Factors To Take Into Account When Adjusting Weaning Weights of Calves

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There is opportunity for improving weaning weights of beef cattle by selection depending upon the degree to which differences observed among calves are genetic. Environmental differences among calves tend to reduce the effect of selection. Two methods of reducing environmental differences are available to the breeder. The best one is to physically control environment by standardizing feeding and management conditions. However, there are many factors over which breeders have very little or no managerial control. For some of these it is possible to use correction factors to adjust for nongenetic differences among individuals and thus improve the effectiveness of selection.

This study was conducted to determine the effect of seven environmental factors on weaning weight of calves raised in Oklahoma and to investigate the importance of two-way interactions among these factors. A second objective was to determine which type of correction, additive or multiplicative, is most appropriate in adjusting weaning weights for important sources of environmental variation.

Materials and Methods

The data used in this study were the adjusted 205 day weaning weights of 13,937 Hereford and Angus calves recorded in the Oklahoma Beef Cattle Improvement Program over a four year period from 1959 through 1962. Each calf was classified according to age of dam, sex, breed, type of pasture, area of the state, month of birth and type of management. The effects of these seven environmental factors were estimated by the method of least squares as outlined by Harvey (1960). The breakdown for age of dam is given in Table 2. Pastures were divided into three general classes (1) Native-ranches with predominately native grasses, (2) Improved-ranches with predominantly cultivated grasses such as Bermuda and Fescue, and (3) Mixed-ranches with a predominance of neither native or improved pastures. The state was divided into six areas: NE, SE, SC, NC, NW, SW. Type of management refers to whether the calves were creep-fed or not creep-fed.

To investigate all possible two-way interactions least squares analyses were computed separately for each sex, breed, type of pasture, type of management, and each of four seasons. Two-way interactions were examined by comparing least squares estimates computed for a given level of one factor within different levels of another factor. The interaction between age of dam and sex for example, was studied by comparing the least squares estimates for age of dam computed in the three separate sex analyses. The failure of the estimates to be the same was considered indicative of interaction. The criterion for assessing the significance of interaction was whether or not the 95 percent confidence intervals on the least squares constants overlapped.

The study of additive versus multiplicative correction factors was conducted by determining which method of adjustment would more nearly equalize averages between adjusted groups and variances within adjusted groups.

Results and Discussion

MAIN EFFECTS AND INTERACTIONS

The analysis of variance is given in Table 1. All factors were statistically significant sources of variation because of the large numbers. However, variance component estimates revealed that breed and pasture differences were of no practical importance. Together they accounted for less than one percent of the total variation in weaning weight. Age of dam, sex, area, month of birth, and type of management were important sources of variation each accounting for more than five percent of the total variance. All of these factors except areas will be considered in this report. Since a breeder is usually located in a given area there is no need of correction for areas.

Age of Dam. The results of the interaction analyses indicated that the effect of areas was essentially the same regardless of sex, breed, type of pasture, season, or type of management. Thus, the estimates of the effect of age of dam given in Table 2 were taken from the overall analysis. The estimates indicate that increases in age of dam of only 3-5 month increments have an important influence on weaning weights of calves out of 2- and 3-year-old cows. It appears that classifying cows into 3- to 5-month increments between 2 and 4 years of age would result in more accurate corrections than yearly increments. Productivity continued to increase at a diminishing rate until the cows were 8 years old. The average weaning weights were essentially the same for calves out of cows between 6 and 13 years of age. Productivity dropped off slightly in 14 and 15 year old cows. These results agree closely with previous reports from the Midwest and other areas of moderate to high rainfall.

Table 1. The Analysis of Variance.

Source of Variation	Degrees of Freedom	Mean Squares	Variance Components	% of Variance
Total	13,936		5,760	100
Direct Effects				
Age of dam	16	332,196*	410	7.1
Sex	2	4,274,254*	999	17.3
Breed	1	59,183*	8	0.1
Pasture	2	184,626*	41	0.7
Area	5	578,190*	303	5.3
Month of Birth	11	427,519*	376	6.5
Management	1	2,154,933*	314	5.4
Error	13,897	3,309*	3,309	57.4

*P < .005, i.e., if in reality there is no difference in weaning weights between age of dam groups, sexes, . . . , and types of management differences as large as those observed in this study would be expected to occur simply due to chance less than 5 times in 1000 such trials.

