average		1.69		1.81		1.84		1.80	

TABLE I (continued)

AVERAGE ADJUSTED DAILY GAIN OF CALVES BY LOCATION AND CALVING PERIODS

Periods	Alcoa		Oak Ridge		Total
	No. of calves	Adj. daily gain	No. of calves	Adj. daily gain	no. of calves
		pounds		pounds	
20	0	-	1	1.51	1
21	0	-	0	-	-
22	1	1.54	5	1.27	6
23	0	-	13	1.67	13
24	0	-	23	1.40	23
25	2	1.50	31	1.44	33
26	2	1.43	13	1.43	15
27	8	1.62	8	1.54	16
28	14	1.56	7	1.59	21
29	8	1.33	4	1.00	12
30	2	1.42	0	-	2
31	1	1.63	1	2.02	2
32	0	-	0	-	-
33	0	-	0	-	-
34	0	-	0	-	-
35	0	-	0	-	-
36	1	1.56	0	-	1
37	0	-	3	2.39	3
Total	39		110		149
Average		1.51		1.48	

TABLE II

AVERAGE TYPE SCORE OF CALVES BY LOCATION AND CALVING PERIODS

Periods	Alcoa		Oak Ridge		Crossville		Springfield		Total no. of calves
	No. of calves	Type[a] score	No. of calves	Type[a] score	No. of calves	Type[a] score	No. of calves	Type[a] score	
		units		units		units		units	
1	0	-	1	13.5	0	-	2	12.8	3
2	6	12.0	2	11.7	0	-	2	11.8	10
3	42	12.3	34	10.8	0	-	3	11.8	79
4	147	12.0	24	11.4	3	11.8	4	12.8	178
5	134	12.0	185	10.9	31	12.1	9	12.5	359
6	87	12.0	175	10.8	66	12.6	2	12.5	330
7	74	11.8	130	10.7	85	12.4	13	12.3	302
8	58	11.7	97	10.6	46	12.1	9	12.3	210
9	43	11.8	85	10.9	31	12.1	8	11.6	167
10	42	11.9	65	10.9	30	12.3	9	11.7	146
11	34	11.1	48	10.6	24	11.5	6	11.7	112
12	41	11.9	34	10.3	18	12.8	2	11.8	95
13	25	11.2	38	10.8	15	11.6	11	12.2	89
14	26	11.5	22	10.4	10	11.5	12	10.2	70
15	14	11.0	12	11.8	8	11.4	8	12.3	42
16	15	11.2	9	11.4	5	10.4	5	13.8	34
17	4	12.1	7	11.0	6	11.3	6	12.2	23
18	9	11.2	6	10.9	6	12.0	2	12.3	23
19	8	10.0	6	10.1	4	10.8	1	10.1	19
Totals	809		980		388		114		2291
Average		11.8		10.8		12.1		12.0	

[a]Type scores: Fancy 15-17; Choice 12-14; Good 9-11.

TABLE II (continued)

AVERAGE TYPE SCORE OF CALVES BY LOCATION AND CALVING PERIODS

Periods	Alcoa		Oak Ridge		Total
	No. of calves	Type[a] score units	No. of calves	Type[a] score units	no. of calves
20	0	-	1	9.5	1
21	0	-	0	-	-
22	0	-	5	8.0	5
23	0	-	13	10.0	13
24	0	-	23	10.7	23
25	2	10.0	31	11.0	33
26	2	10.0	13	10.7	15
27	8	11.7	8	11.8	16
28	14	12.2	7	10.4	21
29	8	11.8	4	10.5	12
30	2	11.0	0	-	2
31	1	12.0	1	12.0	2
32	0	-	1	12.0	1
33	0	-	0	-	-
34	0	-	0	-	-
35	0	-	0	-	-
36	0	-	0	-	-
37	0	-	3	10.2	3
Total	37		110		147
Average		11.7		10.6	

[a]Type scores: Fancy 15-17; Choice 12-14; Good 9-11.

