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Cow Efficiency

C. A. Dinkel
South Dakota State University

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If we are to discuss cow efficiency, perhaps we should define the term so that everyone is thinking about the same thing. Efficiency is usually thought of as a relationship between input and output and is frequently calculated as a ratio of either one to the other. We have used pounds of Total Digestible Nutrients (TDN) required to produce a pound of product either at weaning or at slaughter. The TDN input is that consumed by the cow for the year from weaning to weaning plus the consumption of the calf from birth to weaning or slaughter. In our situation, calf consumption to weaning is creep consumption. In the producer's situation, it is grass consumed plus creep consumption if it is used.

In addition to defining efficiency, it might be well to indicate that we will be primarily discussing the situation in your herd and not comparing your herd to some other alternative breeding plan such as changing from a British to a Continental breed or changing from small to large frame cattle. As you will see, our studies indicate that breed type or size have little or no effect on efficiency. This is not to say that breed differences other than those studied are not important but rather to emphasize that important differences in cow efficiency probably exist in every herd.

Among the first studies of these data were evaluations of factors that cause differences in efficiency at weaning. Results indicated that sex and age of calf and year of birth significantly influenced efficiency at weaning, but age of dam and breed of dam did not. Breed of dam groups evaluated were Angus, Charolais, and the reciprocal crosses. A second part of the study evaluated the importance of cow weight, condition and milk production in determining efficiency at weaning. For this population of cows, cow weight and condition had no effect, but milk production had a primary effect with efficiency tending to increase as milk production increased. Evaluations of the prediction of efficiency at weaning indicated that cow weight or cow condition alone had accuracies of only 1%, milk production 23% and weaning weight 62%. One might expect the latter since weaning weight is the measure of output in the efficiency equation. Dr. M. A. Brown studied data from the first 5 years of the project and found essentially the same results. There were a few differences but none of them significant. For example, in the first 3 years of the study efficiency seemed to increase slightly as cow weight increased, whereas the 5-year study indicated efficiency decreased slightly with increased cow weight. As indicated earlier, however, the association between cow weight and efficiency is essentially zero and one can expect in repeated sampling that results would be alternating plus and minus around the zero point.

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Those having difficulty accepting the above results may find the information in table 1 helpful. Because cow weight and cow height have received so much attention, these have been included along with weaning weight, milk production and age of dam. Each breed group is listed separately with the number of cow year records indicated in parenthesis. The 10% of the breed group most efficient and the 10% least efficient are evaluated for the eight factors and the range is given in parenthesis to indicate the variability present. In addition, the breed group averages for the factors are presented. The relationships of weaning weight and milk production to efficiency (TDN/WW) agree well with results of analysis of all breeds with the possible exception of milk production in the Charolais-Angus. Since efficiency is measured as feed per pound of weaning weight produced, smaller values indicate higher efficiency.

Those people still having difficulty accepting the fact that small cows are not more efficient should note that the difference in average cow weight between the most efficient and least efficient is quite small, with the range indicating that selection for the smallest cow in an attempt to select for efficiency would have resulted in selection of a least efficient cow in all breed groups. Both the analysis of the first 3 years' data and the first 5 years' data indicate essentially no effect of cow size on efficiency, and the range in weight for these most efficient and least efficient groups support these findings. It is obvious from these data that, if one were to cull their cow herd on the basis of cow weight, they might change the average weight of the herd; but they would not change the efficiency of producing a pound of calf at weaning.

Cow height was included in the analysis because of recent emphasis on frame size. The results for frame size are similar to the results for cow weight. The largest difference in height between the most efficient and least efficient is in the Angus group and that amounts to about 3/4 inch. The other breed groups differ by only 3/8 inch. The range in cow height indicates that cow height could be affected considerably through culling a herd on that basis, but again the efficiency would not be changed.

The extremes of weight and height do not appear in the most efficient and least efficient groups; and, in addition, these two groups overlap almost completely with regard to weight and height. Contrast this with weaning weight where there is no overlap at all. Obviously, this does not suggest that one select for intermediates on weight or height, as the data indicate that there are efficient and inefficient cows in all weights and heights. What these results do suggest is that one needs to select for the trait or the best predictor of the trait that is available. For cow efficiency, weaning weight is the best single indicator; however, this is weaning weight of calf not weaning weight of dam. Milk production would have additional utility, but this is not a trait that is commonly measured. Research has indicated that selection for adjusted yearling weight achieves response in weaning weight equal to that achieved by direct selection for weaning weight, thus allowing improvement to be made in both preweaning and postweaning growth through selection on one measure. This selection should be practiced through the use of ratios or preferably breeding values which are supplied by most breed association performance programs. Actual values for weaning weight or yearling weight do not rank the individuals according to the contemporary group in which they were produced as the ratios and breeding value estimates do.