Table 2. Least Squares Estimates For Age of Dam

Age of Dam	Number of Calves	Constants[1]	Averages
— 27 mos.	843	— 49	369
28 — 30 mos.	690	— 36	381
31 — 33 mos.	454	— 28	389
34 — 39 mos.	1,059	— 20	398
40 — 45 mos.	1,005	— 4	413
4 yrs.	1,863	1	418
5 yrs.	1,538	7	425
6 yrs.	1,339	13	431
7 yrs.	1,122	16	434
8 yrs.	1,043	18	436
9 yrs.	984	18	436
10 yrs.	751	16	433
11 yrs.	538	16	434
12 yrs.	308	13	430
13 yrs.	218	15	432
14 yrs.	106	10	427
15 yrs.	76	— 5	413

[1] The average deviation of each age of dam group from the overall average.

They do not show the marked decline after 7 to 8 years that has been observed in the more arid regions of the West.

Sex of Calf. Interaction analyses indicated that sex x breed, sex x pasture, and sex x season interactions were small and unimportant. The interaction between sex and type of management was significant, however, and appeared to be important enough to be taken into account in adjusting weaning weights. The estimates for sex are given in Table 3 according to type of management. Bull calves that were creep-fed deviated significantly more from their mean than those that were not creep fed. These results suggest that bull calves possess greater growth potential than steers or heifers and that this potential is revealed even more when calves are creep-fed than when they are not creep-fed.

The differences observed in this study between bulls and steers and bulls and heifers are larger than those in previous reports. The differences between steers and heifers is smaller than expected. A tendency for producers to keep faster growing more thrifty male calves as bulls and to castrate the slower growing calves has apparently caused the differences between bulls and steers and bulls and heifers to be biased upward and the difference between steers and heifers to be biased downward. Thus, these estimates of the effect of sex are not considered appropriate for use in the field as correction factors.

Month of Birth. Month of birth had an important influence on weaning weight. However, the interaction analyses indicated that the effect of month of birth was dependent on type of management and type of pasture. The least squares constants obtained for month of birth in the separate analyses for creep-fed and noncreep-fed calves are given in Figure 1 and Table 4. These data indicate that creep feeding reduced

Table 3. Least Squares Estimates Within Type of Management for Sex of Calf.

Sex	No Creep		Creep	
	Constants[1]	Averages	Constants[2]	Averages
Bulls	32	423	38	475
Steers	—13	377	—15	421
Heifers	—20	371	—24	412

[1] The average deviation of each sex from the overall average of non-creep-fed calves.
[2] The average deviation from the overall average of creep-fed calves.

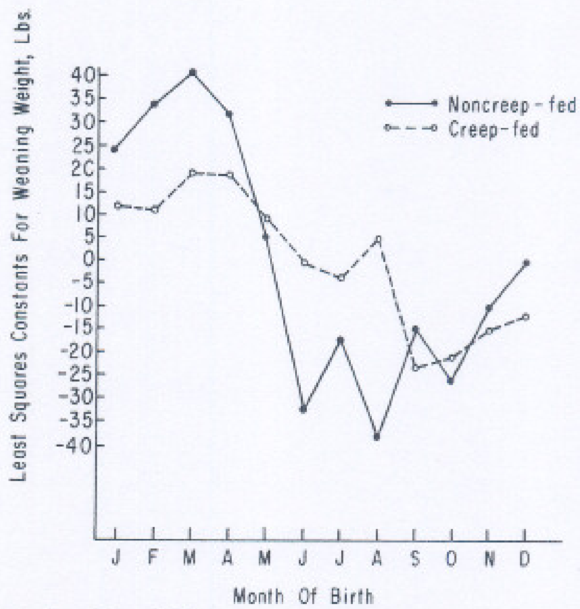

Figure 1. Month of birth by type of management.

the effect of season of birth on weaning weight. Calves born in the spring had an advantage over those born in the summer or fall in both types of management, but this advantage was much greater in calves that were not creep-fed than in those that were creep-fed.

The advantage of creep-feeding was greater for calves dropped in the fall than for those dropped in the spring, and calves dropped in the summer benefited even more from creep-feeding. These results suggest that calves born during the more adverse summer and fall seasons tend to compensate for the low milk production of their dams and reduced level of forage available to them by consuming more creep-feed. In this manner it appears that creep-feeding standardizes the preweaning environment and reduces the effect of season of birth on weaning weight. Thus, it appears that separate correction factors should be used for month or season of birth depending on whether calves are creep-fed or not.

