Effect of Level of Concentrate Feeding on Heritability of Performance Traits in Cattle[1]

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The level of feeding necessary to obtain the best estimate of the genotype of beef cattle for production traits is of interest to scientists and producers. Possible interactions between genotypes and environment are also of interest from both a scientific and practical standpoint. The producer has two factors to consider: the added costs of heavy grain feeding of replacement animals and the possibility that feeding at higher levels of concentrates may interfere with, rather than increase, reproductive performance of breeding stock.

Falconer and Latyszewski (1952) have shown that mice responded to selection for rate of gain under a high level and under a level which was 75 per cent of the high level. However, when those selected under the high level were tested under the low level, they were no different from unselected mice. Those selected under the low level were approximately equal to the ones selected under the high level of feeding when both were tested on a high level of feeding. Thus, Falconer (1952) and Falconer and Latyszewski (1952) conclude that selection under the environment in which animals are expected to produce would be most effective unless the heritability of traits is increased in a different environment over that existing in the generally accepted environment.

Hammond (1947) concludes that it is necessary for animals to produce under an environment that permits their full expression of inherent capacity if one is to differentiate desirable genotypes from inferior genotypes. However, Morley (1956) concluded from selection studies with sheep under different planes of nutrition that the opinions of Hammond (1947) are not generally valid. Morley found no indication that the percentage response to selection would be different for wool traits under different planes of nutrition; however, there was evidence that selection for body weight might be more effective under the higher plane of nutrition.

McBride (1958) discussed the possibility that improved environments might bring about conditions of lowered environmental variation without changes in other components and that this would result in increased heritabilities. Thus, the increased response to selection would be the ratio of the phenotypic standard deviation in the unimproved environment to that in the improved environment.

The objectives of the present study was to determine the effects of two levels of feeding during the feed test on heritability estimates obtained.

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Materials and Methods

The data used in the study were 64 cow-calf records obtained at the Squaw Butte Experiment Station, Burns, Oregon. Individual records on birth weight, suckling daily gain, postweaning daily gain on feed, and post feedlot performance of daily gain on range and final weight off range were obtained on heifers raised during the years 1956-58. The postweaning test periods averaged 126 days. One half the heifers tested received a ration composed of 86 per cent roughage and 14 per cent concentrate, while the other half received a ration made up of 50 per cent roughage and 50 per cent concentrate.

The high and low concentrate rations provided an average daily TDN intake of 4.26 and 2.26 pounds, respectively, above maintenance requirements as calculated according to Winchester and Hendricks (1953).

All animals tested over the three-year period were retained in the Squaw Butte breeding herd and bred as two-year heifers to the same sire. Offspring resulting from the first mating of each of these heifers were individually fed as weaner calves for about 120 days during the winters of 1959, 1960, and 1961. A common ration (50 per cent roughage and 50 per cent concentrate) was fed to the offspring during their test period. This ration provided an average of 4.42 pounds of TDN daily above maintenance requirements (Winchester and Hendricks, 1953).

During the summer following each testing period, the animals were grazed in common on sagebrush-bunchgrass range. Individual records of weight gains on summer range were maintained on all animals. Native meadow hay composed chiefly of rush (Juncus spp.) and sedge (Carex spp.) made up the roughage portion of rations used in testing both the dams and their offspring. The concentrates fed were barley and cottonseed meal. Animals were tied to individual feed mangers from 7:00 a.m. until 3:00 p.m. daily and ranged in common lots during the remainder of the day. All weights were taken following an overnight restriction from feed and water.

Heritability estimates were computed from regressions of offspring performance on dam performance. The regressions were computed within year and sex subclasses for each level of feeding.

Results and Discussion

The means for the various traits of the calf and dam by level of feeding of the dam are given in table 1. The birth weights and suckling daily gains of the dams indicate that the two groups were very nearly equal before starting the two levels of feeding. The dams on the low level of feeding gained 55 per cent as much as those on the high level and, although they gained at a faster rate on the range, they still weighed only 90 per cent as much as those fed at the high level at approximately 18 months of age.

Table 1. Means for performance traits for calves and dams by level of feeding of dams.

