Formulating and Using EPDs to Improve Feed Efficiency

Dorian J. Garrick
Department of Animal Sciences, Colorado State University, Fort Collins, CO 80523.

Many producers have been communicating their apparent need for an EPD to reflect feed efficiency. Over the last few decades, the nature and scope of traits for which EPDs have been generated or sought has grown from output-based characteristics (eg weaning and yearling weights), to include carcass and meat quality attributes (eg marbling and fat depth) and most recently, reproductive characteristics (eg heifer pregnancy and stayability). Producers have recognized that feed requirements are a major determinant of the likely stocking rate in extensive cow-calf circumstances and a significant component of the finishing costs of cattle. Some breeders have attempted to collect intake records with a view to gaining information on efficiency of conversion of feed into beef.

Common measures of feed efficiency used in intensive industries such as poultry and pork production include gain per unit of feed and its reciprocal feed per unit of gain. A natural use for individual feed intake information for an interested breeder is therefore to calculate such a ratio based on phenotypic performance for phenotypic selection, or to calculate an EPD using the phenotypic ratios.

Animal breeders have long recognized the theoretically undesirable properties of ratio traits (Gunsett, 1987) and known that index selection based on inputs and outputs is a more effective method of improving efficiency. Recent research (MacNeil, 2005) has demonstrated the theoretical result in the context of improving beef cattle efficiency.

The logical development of an index approach begins with the definition of a breeding goal. We will limit our consideration to breeding goals that emphasize profit. The next step is to list the traits that influence the breeding goal (Harris et al., 1984). Recalling the definition of profit as income minus costs, the list of traits should include measures of output (eg sale weight) and measures of input (eg feed requirements). It does not make sense to include feed efficiency in the list, as that would represent double counting since the outputs and the inputs that comprise the definition of feed efficiency are already in our list of traits.

The next step in the logical development of a breeding program is to determine the relative emphasis of each trait in the list. This involves quantifying the answer to the following question “how much does profit change for a unit change in this trait, all other traits in the list held constant“. At this point, any double counting of traits in the previous step should become apparent. Suppose our list of traits had included weaning weight, feed costs and feed efficiency. We would need to answer the question, “how much does income and therefore profit increase if weaning weight increased by 1 lb with no change to feed requirements or feed efficiency”. The answer would be the expected sale price per lb. We would then need to answer the question “how much does expenses and therefore profit change with a unit increase in feed requirements with no change in sale weight or feed efficiency”. The answer would be the feed cost. Finally, we would need to answer the question, “how much does profit change if there was a unit change in feed efficiency with no change in sale weight or feed requirements”. The answer is there would be no change in profit since the determinants of income and expenses would be unchanged.

Indexes are constructed by summing up the values obtained by multiplying each EPD by its influence on profit, known as the relative economic value. Given the relative economic value for feed efficiency is zero, a feed efficiency EPD would get no emphasis in an index with profit as a goal. Productivity would get rewarded based on the value of extra production, and feed requirements would get penalized based on the cost of any additional feed required. The animals with the highest index values would be those with the greatest net income, or sale value less costs. These are the most economically efficient animals. Hence this index would improve economic efficiency. It would also be expected to increase biological efficiency. The reverse is not necessarily true. That is, selection for an efficiency ratio will not necessarily improve profit. This can be demonstrated by the trivial example with three animals shown in Table 1.

The rancher with a goal based on individual animal profit would clearly prefer the sire Romeo over Oscar and Papa. However, the rancher with an efficiency ratio mindset would prefer Papa. Papa has a higher ratio than Oscar, even though it achieves the same profit. Romeo has a lower (less favorable) ratio but higher profit. The conclusion is that if your goal is profit, it is better to select on an index of profit than on a ratio of input and output components.

Selection objectives developed for various Breed Associations and other organizations by Dr Mike MacNeil (Charolais, Circle-A Angus Sire Alliance, Hereford, Limousin and Simmental) reward productive animals but recognize increases in feed requirements associated with faster growth or larger mature size bring associated costs. Such indexes will increase feed efficiency, principally by diluting maintenance. The decision support software developed by the National Beef Cattle Evaluation Consortium (ert.agsci.colostate.edu) uses EPDs to predict the productive and economic consequences of using particular animals as sires, within the context of a particular production, management and economic circumstance. That software identifies the changes in productivity and the changes in feed requirements. It provides the user with two options regarding the valuation of feed. The number of animals that can be managed to consume the same amount of feed that the existing herd requires can be calculated by the system, a method of valuing feed based on its opportunity cost (Garrick, 2002). Alternatively, the number of breeding cows can be kept constant and any increase (decrease) in feed requirements can be met by feed purchases (sales) at a user-input price.

Some ranchers/feedlotters are motivated to consider the concept of individual efficiency ratios primarily when they have means to record individual feed intake. However, nutritionists have been researching and publishing models (NRC 1996) to predict feed requirements on the basis of maintenance, growth rate, composition of gain, pregnancy and lactation for at least a century. Accordingly, feed requirements of individual animals can be estimated from many of the routinely recorded performance attributes. It is therefore not necessary to observe and record individual feed intake in order to account for the expected feed requirements of animals from the same cohort or contemporary group that differ in productivity. Observed feed intake measures are typically more costly to obtain than feed requirements predicted from performance and have the disadvantage of including measurement errors. However, they do provide the means of identifying sires whose offspring consistently consume more or less than is expected. Such difference between observed and expected feed intake are known as residual feed intakes or RFI.

The US beef cattle industry, along with those in most other countries, does not currently have any national system to collect or manage feed intake measurements. From the perspective of national evaluations, even if the US did have such a system, there is no agreed approach to utilize that information. It has already been argued in this document that it makes little sense to produce EPDs for some ratio trait such as feed efficiency. It does make sense to rank animals for profit including the costs associated with feed intake. One alternative would be to produce an EPD for feed intake. This could be calculated from production records of growth and performance for some animals and from phenotypic observations on feed intake on others. Such an evaluation would nee to be done in a multitrait setting, so that bulls with many performance recorded offspring would have an upper limit on the accuracy of their feed requirement EPD. Alternatively, decision support models and selection indexes could account for expected intake, in the same manner as they do today, and EPDs could be produced for RFI. Such EPDs could be readily taken into account in the selection index or decision support approach. In any event, standardized approaches need to be developed for the collection of feed intake data. Furthermore, there are many alternative approaches to predict RFI from feed intake data. An approved method needs to be agreed upon and communicated. Where collected, raw feed intake measures rather than computed RFI should be stored on databases, in order that different methods of computing RFI could be implemented in the future. The National Beef Cattle Evaluation Consortium is currently debating many of these issues. There is a role for BIF in this regard, to standardize and communicate the outcome of such deliberations.

Table 1. Output, input, profit and efficiency ratios of three candidate sires for selection.

Bull ID	Output ($/dtr[1])	Input ($/dtr)	Net Income[2]	Efficiency[3]
Oscar	$500	$200	$300	2.5
Papa	$400	$100	$300	4.0
Romeo	$750	$300	$450	2.5

[1] Output and input are expressed in financial terms, per daughter (dtr).
[2] Net income is the value of the outputs column less the cost of inputs column and may not be the same as profit which typically includes other fixed costs.
[3] Efficiency is defined here as the ratio of outputs to inputs ($/$). In this case, higher ratios are desirable. It could equally be defined in other units such as lb/lb or as its reciprocal, inputs/outputs, in which case lower values would be desirable.

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