The least squares constants obtained for month of birth in separate analyses for native and improved pasture are given in Figure 2 and Table 5. Calves raised on native pasture had a significant advantage over those raised on improved pasture when born in the spring or fall. Those raised on improved pasture had an advantage over those raised on native pasture when dropped during the summer months.

These data indicate that season of birth can have an important influence on weaning weight. The most effective method of reducing the source of nongenetic variation available to the breeder is to restrict the calving season to a two- or three-month period. However in herds where calves are born in more than one season of the year adjustments should be made for season of birth. It is evident from these data that no single set of correction factors are appropriate for season of birth. Separate

Table 4. Least Squares Estimates Within Type of Management For Month of Birth

Month	No Creep		Creep	
	Constants[1]	Averages	Constants[2]	Averages
Jan.	24	415	12	448
Feb.	34	425	11	448
Mar.	41	432	19	456
April	32	422	19	455
May	6	396	10	446
June	−33	357	0	436
July	−17	374	− 4	432
Aug.	−38	352	5	441
Sept.	−14	377	−24	413
Oct.	−27	364	−21	415
Nov.	−10	380	−15	421
Dec.	1	391	−12	424

[1] The average deviation for each month of birth from the overall average of non-creep-fed calves
[2] The average deviation from the overall average of creep-fed calves.

Table 5. Least Squares Estimates Within Type of Pasture For Month of Birth.

Month	Native Pasture		Improved Pasture	
	Constants[1]	Averages	Constants[2]	Averages
Jan.	16	440	4	419
Feb.	20	445	20	435
Mar.	36	460	25	439
April	27	451	18	433
May	− 1	424	10	425
June	− 4	420	9	424
July	−30	394	18	432
Aug.	−32	392	− 9	405
Sept.	−17	407	−11	404
Oct.	− 5	420	−35	380
Nov.	− 3	422	−26	388
Dec.	− 6	418	−24	391

[1] The average deviation of each month of birth from the overall average of calves raised on native pasture.
[2] The average deviation from the overall average of calves raised on improved pasture.

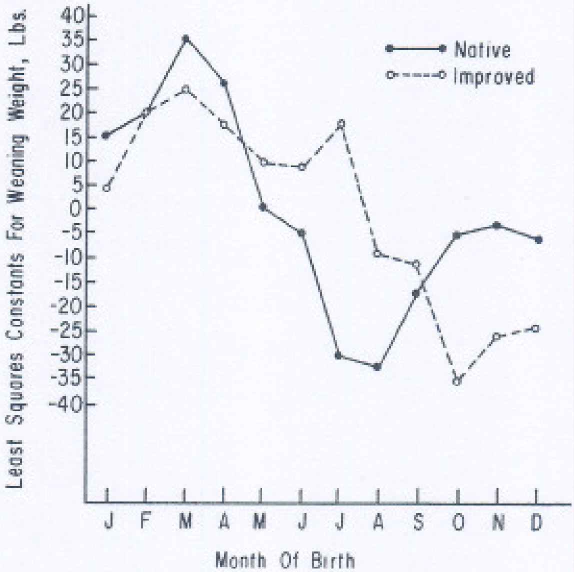

Figure 2. Month of birth by type of pasture.

corrections should be used depending on whether calves are creep-fed or not creep-fed and whether they are raised on native or improved pastures. Ranches that wean a large number of calves born throughout the year use corrections for their own particular situation based on their own records possibly within each year.

METHOD OF ADJUSTMENT

Both additive and multiplicative adjustments are used to adjust weaning weights for differences between calves due to nongenetic factors such as age of dam and sex. With additive adjustments the average difference between the sub-class chosen as standard and the sub-class represented by particular calf is added to the calf's weaning weight.

With multiplicative adjustments, the calf's weaning weight is multiplied times the ratio of the respective subclass averages. Multiplicative factors increase or decrease the weight relative to the existing weight of the calf while additive factors are the same regardless of existing weight. Both methods make about the same correction for calves of average or near average weight but they are different for animals at extreme light or heavy weights.

