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INTERRELATIONSHIPS OF HEIFER MILK PRODUCTION AND OTHER BIOLOGICAL TRAITS WITH PRODUCTION EFFICIENCY TO WEANING

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CATTLE 90-9

Summary

Interrelationships among milk production, cow-calf feed efficiency and other biological traits were evaluated on first-calf females and their calves. Production efficiency was defined as cumulative feed metabolizable energy consumed by the dam-calf pair during the year divided by calf weaning weight. Results indicated that increased levels of milk production were associated with improved production efficiency to weaning as long as calves have the genetic potential to convert the extra milk into body weight gains. However, the incremental improvement in efficiency per unit of increased milk was less for each additional unit of milk.

(Key Words: Beef Cattle, Milk Production, Production Efficiency.)

Introduction

Biological efficiency of energy utilization by the cow-calf herd is of great economic importance due to the relatively low reproductive rate of the species. The importance of level of milk production as a component of efficiency has been much debated. Increasing levels of milk production may increase calf weaning weights but may also increase maintenance requirements of the lactating female, leading to increased feed energy needs. It has often been suggested that milk production potential should be matched with availability of feed resources under individual situations in order to maintain adequate body condition for acceptable reproductive performance. Relationships among efficiency of feed utilization, milk production and other biological traits are of interest. The objective of the present study was to evaluate these relationships to determine how milk production differences might affect efficiency of feed utilization of the cow-calf unit.

Materials and Methods

Data for this study were obtained from a comprehensive project designed to evaluate genetic aspects of efficiency of feed utilization by beef cattle. Records from 425 2-year-old heifers and their crossbred calves born in the years 1981 through 1988 were analyzed. Heifer breed types included crossbred Angus-Hereford, Simmental-Hereford and Tarentaise-Hereford produced in two-breed rotational crossbreeding systems, F1 Salers-Hereford and straightbred Hereford. Individuals in the same rotation varied in percentage Hereford and breed groups were formed based on percentage of Hereford breeding within each rotation for statistical analyses.

Pregnant females were placed in a drylot facility each October at an average age of 19 months. Individual feeding stalls allowed measurement of feed intake for a 1-year period through production of the heifer's first calf at weaning the following October. Heifers were placed in individual feeding stalls twice daily and provided access to predetermined quantities of pelleted hay, chopped hay and grain. Feed not consumed by a heifer was periodically weighed and discarded. Feeding levels were adjusted individually at 28-day intervals based on weight change during the period, stage of production and level of milk production. Diets were adjusted to provide gains assumed to be desirable for typical replacement heifer development and reproductive performance. Feed intakes were expressed as the total cumulative metabolizable energy (ME) consumed for the 1-year period.

Calves were allowed access to their dams for nursing during the two daily periods that cows were in the individual feeding stalls. At other times, calves were maintained separately from cows to eliminate cross-nursing. It is possible that such a procedure might restrict total milk intake, although relative differences in milk production potential between cows are expected to be expressed. Calves were allowed overnight access to a high-roughage creep feed intended to replace forage the calf would have consumed under conventional pasture conditions.

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Milk production of individual heifers was estimated after an overnight separation (approximately 14 hours) of the calf and dam using weigh-suckle-weigh procedures. Estimated milk production was evaluated on four to six different dates each year and is expressed as the average of those measurements. Cow weight is based on an average of weights obtained at 28-day intervals during the 1-year drylot period. Cow hip height, an average of measurements obtained at first calving and also at weaning, was used as an estimate of skeletal size. The ratios of weight to height at these two time points were used as estimates of body condition. Production efficiency is defined as the cumulative feed energy intake of the dam-calf unit during the 1-year test period divided by calf weaning weight. Thus, the lower the value, the more efficient a cow-calf pair.

Least-squares analyses provided development of response surface equations in which production efficiency was the dependent variable. The linear and quadratic effects of milk production were included simultaneously as predictors of efficiency in each of three surface response models, along with the linear effect of either dam weight, dam height or cumulative dam ME intake. The statistical models used for surface fitting and for residual correlation also accounted for the effects of breed groups, year to year variation, calf sex, age of calf at weaning and estimated dam body condition at calving and at weaning.

