Inheritance of Productivity of Beef Cows

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More than a million beef cows over two years of age are being kept by Oklahoma cattlemen for the production of beef calves, most of which are marketed at weaning time as feeders or as fat slaughter calves. The success of this system of production depends heavily upon items of cow productivity which include regularity of reproduction, mothering ability, and length of productive life. Some of these items have been treated in some aspect in previous Oklahoma Agr. Exp. Sta. Pubs. (No. M.P. 48, pp. 23-28, on regularity of reproduction, pp. 28-33, on one factor affecting longevity; No. M.P. 45, pp. 30-38, and No. M.P. 31, pp. 10-16, on mothering ability of beef cows as measured by calf weights).

It has been found that there are wide differences among beef cows in their lifetime productivity as measured by the seven-month weights of their calves. Many cows produce as many pounds of calf in four years as others in the same herd produce in five years even when they have all weaned the same number of calves sired by the same bulls. These differences probably exist because some cows transmit to their calves greater growth potential and some cows provide the calf with a more favorable environment during the suckling period. It has been shown that a high producing cow one year is likely to be among the higher producing group each year and that a low producing cow one year tends to repeat her poor performance each year. This has led to the performance testing programs in this and other beef cattle producing states. The goal is to identify those individual differences which exist among beef cows within each herd. Breeders have been able to remove many of the poor producing cows during the past two or three years when economic and weather conditions required a reduction in the size of the breeding herds. Some kept replacement females from the more productive cows only, expecting that part of the advantage of the dams would be passed on to their daughters. Very few data have been available which could be used to determine how effective such selection might be.

Nature of the Present Study

The data for this study were obtained from a high-grade Hereford herd of approximately 100 cows which have been in a long-time management study at the Ft. Reno experiment station and from daughters of these cows which are being used in a modified replication of the earlier study. The older cows were dropped during the winter of 1947-48. Half of these cows calved first at two years of age during the spring of 1950 and the remainder calved first at three years of age in 1951. The calves were identified and weighed at birth, and weaning weights were obtained during early October when the calves were approximately seven months of age. Beginning with the breeding season of 1952, the cows have been assigned to breeding groups of equal numbers balanced according to management treatment imposed during the winter and past

average productivity. It was therefore possible to identify both sire and dam of each calf dropped from 1953 through 1957. Some cows have produced as many as eight calves during this period and all cows remaining in 1957 had produced either 6, 7, or 8 calves. The average lifetime performance for this group of cows, as measured by the 210-day weights of their calves adjusted to a steer equivalent, has been 483 pounds per year with a range of 162 pounds. The highest producing cow during this time has been one which weaned 8 calves at 539 pounds and the poorest producing cow weaned 8 calves at 377 pounds each. The cows were not culled for low performance during this time.

In 1954 it was decided that this experiment should be replicated using daughters of the foundation herd for each replication. All heifers were to calve at two years of age and they were to be on different levels of supplemental winter feeding. Thirty-three 1954 heifer calves by four different sires and twenty-six 1955 heifer calves by five different sires have now produced one or two calves. It was therefore possible to relate the performance of these 59 daughters to the performance of their dams and get an early estimate of the heritability of mothering ability or cow productivity as indicated by calf weaning weights. These 59 daughters were by seven different sires (two sires were repeated in 1954 and 1955 calf crops) and were from 46 different dams (only 13 cows had two daughters in the study).

Results and Discussion

The number of heifers by each sire and the average 210-day weights of their calves are presented in Table 1. The average lifetime production for the dams of each group of heifers is also presented. Although within each breeding season the cows were assigned to each sire so that their average lifetime production was equal, the heifers in each group did come from cows which differed somewhat in past productivity due to chance in sex determination. It is obvious that the daughters by different sires weaned calves which differed considerably in 210-day weights.