Thus, the two methods differ in their effect on variation within adjusted groups. Additive corrections do not alter the variance within adjusted groups while multiplicative factors raise or lower the variation depending on whether the correction factors are larger or smaller than 1.00. In order for correction factors to be most satisfactory they should equalize both averages between adjusted groups and variation within adjusted groups.

Age of Dam. The additive and multiplicative corrections derived in this study for age of dam are given in Table 6 along with the means and standard deviations that would result from their use. No corrections were made for cows ranging in age from 6 through 13 years since their average weaning weights had a range of only six pounds. The means were equalized fairly well by both methods. The standard deviations are measures of variation in weaning weight among calves of the various age of dam groups.

The method of correction in which the standard deviations are more nearly equal for all age groups is most appropriate for use in adjusting weaning weights. The additively adjusted standard deviations had a range of 12.8 pounds (62.2-49.4) and themselves a standard deviation of 3.2 pounds. The multiplicatively adjusted standard deviations had a greater range of 22.9 pounds (72.-49.9) and a standard deviation of 5.7 pounds. These results indicate that additive adjustments are more appropriate than multiplicative corrections in adjusting weaning weight for the effect of age of dam. Although additive adjustments would not equalize the variances in adjusted groups, they at least would not cause further divergence as would multiplicative corrections.

Sex of Calf. The results for sex are given in Table 7 according to type of management. These data indicate that multiplicative corrections are more appropriate than additive corrections in adjusting for the effect of sex. The multiplicatively adjusted standard deviations are more

Table 6. Additive Versus Multiplicative Adjustment for Age of Dam.

Age of Dam	Correction Factor	Additive Adjusted Average	Standard Deviation	Correction Factor	Multiplicative Adjusted Average	Standard Deviation
— 27 mos.	+64	433	62	1.17	431	73
28 — 30 mos.	+52	433	56	1.13	431	63
31 — 33 mos.	+44	433	57	1.11	432	63
34 — 39 mos.	+35	433	59	1.09	434	65
40 — 45 mos.	+20	433	55	1.05	434	58
4 yrs.	+15	433	56	1.04	435	59
5 yrs.	+ 8	433	54	1.02	433	55
6 yrs.	0	431	55	1.00	431	55
7 yrs.	0	433	59	1.00	433	59
8 yrs.	0	436	59	1.00	436	59
9 yrs.	0	436	58	1.00	436	59
10 yrs.	0	433	54	1.00	433	54
11 yrs.	0	434	53	1.00	434	54
12 yrs.	0	430	54	1.00	430	55
13 yrs.	0	432	50	1.00	432	50
14 yrs.	+ 6	433	49	1.01	432	50
15 yrs.	+20	433	58	1.05	433	60
Avg. Adjusted S.D.			56			58
Range			13			23
Standard deviation			3			6

nearly equal for the three sexes in both types of management than the observed standard deviations. This study suggests further that multiplicative adjustments have an advantage over additive corrections by accounting for the interactions between sex and type of managements. The multiplicative correction factors came out the same for both types of management while additive corrections differed.

Season of Birth. The results for season of birth given in Table 8 show that variation within adjusted groups is more nearly equal after additive adjustment than after multiplicative adjustment. Consequently, it appears that additive corrections would be more appropriate than multiplicative corrections in adjusting for season of birth.

Type of Management. Table 8 also gives the results for type of management. The observed standard deviations were essentially the same in creep-fed and non-creep-fed calves indicating that where adjustment is needed for type of management an additive adjustment is more appropriate than a multiplicative adjustment.

Regarding the effect of type of management, it is unsound from the standpoint of an ideal breeding program to creep-feed some calves and not others. Inasmuch as all calves are handled alike no correction

Table 7. Additive Versus Multiplicative Adjustments for Sex to Type of Management.

	Additive		Multiplicative	
Item	Correction Factor	Adjusted Standard Deviation	Correction Factor	Adjusted Standard Deviation
No Creep				
Bulls	−45	60	0.89	53
Steers	0	57	1.00	57
Heifers	+ 7	55	1.02	56
Creep				
Bulls	−53	62	0.89	55
Steers	0	54	1.00	54
Heifers	+ 9	52	1.02	53

Table 8. Additive Versus Multiplicative Adjustments for Season of Birth and Type of Management.