Results and Discussion

Residual correlations among traits of interest, adjusted for the previously mentioned effects, are presented in Table 1. The adjustment for breed group, for example, was expected to give results similar to those that would be obtained by computing correlation coefficients separately for each breed group and then computing an average of the coefficients. Desirable correlations with efficiency were detected (P<.05) for average milk production and calf weaning weight. These values indicate that, among cows within a given breed group, cow-calf pairs with higher levels of milk production and(or) increased calf weaning weight utilized less feed energy per unit of calf weaning weight on average. Significant positive correlations (P<.05) with average milk production were found for dam ME intake and calf weaning weight, indicating that higher milk-producing dams, on average, tended to produce heavier calves at weaning but at higher feed energy levels of the dam. Dam size (weight or height) did not appear to be related to production efficiency to weaning, although dam size was correlated with dam ME intake.

TABLE 1. PHENOTYPIC CORRELATION COEFFICIENTS AMONG TRAITS OF INTEREST[a]

Traits[b]	AVGWT	AVGHT	COWME	CREEP	WWT	EFF
AVGM	.01	.04	.43	-.09	.58	-.50
AVGWT		.82	.42	.13	.20	-.03
AVGHT			.47	.09	.19	.01
COWME				.04	.51	-.09
CREEP					.26	-.18
WWT						-.86

[a] Correlation coefficients less than -.11 or greater than .11 were significant (P<.05).

[b] AVGM = milk yield, AVGWT = dam weight, AVGHT = dam height, COWME = cumulative ME intake of dam, CREEP = calf creep ME intake, WWT = calf weaning weight and EFF = (COWME + CREEP)/WWT.

Equations presented in Table 2 were used to develop the response surface graphs presented in Figures 1 through 3. Predictive value (R^2) of the equations presented are inclusive of variables which were not allowed to deviate from their respective means (i.e., effects of year, breed group, sex, calf age, cow condition).

Figure 1 illustrates relationships of production efficiency with milk production and dam weight, while Figure 2 includes production efficiency, milk production and dam hip height. These graphs indicate that, at any given heifer body size, increasing levels of milk production (within the range evaluated) resulted in improved efficiency of feed utilization. However, the improvement in production efficiency per additional unit of milk becomes less at higher levels of milk production. This decreasing rate of improvement in efficiency may depend on the relationship of milk production potential with dam maintenance requirements and may also depend to some extent on the genetic ability of the calf to consume and utilize the extra milk. Efficiency did not vary significantly over the range of dam body weight or height at a given level of milk production. This indicates that both inefficient and efficient dams existed within any size group included in the study.

Figure 3 illustrates the relationship of production efficiency with milk production and dam intake. As mentioned previously, heifers were provided access to limited amounts of feed and in most cases dam feed intake was not ad libitum. Those individuals that were able to produce a relatively large amount of milk compared to feed energy intake were the most efficient, as would be expected considering the positive correlation between milk yield and calf weaning weight. The fact that efficiency tends to improve with decreased dam intake according to the regression analysis (Table 2 and Figure 3) seems to contradict the correlation between efficiency and dam intake (r = -.09) at first glance. However, it is important to keep in mind that milk production differences were accounted for in the regression analysis but not in the correlation analysis. The regression analysis suggests that efficiency tends to improve with decreased dam intake if milk production is held constant. However, it seems unlikely that milk can be held constant as dam intake decreases if body condition is to be maintained at a constant level. This last statement is supported by the correlation between dam intake and milk production (r = .43).

The results of this study indicate that increased levels of milk production (within the range observed in the study) tended to be associated with improved production efficiency to weaning in first-calf dams. However, the incremental improvement in efficiency per unit of increased milk was less for each additional unit of milk. Although an increase in energy requirements of the dam can be expected with increased milk production potential, the additional increase in calf weaning weight appeared to offset this as long as the calf had sufficient genetic growth potential to convert the higher levels of milk into body weight gain. Future research is planned to evaluate similar relationships between efficiency and milk production among older cows. Some research has indicated that increased milk production in the cow is sometimes unfavorably related to postweaning feed efficiency of the calf. Evaluation of the relationship between milk production and subsequent postweaning calf performance for the animals involved in the present study is planned for a future paper. Finally, it should be recognized that a comprehensive evaluation of the association between milk production and production efficiency should take reproductive performance into account. For example, cows which sacrifice body condition while maintaining relatively high levels of milk production might have relatively desirable feed to calf weight ratios for the current calf crop but perhaps at the expense of subsequent reproductive performance. While the effects of reproductive performance per se on efficiency were not considered in the present study, estimates of dam body condition (weight/height ratios) were taken into account in the statistical analysis.