Table 1.—Distribution of the data by sires of the heifers and by seasons in which their calves were produced

Sires	No. of heifers	1956 Calves		1957 Calves		Lifetime Prod. of Dam	
		No.	Ave. Wts.	No.	Ave. Wts.	No. Calves	Ave. Wt.
		Production of 1954 Heifers					
247	9	8	421	9	441	6.33	504
311	10	10	420	10	399	7.20	492
182	3	2	464	3	457	7.67	493
901	11	9	397	10	398	6.54	479
		Production of 1955 heifers					
182	2	—	—	2	378	7.00	481
901	10	—	—	10	352	7.50	494
120	5	—	—	5	369	6.50	504
242	4	—	—	4	328	7.50	482
219	5	—	—	5	360	6.80	490

Table 2.—Heritability estimates of cow productivity obtained from intra-sire, intra-season regression of daughters production on that of her dam

Items	Studied	Number Pairs	Regression Coefficient	Heritability
(1)	First Record of Daughter and Dam	59	.15	.30
(2)	1957 Record of Daughter and Dam	56	.19	.38
(3)	Lifetime Averages of Daughters and Dams	59	.43	.86
(4)	1956 and 1957 Records of Daughters and Dams	25	.45	.90

The calves dropped in 1956 by the 1954 heifers were sired by a pair of half-brothers from line 2 at Ft. Reno. The 1957 calves produced by the same heifers were sired by a pair of half-brothers from non-related stock, and the 1957 calves produced by the 1955 heifers were sired by a pair of half-brothers from line 3 at Ft. Reno. The dams of these 1954 and 1955 heifers were bred to different bulls each year from lines 2 and 3. The 1957 calves were lighter in weight than one might expect based upon the weights of 1956 calves and earlier experience. The calves at Ft. Reno in all lines and experimental treatments were about 40 to 50 pounds lighter at 210 days of age in 1957 than in previous years, probably because of poor quality forage available in 1957. This would not be expected to affect the heritability estimates however because they were from an intra-season analysis.

In order to get an estimate of the relative importance of hereditary factors upon the expression of cow productivity as measured by 210-day calf weights, the production of daughters within each sire and season group was related to the production of their dams. The statistical procedure was to obtain an intra-sire, intra-season regression of the heifer's performance on that of her dam. Four different regressions were obtained. They are presented in Table 2. When the first record of the daughter, which was made in 1956 for those heifers dropped in 1954 and in 1957 for the 1955 heifers, was regressed on the first record of her dam, which was made in either 1950 or 1951, a heritability estimate of .30 was obtained from the 59 daughter-dam pairs which made up these data. Fifty-six of the daughters and their dams produced calves in 1957. When these single records for both daughters and dams were used in the regression analysis, heritability was estimated at .38, which is not appreciably different from the first estimate. On the other hand when the average of all records for both daughters and their dams were used in the regression analysis, a heritability estimate of .86 was obtained. About half of the daughters had two records which could be averaged and all of the dams had from six to eight records from which to obtain an average. One additional estimate was obtained by regressing the average production of the 25 daughters which were dropped in 1954 on the 1956 and 1957 production of their dams. This estimate was also very

high (.90) and is very close to the estimate obtained when all records were considered.

Another method, which is somewhat more crude but perhaps more meaningful, of calculating these heritability estimates is to divide the dams of the heifers by each sire into high-producing and low-producing groups and to compare the production of their unselected daughters with that of their dams. This is shown in Figure 1. In this case the 30 dams which were classified as high producing cows in each sire and season group had an average production of 497 pounds on their first calves which were either produced at three years of age or whose weights were adjusted to that age. The low producing 29 cows weaned first calves which averaged only 425 pounds. The daughters of the high producing half weaned calves which averaged 396 pounds while the daughters of the low producing cows weaned calves which averaged 386 pounds. All of these heifers were calved at two years of age and the records were not adjusted for age or season. If we divide the 72 pound difference between the two groups of dams, which had been sorted on the basis of their first records, by the 10 pound difference between their unselected daughters and multiply the resulting fraction (.14) by 2, because the sire's effect is not included in this regression, we obtain an estimate of heritability of .28 as compared to .30 obtained by the more refined technique. If the differences between dam and daughter groups are weighted to adjust for differences in the number of daughters by each sire, a 71-pound