TABLE III

AVERAGE CONDITION SCORE OF CALVES BY LOCATION AND CALVING PERIODS

Periods	Alcoa		Oak Ridge		Crossville		Springfield		Total no. of calves
	No. of calves	Cond.[a] score units	No. of calves	Cond.[a] score units	No. of calves	Cond.[a] score units	No. of calves	Cond.[a] score units	
1	0	-	1	10.5	0	-	2	9.5	3
2	6	9.3	2	8.0	0	-	2	10.5	10
3	42	9.7	34	9.9	0	-	3	9.0	79
4	147	10.3	24	10.9	3	9.5	4	10.3	241
5	134	9.8	185	9.6	31	10.5	9	10.4	359
6	87	10.3	175	9.5	66	11.2	2	9.5	330
7	74	10.0	130	9.0	85	10.9	13	10.2	302
8	58	10.0	97	9.2	46	10.9	9	10.3	210
9	43	9.7	85	9.2	31	10.5	8	8.7	167
10	42	10.0	65	9.1	30	10.6	9	9.6	146
11	34	11.2	48	8.5	24	10.6	6	11.0	112
12	41	9.7	34	8.5	18	11.9	2	10.3	95
13	25	9.0	38	8.8	15	10.0	11	10.1	89
14	26	9.4	22	7.8	10	9.9	12	8.1	70
15	14	8.2	12	9.0	8	11.2	8	8.3	42
16	15	8.3	9	8.6	5	9.6	5	10.3	34
17	4	8.0	7	8.4	6	10.4	6	7.7	23
18	9	8.2	6	8.1	6	10.5	2	9.0	23
19	8	7.5	6	7.1	4	9.6	1	8.5	19
Totals	809		980		388		114		2291
Average		9.9		9.2		10.8		9.5	

[a]Condition scores: Prime 15-17; Choice 12-14; Good 9-11; Standard 6-8; Utility 3-5.

TABLE III (continued)

AVERAGE CONDITION SCORE OF CALVES BY LOCATION AND CALVING PERIODS

Periods	Alcoa		Oak Ridge		Total
	No. of calves	Cond.[a] score	No. of calves	Cond.[a] score	no. of calves
		units		units	
20	0	-	1	5.0	1
21	0	-	0	-	-
22	0	-	5	8.0	5
23	0	-	13	9.1	13
24	0	-	23	9.0	23
25	2	8.0	31	9.3	33
26	2	9.5	13	9.5	15
27	8	10.7	8	10.3	16
28	14	10.6	7	9.2	21
29	8	10.0	4	7.6	12
30	2	10.0	0	-	2
31	1	10.0	1	9.0	2
32	0	-	1	11.0	1
33	0	-	0	-	-
34	0	-	0	-	-
35	0	-	0	-	-
36	0	-	0	-	-
37	0	-	3	11.3	3
Total	37		110		147
Average		10.2		9.2	

[a]Condition scores: Prime 15-17; Choice 12-14; Good 9-11; Standard 6-8; Utility 3-5.

TABLE IV

AVERAGE WEANLING INDEX OF CALVES BY LOCATION AND CALVING PERIODS

Periods	Alcoa		Oak Ridge		Crossville		Springfield		Total
	No. of calves	Index[a]	No. of calves	Index[a]	No. of calves	Index[a]	No. of calves	Index[a]	no. of calves
		units		units		units		units	
1	0	-	1	120	0	-	2	111	3
2	6	113	2	105	0	-	2	111	10
3	42	110	34	110	0	-	3	109	79
4	147	109	24	115	3	118	4	107	241
5	134	109	185	109	31	113	9	115	359
6	87	111	175	108	66	120	2	122	330
7	74	108	130	106	85	113	13	115	302
8	58	112	97	108	46	118	9	116	210
9	43	109	85	108	31	117	8	107	167
10	42	113	65	110	30	118	9	111	146
11	34	104	48	104	24	114	6	123	112
12	41	112	34	105	18	120	2	120	95
13	25	107	38	110	15	115	11	117	89
14	26	110	22	102	10	109	12	107	70
15	14	104	12	113	8	121	8	116	42
16	15	105	9	113	5	111	5	135	34
17	4	105	7	104	6	120	6	104	23
18	9	100	6	115	6	122	2	117	23
19	8	105	6	101	4	111	1	117	19
Totals	809		980		388		114		2291
Average		109		108		116		114	

[a]Weanling index constructed by using adjusted daily gain and type score.