	Additive		Multiplicative	
Item	Correction Factor	Adjusted Standard Deviation	Correction Factor	Adjusted Standard Deviation
Season				
Feb.-Apr.	0	56	1.00	56
May-July	+26	62	1.06	66
Aug.-Oct.	+48	57	1.12	64
Nov.-Jan.	+28	55	1.07	59
Management				
No Creep	0	57	1.00	57
Creep	−28	57	0.93	53

is necessary. However, the practice of creep-feeding bull calves and not heifer calves may be sound from an economic point of view since bull calves apparently benefit more from creep-feeding than steers or heifers. The results of this study indicate that correction for sex and type of management would not be too difficult in instances where such a management scheme was allowed. By using a multiplicative correction to adjust to a common sex one could account for the effect of sex and sex by type of management interaction simultaneously. All that would remain is adding a correction factor for type of management appropriate for the specific conditions involved.

Summary and Conclusions

The data used in this study were the adjusted 205 day weaning weights of 13,937 Hereford and Angus calves recorded in the Oklahoma Beef Cattle Improvement Program over a four year period. It was determined that age of dam, sex, month of birth and type of management (creep versus no creep) are important sources of nongenetic variations that should be taken into account when adjusting weaning weights of values to improve the accuracy of selection.

The results for age of dam indicated that the effect of age of dam is essentially the same regardless of sex, breed, type of pasture, season of birth, or type of management. Weaning weights increased 46 pounds as cows increased in age from 2 to 4 years. It appears that classifying cows into 3 to 5 month increments between 2 and 4 years of age would result in more accurate corrections than yearly increments. This study has suggested that additive corrections are more appropriate than multiplicative corrections in adjusting weaning weights for the effect of age of dam.

The estimates of the effect of sex obtained in this study are not appropriate for use in the field as correction factors since the effect of sex was confounded with the effect of selection for size in the bulls of these data. This study has indicated, however, that the effect of sex is dependent on whether or not calves are creep-fed. It appears that bull calves benefit more from creep-feeding than steers or heifers. It was also determined that multiplicative adjustments are more appropriate than additive corrections in adjusting for the effect of sex since they more nearly equalize variation within sexes and it appears that they account for the interaction between sex and type of management.

A breeder can eliminate the effect of season of birth on the weaning weights of calves most effectively by restricting calving to a two- to three-month period, but in herds where calves are born throughout the year adjustments should be made for season of birth. This study has indicated that additive corrections should be used for season of birth and that separate corrections should be used depending on whether calves are creep-fed or not creep-fed and on whether they are raised on native or improved pasture.

Literature Cited

Harvey, Walter R. 1960. Least-squares analysis of data with unequal numbers. Agricultural Research Service. U.S.D.A. ARS-20-8.

Reproductive Performance of Sows Fed at Two Levels During Gestation

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Level of feed intake at various stages of reproduction greatly influences sow productivity. Previous research with swine has shown that increasing the nutrient intake of the female prior to breeding increases the number of ova shed, but continued heavy feeding during gestation leads to high embryonic mortality. The recommended practice is to flush sows (increase their feed intake) about 10-12 days prior to breeding and then reduce their feed intake immediately after breeding. This limited intake is recommended for about the first 90 days of pregnancy, and then slightly higher levels are recommended during the last month of gestation since the unborn pig makes most of his growth during this period.

The requirements for sows will be affected by their size and growthness, environmental temperatures, and housing conditions. However, in view of the results obtained at this station and in other investigations, there may be a tendency to overfeed during gestation in many cases and this results in a waste of feed and lower productivity.

Since feed cost is one of the major items in swine production, the present study was initiated in the spring of 1965 to study the effects of reduced feed intake during gestation on reproductive performance of sows and gilts.

Materials and Methods

This study was conducted in the spring and summer of 1965 using 20 gilts and 20 sows from the OK 14 (Hampshire) breeding herd at Stillwater. All sows and gilts were managed in a similar manner prior to breeding. On April 1, the ration listed in Table 1 was increased from 5 lbs. per day to 7 lbs. per day for gilts and from 6½ lbs. per day to 8 lbs. per day for sows. The breeding period started on April 12 and continued for six weeks. Each female was hand mated twice daily while in heat and sows and gilts were each randomly assigned to one of the two feeding levels described in Table 2 at breeding.

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