Trait	Low Level of Feeding of dam			High Level of Feeding of dam		
	Number	Dam	Calf	Number	Dam	Calf
Birth weight lbs.	34	74	68	30	74	69
Suckling daily gains lbs.	34	1.45	1.26	30	1.45	1.32
Daily gain on feed lbs.	34	.91	1.70	30	1.65	1.73
Weight off feed lbs.	34	503	542	30	602	547
Daily gain on range lbs.	34	1.45	1.59	30	1.23	1.43
Weight off range lbs.	34	641	661	30	715	656

Calves from both groups of dams were fed at the high level during the feeding period. Calves from cows fed at the low level gained slightly less during the suckling period. Daily gain on feed and weights off range were nearly identical for calves from both groups of dams.

The regression coefficients of offspring on dam and heritability estimates, calculated as twice the regression, are given in table 2 by level of feeding of dam. The regression coefficients of traits in the offspring on the same traits in their dams differed considerably when the dams established their records under a high level of feeding from those obtained when dams established their records under a low level of feeding. Sampling error could be a large factor in these data and the numbers involved are too few to give much confidence in the reliability of the heritability estimates. However, there appears to be a definite trend in the regression coefficients with the daily gains of the calves during the three different gain periods showing opposite trends under the two levels of feeding dams. Suckling daily gain and subsequent weights of the calf indicate negative regression coefficients on dams' performance when dams were fed at a low level as calves and positive regression coefficients when dams were fed at a high level. Rollins and Wagnon (1956) reported heritabilities for weaning weight computed from twice the regression coefficient of offspring on dam to be 0.84 and -.13 in two herds carried under optimum and suboptimum nutritional regimes, respectively. Koch and Clark (1955a) obtained heritabilities computed from regression coefficients of offspring on dams to be 0.44 for birth weight, 0.07 for gain from birth to weaning, 0.11 for weaning weight, 0.18 for gain from birth to yearling, and 0.43 for yearling weight. With the exception of birth weight, the heritability estimates obtained from regression coefficients of offspring on dam were lower than those computed from paternal half sibs or regression coefficients of offspring on sire. Koch and Clark (1955b) further report that growth rate and maternal ability are negatively correlated genetically in an environment where cattle are handled under range conditions with a minimum of supplemental feeding.

Table 2. Regression coefficients of offspring on dam and heritability estimates for various performance traits.

	Level of feed testing on dams					
	Low level			High level		
Trait	d.f.	Regression b_{OD}	Heritability $2b_{OD}$	d.f.	Regression b_{OD}	Heritability $2b_{OD}$
Birth weight	28	0.29	0.58	24	0.26	0.52
Suckling daily gain	28	-.27	-.53	24	0.34	0.68
Daily gain on feed	28	0.14	0.27	24	-.04	-.08
Weight off feed	28	-.08	-.16	24	0.31	0.63
Daily gain on range	28	-.42	-.84	24	0.24	0.48
Weight off range	28	-.01	-.02	24	0.50	1.00

It appears that level of feeding may influence subsequent maternal ability and that the maternal environment provided the calf is an important factor influencing the regression coefficients of offspring on dam. The dams were all treated alike except for the feeding period just subsequent to weaning. To gain more insight as to the effect of level of feeding on maternal ability, correlation coefficients between the dams' rate of gain on feed with rates of gain of the calves during the three periods were computed and are presented in table 3.

Table 3. Correlation coefficients of daily gain on feed of dam with gains of the calf by level of feeding of dam.

	Daily gain on feed of dam	
Calf	Low level	High level
Suckling daily gain	-.39	0.47
Daily gain on feed	0.08	-.06
Daily gain on range	0.23	-.20

These correlation coefficients indicate that heifers gaining the fastest during the feed test on the low level produced somewhat slower gaining calves from birth to weaning but slightly faster gaining calves subsequent to weaning. The opposite effect is seen when dams were reared under the high level of feeding.

Selecting fast gaining cattle under low and high levels of feeding may be exerting pressure for different components of growth (Falconer and Latyszewski, 1952), i.e., selection for growth of lean tissue versus the ability to fatten. If selection for different genotypes is involved, the relationship between growth and maternal ability may be quite different under the two levels of feeding. More data on this subject are needed to give a clearer understanding of the actual relationships. It does appear, however, that maternal ability of the dam influences the heritability estimates obtained by regression coefficients of offspring on dam and thus should be scrutinized carefully.

Summary

Records on dam and offspring performance collected at the Squaw Butte Experiment Station, Burns, Oregon, were used to compute regression coefficients of offspring performance on dams' performance under two levels of feeding of dams. All calves were fed on the high level of feeding. Regression coefficients of offspring on dam were generally much higher when dams established their records on the high level as compared to those on the low level of feeding. It appears that more progress would be made by testing and selecting animals in the environment under which the animals are expected to produce.

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