TABLE IV (continued)

AVERAGE WEANLING INDEX OF CALVES BY LOCATION AND CALVING PERIODS

Periods	Alcoa		Oak Ridge		Total no. of calves
	No. of calves	Index units	No. of calves	Index units	
20	0	-	1	90	1
21	0	-	0	-	-
22	0	-	5	73	5
23	0	-	13	103	13
24	0	-	23	91	23
25	2	85	31	95	33
26	2	92	13	93	15
27	8	100	8	103	16
28	14	107	7	98	21
29	8	95	4	74	12
30	2	100	0	-	2
31	1	107	1	123	2
32	0	-	1	102	1
33	0	-	0	-	-
34	0	-	0	-	-
35	0	-	0	-	-
36	0	-	0	-	-
37	0	-	3	128	3
Total	37		110		147
Average		101		95	

TABLE V

ANALYSES OF VARIANCE FOR VARIOUS TRAITS FOR CALVING PERIODS FOUR THROUGH NINETEEN

Source	Degrees of freedom	Sums of squares	Mean square	F
Adjusted Daily Gain				
Location	3	.28	.093*	7.75
Period	15	.15	.010	.83
Location x period	45	.56	.012	
Total	63	.99		
Type Score				
Location	3	12.26	4.09*	13.19
Period	15	11.36	.76*	2.45
Location x period	45	13.83	.31	
Total	63	37.45		
Condition Score				
Location	3	22.98	7.66*	15.63
Period	15	26.17	1.74*	3.55
Location x period	45	22.19	.49	
Total	63	71.34		
Weanling Index				
Location	3	1021.80	360.60*	12.63
Period	15	387.36	25.82	.96
Location x period	45	1213.45	26.97	
Total	63	2622.61		

* P = < .05

TABLE VI

REGRESSION COEFFICIENTS BY YEARS FOR PERFORMANCE AT WEANING ON DAY IN YEAR CALVED

Location	Breed	Year	No. of calves	Regression Coefficients: Adj. daily gain	Type score	Condition score	Weanling index
First Half of Year - Periods 1-19							
Alcoa	Hereford	1952	54	.0068	-	-	-
		1953	44	-.0006	-.0003	-.0050	-.0226
		1954	179	.0004	-.0072	-.0143	-.0230
		1955	178	.0012	-.0041	-.0095	.0230
		1956	166	.0005	-.0140	-.0130	-.0530
		1957	177	.0002	-.0120	-.0150	-.0500
Oak Ridge	Hereford	1953	137	-.0028	-.0024	-.0106	-.1245
		1954	136	-.0020	.0001	-	-.0793
		1955	203	-.0001	-.0025	-.0110	-.0180
		1956	327	-.0011	-.2200	-.0220	-.1100
		1957	263	-.0006	-.0069	-.0094	-.0600
Spring-field	Hereford	1952	19	-.0005	.0170	-.0260	.0630
		1953	13	-.0011	-.0240	-.0370	-.1650
		1954	13	.0030	-.0085	-.0028	.0800
		1955	20	.0008	.0049	-.0130	.0550
		1956	25	-.0004	-.0081	-.0230	-.0480
		1957	27	-.0016	-.0130	-.0200	-.1300
Cross-ville	Angus	1952	52	.0003	.0023	-.0600	.0621
		1953	63	.0016	-.0012	-.0200	.0200
		1954	64	.0024	-.0021	-.0070	.0700
		1955	80	.0014	-.0036	-.0150	-.0026
		1956	78	.0007	.0170	.0160	.1142
		1957	56	-.0011	-.0370	-.0320	-.2400

TABLE VII

REGRESSION COEFFICIENTS BY YEARS FOR PERFORMANCE AT WEANING ON DAY IN YEAR CALVED

Location	Breed	Year	No. of calves	Regression coefficients: Adj. daily gain	Type score	Condition score	Weanling index
			Second Half of Year - Periods 20-37				
Alcoa	Hereford	1952	14	-.0004	-	-	-
		1953	17	.0024	.0232	.0162	.2182
		1954	8	-.0035	-	-	-
Oak Ridge	Hereford	1952	33	.0054	-.0086	.0100	.1700
		1953	57	-.0044	.0108	-.0026	-.1202
		1954	20	-.0094	.0142		-.2040

