Feed Efficiency: What role will genomics play?

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Improvement of the economic position of the farm or ranch is an ongoing process for many commercial cow-calf producers. Profitability may be enhanced by increasing the volume of production (i.e. the pounds of calves you market) and/or the value of products you sell (improving quality). The reduction of production costs, and thus breakeven prices, can also improve profitability. For commercial beef producers, the implementation of technologies and breeding systems that increase the quality and volume of production and/or reduce input costs is essential to maintain or improve the competitive position of the operation. Profitability is influenced by these factors concurrently. Efficiency is the proportion of outputs to inputs and is frequently used by beef producers. There are many different 'efficiencies' that affect beef production, especially at the cow-calf level. Some of these efficiencies are observed at the individual animal level and some observed at the system or herd level. The various efficiencies can be categorized into with measures of biological or economic efficiency. Improvement in individual animal efficiency, especially during the post-weaning growing or finishing phases, may or may-not improve efficiency at the herd or system level, and may have undesirable correlated response in traits of cows.

So, why is improvement in feed efficiency important and why does the beef industry focus on it? During the growing and finishing phase of production, a 1% improvement in feed efficiency has the same economic impact as a 3% increase in rate of gain. The traits that beef producers routinely record are outputs which determine the value of product sold and not the inputs defining the cost of beef production. The inability to routinely measure feed intake and feed efficiency on large numbers of cattle has precluded the efficient application of selection despite moderate heritabilities (h^2 = 0.08-0.46). Feed accounts for approximately 65% of total beef production costs and 60% of the total cost of calf and yearling finishing systems. The cow-calf segment consumes about 70% of the calories; 30% are used by growing and finishing systems. Of the calories consumed in the cow-calf segment, more than half are used for maintenance. Without doubt, improvement of the efficiency of feed utilization in the beef industry would strengthen the economic position of producers and enhance domestic and global food security through better utilization of scarce feedstuff resource.

Beef producers and animal breeders have long sought to improve the efficiency of feed utilization in beef production systems. However, effective selection for improved individual feed efficiency has been elusive. The earliest selection for feed efficiency was associated with selection of faster growing, leaner animals. Selection for improved average daily gain, without consideration of potential changes in other traits, resulted in undesirable changes in the mature weight and body composition of cows. A number of methodologies have been proposed to correct observations on the phenotypic and genetic scales for differences in gain, metabolic weight or feed intake. Residual feed intake and residual gain are two such phenotypes. Other researchers have proposed the incorporation of a feed intake genetic prediction computed from feed intake records and/or gain records into selection indexes. The index architecture can

then appropriately weight predictors by economic values that connect input costs associated with feed intake with a variety of output predictors for different breeding objectives.

Even though a variety of technologies have been proposed for the development of selection tools for improved feed efficiency, all have suffered from an inadequate supply of individual feed intake measurements. The measurement of individual feed consumption has been limited by both availability of reliable, efficient technology to monitor individual feed intake in typical industry settings and by the cost of such equipment. Certainly systems will continue to evolve and become more available over time. However, collection of individual feed intake records on growing animals will continue to be expensive and time consuming. Collection of feed intake records to evaluate the relative differences in the efficiency of growing animals doesn't address the differences in maintenance requirements of cows.

Genomics technologies offer both the promise of discovery tools to detangle the genetic architecture of feed efficiency and also the diagnostic tools needed for industry deployment. Feed efficiency and intake are prime candidates for the application of genomic technologies because of the high cost of phenotype collection, their moderate heritabilities and the traits significant economic impact on the beef industry. Genomics technologies will play a key role in identification of genomic regions associated with differences in genetic merit for feed intake and efficiency. Additionally, genomics technologies will aid in the elucidation of gene networks that influence feed efficiency. These discoveries may also help researchers to exploit variations in genetic sequence that contribute to improvements in metabolic efficiency. Improvements in metabolic efficiency would help reduce forage intake and costs associated with the cow-herd which is responsible for approximately half of the calories consumed in the beef industry. Other research has been proposed that uses genomics tools to aid in the understanding of the host's genomic control of the rumen microbiome and proliferation of a variety of microflora species. It is thought that there may be a genetic component that affects the ability of an animal (and its microbiome) to digest and absorb different feed stuffs.

Genomics research includes the training and validation of molecular breeding value (MBV) prediction equations based on DNA marker panels (subsets of markers from SNP chips) associated with variation in a trait. Once these prediction equations are in place, commercial application via diagnostic tests can begin.

Perhaps the most important contributions of genomics technology to improvement in feed efficiency and feed intake will come through incorporation of MBV into national cattle evaluation (NCE) systems where the MBV can be blended with phenotypic measurements to compute EPD. Subsequently these genomic enhanced EPD (G-EPD) can be incorporated into a variety of selection indexes that target a variety of market endpoints. Leveraging MBV data in NCE provides improved EPD accuracies and reduces the cost of that accuracy gain compared to phenotypic record collection alone. MBV produced from inspection of DNA genotypes and application of prediction equations to those genotypes has a number of advantages over phenotype based analyses. First, MBV predictions contribute to accuracy improvements independent of contemporary group size. Secondly, cows can build accuracy as rapidly as bulls enabling the identification of females in the population that are outstanding selection candidates. These two benefits further support the development and adoption of genomics tools for the genetic improvement of feed efficiency.