The lack of weight or height effect on weaning efficiency has led some people to forget efficiency, either through feeling that efficiency is no longer important or that there is nothing in addition to their current selection for weaning weight that they can do about it anyway. If one considers the extreme range in individual cow records for weaning efficiency, we find in these data the most efficient cow required 8.2 and the least efficient 17 pounds of TDN per pound of weaning weight. The difference of 8.8 pounds is larger than the requirement of the most efficient cow. Temporary environmental effects that influence feed consumption and weaning weight can have a large effect on individual records such as these. Taking the average for the three calves which each of these cows produced, we find the difference has narrowed to 9.6 for the most efficient and 14 for the least efficient. This translates into an additional 2 ton of alfalfa hay required by the least efficient cow to produce a 500 pound calf. Another way of looking at it is that these inefficient cows are not producing 500 pound calves, but they are still consuming feed. In this case the inefficient cow produced a 385 pound calf while consuming the equivalent of 600 more pounds of alfalfa hay than the most efficient cow which produced a 530 pound calf. This difference of 145 pounds less calf and 600 pounds more hay consumption does indicate the trait is important.

Because of the importance of the cow-calf industry to South Dakota, it is necessary that we avoid the "nothing we can do about it" attitude and learn more about cow efficiency in order that we might better manage as well as breed for more efficient production. We need to evaluate the repeatability of this trait, to know if it is uniform in expression from year to year and we need to obtain an estimate of the heritability of the trait so that we will know the extent to which differences among animals will be transmitted to their offspring. Perhaps of primary importance is the matter of finding better predictors of weaning efficiency in order that we might select our replacment heifers at weaning or yearling ages more accurately. The reason that this is so important is that the high accuracy for weaning weight quoted earlier is based on the weaning weight of the calf produced by the cow rather than her own weaning weight. If we wait until the cow is in the herd and has produced a calf, providing us the information to make our efficiency predictions, economically we have a hard time culling her as long as she settles for the next calf crop. To avoid this and to make maximum progress by selection, we need predictors of efficiency that can be utilized in selecting replacement heifers either at weaning or yearling ages.

Considerable confusion exists both in industry and in scientific circles with regard to interpretation and application of experimental results currently available. Part of this stems from poorly designed experiments and experiments involving too few animals. For example, if one is truly interested in evaluating effects of cow size free of other sources of variation, then all cows should be fed at a level that will allow them to reproduce at their genetic potential. If this is not done, the experimental results will not be indicative of cow size effects alone but will be a mixture of cow size and nutritional level. This confounding of the two sources of variation prevents accurate interpretation of the results. Similar confounding of breed and cow size effects exists in other research results.

Another example is confusion of economic evaluation with biologic evaluation. This paper deals only with the relationships of cow efficiency to other biological traits and does not deal with dollar evaluation. Economic evaluation requires some sort of system evaluation in order to bring in all the interrelationships among biologic traits that sometimes result in trade-off. That is, one can sacrifice biological improvement in one desirable trait in order to gain in net dollars through a related improvement in another trait. Realizing this may help in relating results of this paper with those of other papers in this proceedings. For example, the paper by Buckley indicates economic advantage to large size cows in a comparison of two energy partitions. The procedures used take into account correlations among many of the biologic and economic traits involved. Trade-offs exist between weaning weight, percent weaned and price per pound in evaluations of net return at weaning which allow increases in one trait to offset losses in one or more of the others. These are only part of a number of such relationships that exist in a combined biologic and economic system.

A third area that may cause some people confusion is that of equating fast gain with large mature size. Animals can grow to a large size by growing slowly for a long time, and this is not desirable growth for present production systems. We need rapid growth at a young age, but there is little to recommend large mature size. Unfortunately, we will have to accept some increase in mature size as we increase early growth rate because of the high correlation between the two traits, unless research can produce a method of determining at a young age which of the rapid gaining animals contain the genes that limit their mature weight. It is important to remember that measures of early growth such as weaning weight and yearling weight are not direct measures of mature size even though they are correlated with it. This is especially important in consideration of measures of frame size, since frame size is primarily a predictor of mature size rather than a predictor of growth rate. Feeders have discriminated against calves from small cows because of lower growth rate and increased finish at desirable weights. Producers with small cows interested in increasing cow size should keep in mind that the trait needed by the feeder is growth rate at an early age and should make their selections directly for that trait, thereby increasing cow size through the correlated effects of early growth with mature size. Selection for frame size will result in larger cows at maturity but will not necessarily achieve the desired increase in early growth rate. This assumes selections are made in the same population of replacement heifers, which is the only way two methods of selection can be fairly compared. Optimum improvement in early growth can be obtained by purchasing bulls from breeders who have the longest history of selecting their herd sires on their breeding value for early growth. Since breed association breeding value programs are relatively new, selection for high ratios within contemporary groups should be considered where breeding values are not available. References to cow size in other reports of our efficiency or systems (Simumate) research refer to size related to rate of early growth rather than frame size except where frame size is specifically indicated.