TABLE 2. EQUATIONS USED TO DETERMINE RESPONSE SURFACE OF PRODUCTION EFFICIENCY TO MILK PRODUCTION AND OTHER TRAITS[ab]

Equation	R^2
EFF = 20.8097 - .5825 (AVGM - 7.75) + .0236 (AVGM - 7.75)^2 - .0014 (AVGWT - 982.21)	.83
EFF = 20.8115 - .5839 (AVGM - 7.75) + .0234 (AVGM - 7.75)^2 + .0409 (AVGHT - 50.24)	.83
EFF = 20.8881 - .6530 (AVGM - 7.75) + .0202 (AVGM - 7.75)^2 + .0007 (COWME - 8725.13)	.83

[a] Traits defined in Table 1.
[b] R^2 values are for equations inclusive of variables not allowed to deviate from their means (i.e., year, breed group, calf sex, cow condition, weaning age).

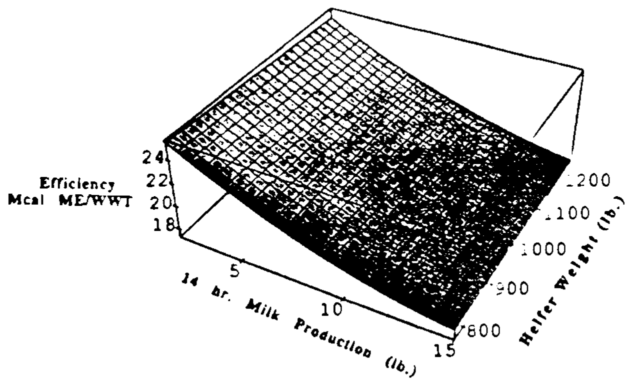

Figure 1. Response surface of production efficiency to average 14-hour milk production and average heifer body weight.

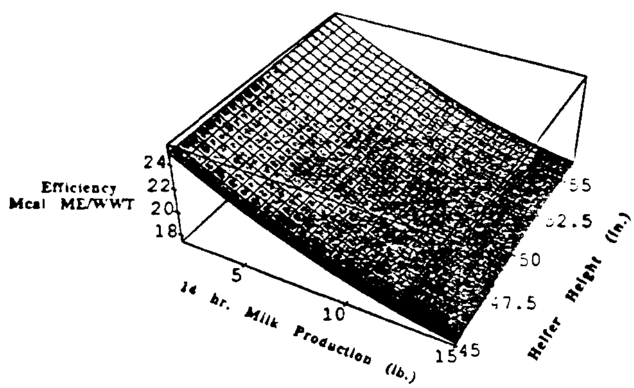

Figure 2. Response surface of production efficiency to average 14-hour production and average heifer height.

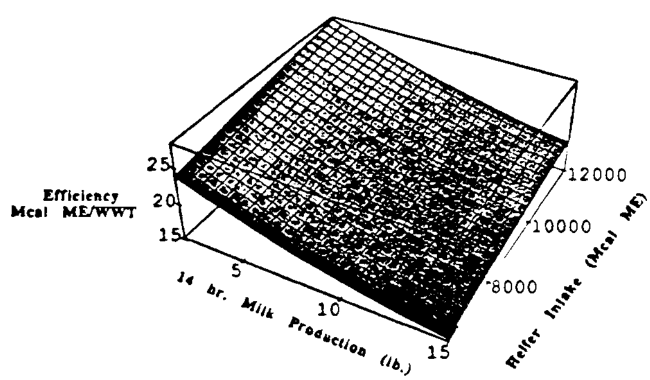

Figure 3. Response surface of production efficiency to average 14-hour milk production and cumulative heifer intake.