TABLE VIII

REGRESSION COEFFICIENTS BY LOCATIONS FOR PERFORMANCE AT WEANING ON DAY IN YEAR CALVED

Location	Breed	Regression coefficients			
		Adj. daily gain	Type score	Condition score	Weanling index
First Half of Year - Periods 1-19					
Alcoa	Hereford	.0003	-.0055**	-.0103**	-.0216
Oak Ridge	Hereford	-.0018**	-.0258**	-.0116**	-.0926**
Springfield	Hereford	.0004	-.0049	-.0170**	-.0084
All Herefords	Hereford	-.0009**	-.0186**	-.0114**	-.0669**
Crossville	Angus	.0010*	.0011	-.0166**	.0312
All Locations	Angus and Hereford	-.0008**	-.0172**	-.0117**	-.0602**
Second Half of Year - Periods 20-37					
Alcoa	Hereford	.0001	.0232	.0162	.2182
Oak Ridge	Hereford	.0032*	-.0044	.0078	.1034
Combined	Hereford	.0026*	-.0032	.0082	.1085

* $P < .05$

** $P < .01$

TABLE IX

CORRELATION COEFFICIENTS BY LOCATIONS FOR PERFORMANCE AT WEANING WITH DAY IN YEAR CALVED

Location	Breed	Correlation coefficients			
		Adj. daily gain	Type score	Condition score	Weanling index
First Half of Year - Periods 1-19					
Alcoa	Hereford	.0642	-.1670**	-.3025**	-.0665
Oak Ridge	Hereford	-.3147**	-.5128**	-.3482**	-.3057**
Springfield	Hereford	.0397	-.1560	-.3630**	-.0227
All Herefords	Hereford	-.1621**	-.4143**	-.3323**	-.2135**
Crossville	Angus	.3933**	.0237	-.2457**	.0695
All Locations	Hereford and Angus	-.1345**	-.3818**	-.3163**	-.1857**
Second Half of Year - Periods 20-37					
Alcoa	Hereford	.0020	.2957	.0650	.2817
Oak Ridge	Hereford	.2337*	-.0866	.1430	.1647
Combined	Hereford	.2036*	-.0392	.1490	.1708

* $P < .05$

** $P < .01$

TABLE X

BREAKDOWN OF A YEAR INTO TEN-DAY CALVING PERIODS

Period	Range	Dates	
		From	To
	First Half of Year		
1	0-9	Jan. 1	Jan. 9
2	10-19	Jan. 10	Jan. 19
3	20-29	Jan. 20	Jan. 29
4	30-39	Jan. 30	Feb. 8
5	40-49	Feb. 9	Feb. 18
6	50-59	Feb. 19	Feb. 28
7	60-69	Mar. 1	Mar. 10
8	70-79	Mar. 11	Mar. 20
9	80-89	Mar. 21	Mar. 30
10	90-99	Mar. 31	Apr. 9
11	100-109	Apr. 10	Apr. 19
12	110-119	Apr. 20	Apr. 29
13	120-129	Apr. 30	May 9
14	130-139	May 10	May 19
15	140-149	May 20	May 29
16	150-159	May 30	June 8
17	160-169	June 9	June 18
18	170-179	June 19	June 28
19	180-189	June 29	July 8

TABLE X (continued)

BREAKDOWN OF A YEAR INTO TEN-DAY CALVING PERIODS

Period	Range	Dates	
		From	To
	Second Half of Year		
20	190-199	July 9	July 18
21	200-209	July 19	July 28
22	210-219	July 29	Aug. 7
23	220-229	Aug. 8	Aug. 17
24	230-239	Aug. 18	Aug. 27
25	240-249	Aug. 29	Sept. 6
26	250-259	Sept. 7	Sept. 16
27	260-269	Sept. 17	Sept. 26
28	270-279	Sept. 27	Oct. 6
29	280-289	Oct. 7	Oct. 16
30	290-299	Oct. 17	Oct. 26
31	300-309	Oct. 27	Nov. 5
32	310-319	Nov. 6	Nov. 15
33	320-329	Nov. 16	Nov. 25
34	330-339	Nov. 26	Dec. 5
35	340-349	Dec. 6	Dec. 15
36	350-359	Dec. 16	Dec. 25
37	360-365	Dec. 26	Dec. 31