Practical aspects in applying research results to the ranch then become that of reducing carrying capacity sufficiently in proportion to increases in cow size or milk production to allow the larger or higher producing animal to reproduce. In a ranch situation, the producer needs to be careful that he does not increase the nutrient requirement of the larger, high producing cow beyond her ability to extract the necessary energy from the types of feed available on the ranch. There is a definite need for more research information that will assist the producer in matching cow size and levels of milk production to available feed resources. This is particularly true for the drier, more sparsely vegetated range areas. Research at the Antelope Range Livestock Station reported in previous years has been directed in part to an evaluation of this question.

Since calves sold at weaning must go on and produce efficiently for the backgrounder and feeder, we need to be concerned with the relationship between weaning efficiency and measures of postweaning efficiency. Dr. Brown found correlations between weaning efficiency and total TDN per pound of slaughter weight and per pound of retail cut of .51 and .48, respectively. These correlations indicate a moderate relationship with more efficient calves at weaning tending to be more efficient at the later age. This relationship can be partially evaluated for the different breed of dam groups in table 1. In each group the more efficient calves at weaning are also more efficient in slaughter weight and retail cut production. Cow size was not closely related to efficiency of production of slaughter weight or retail cuts. Dr. Brown also evaluated breed of dam effects on TDN requirements per pound of slaughter weight and per pound of retail cut in data collected in the first 5 years of the project. Calves from Angus dams required less TDN per unit of slaughter weight than calves from Charolais or crossbred cows, although the differences were not large. On the other hand, there were no significant differences among breed of dam groups for TDN requirement per unit of retail cuts. It is possible that calves from the Angus cows deposited more fat in the postweaning period and this fat was trimmed when carcasses were broken down into retail cuts.

Fortunately, there does not seem to be any antagonisms between cow efficiency and other desirable production traits. Thus, if selection for efficiency could be practiced at an early age, considerable benefit could accrue to the producer if the trait is heritable even to a moderate degree. This improvement could apparently be independent of cow weight or cow height. The need for more information about efficiency of production and particularly cow efficiency has been indicated. We will continue to research these needs as our fund support will allow. They appear to us to be an important area of study when one considers the relative importance of the beef cow in determining new dollar income to the state of South Dakota.

TABLE 1. HERD DESCRIPTION BY BREED GROUP

Breed group	Weaning weight (lb)	Milk production (lb)	Weaning efficiency TDN/WW[a]	Cow weight (lb)	Cow height (inches)	Cow age (yr)	Postweaning efficiency TDN/SW[b]	Postweaning efficiency TDN/RC[c]
Angus (63)								
6 most efficient	602	46	8.7	909	46.1	3.7	7.6	19.7
	(504-663)	(36-57)		(834-1045)	(44-48)			
6 least efficient	393	39	13.1	902	45.3	2.7	9.3	26.8
	(350-443)	(34-47)		(829-976)	(44-47)			
Angus average	495	50	10.7	927	45.7	3.6	8.3	22.3
Ang x Char (52)								
5 most efficient	560	55	9.0	1006	47.6	4.2	7.4	18.6
	(504-614)	(41-67)		(966-1066)	(46-50)			
5 least efficient	398	40	13.5	988	47.2	3.8	9.4	26.9
	(366-432)	(32-54)		(848-1130)	(46-49)			
A x C average	502	47	11.0	969	47	3.5	8.6	23.3
Char x Ang (62)								
6 most efficient	580	48	8.6	992	46.9	4.3	7.1	16.6
	(556-602)	(28-64)		(975-1051)	(46-47)			
6 least efficient	366	48	14.4	976	46.5	2.8	10.3	30.1
	(335-440)	(27-74)		(921-1149)	(46-49)			
C x A average	494	46	10.9	996	46.9	3.5	8.5	22.6
Charolais (44)								
5 most efficient	590	49	8.8	1021	48.4	4.2	7.7	19.2
	(542-635)	(32-72)		(959-1087)	(47-50)			
5 least efficient	420	39	13.5	1043	48.8	3.4	9.2	24.9
	(316-490)	(32-44)		(818-1188)	(47-50)			
Charolais average	505	43	10.9	1050	48.8	3.5	8.5	22.2
All breed average	498	47	10.9	981	47.2	3.5	8.5	22.6
	(316-663)	(22-74)		(756-1247)	(42-52)			

[a] TDN per pound of weaning weight.
[b] TDN per pound of slaughter weight.
[c] TDN per pound of retail cut.