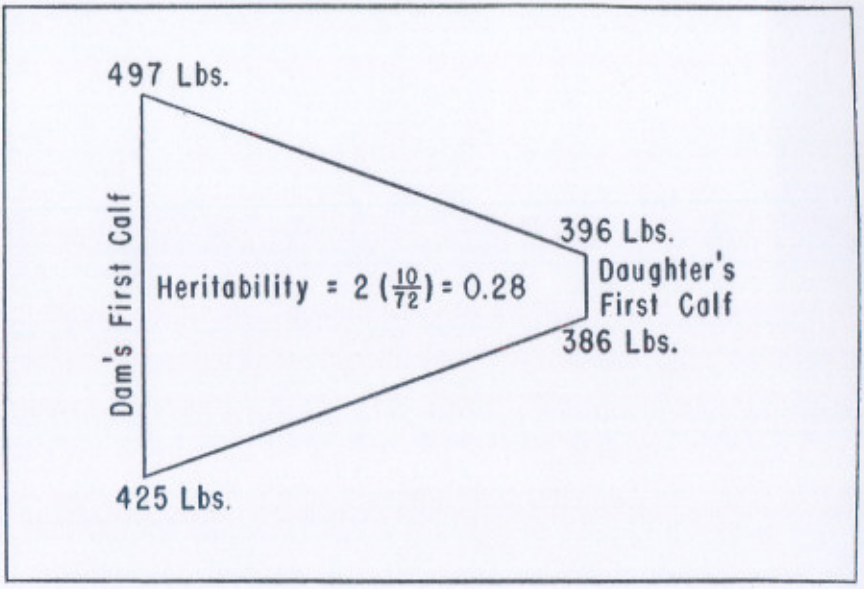

Figure 1.—Heritability of cow productivity from the intra-sire regression of the daughter's first record on that of her dam.

difference in the dams is obtained and when divided by the 12 pound weighted mean difference obtained for their daughters, the fraction is .17 and the estimate of heritability becomes .34. These estimates are essentially the same and indicate that approximately 30 percent of the variation in 210-day calf weights from first calf heifers can be accounted for by hereditary differences among the heifers. It is of interest that when the single records of the daughter and of her dam made in the same season (1957) were studied, the heritability estimate was slightly larger (.38) than when the first records of each were considered.

When the average lifetime performance of the dam was related to one or two records of the daughter, the heritability estimate was increased considerably and this was expected to be the case because the average of six to eight records per dam is a much more reliable estimate of the real genetic worth of the cow than a single record. It was also very interesting that a very high estimate (.90) was obtained from the 1954 daughter group by comparing the average of the 1956 and 1957 records of both dams and daughters. This estimate however is based upon fewer than half of the dam-daughter pairs used in the other estimates and may be the result of chance.

Although the amount of data used in this study is quite limited, the estimates are rather consistent and suggest that the selection of replacement heifers from the more productive dams should be effective in raising the average 210-day weights of beef calves. Selection of heifers based upon the average of two or more records of their dams should be much more effective than that based upon the first record or any other single record of the dams. These results are to be expected when selecting among heifer calves which are by the same sire. The average 210-day calf weights from daughters of the different sires, given in Table 1, indicate the importance of the sire upon the productivity of his daughters. These data indicate the importance of selecting the daughters of sires which transmit greater mothering ability potential, but the sire can be evaluated only by considering the performance of his female relatives—his mother, sisters, and daughters. Initial selection of a bull should be based upon the average lifetime production of his dam and his unselected sisters, but final selection must await the performance of his female offspring. Although the trait of cow productivity is a maternal trait expressed only by the female, the greatest opportunity for improving this trait in a herd is probably by the selection of sires, because of the high replacement rate required for females and the low reproductive rate of the cows. A much smaller percentage of the males is required and the number of offspring may be increased for sires which prove outstanding. Obviously the greatest improvement can be expected when one selects all of his breeding animals for the same traits. The producers who are marketing calves at weaning time and the breeders who are providing the bulls which they use share the responsibility for the improvement of this important economic trait in beef cattle.