1 Input Factors Affecting Profitability: a Changing Paradigm and a Challenging Time

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Introduction

Since their creation in the 1960s, US beef cattle improvement programs have predominantly focused on improving output-related traits through genetic selection of beef seedstock cattle. Such traits historically included economically relevant weight and carcass traits by much of the seedstock industry and, more recently, fertility traits by a few select breed associations. However, during that time almost no emphasis was placed on cost-related traits, including feed intake, feed efficiency, and/or feed utilization associated with the output traits, based on the absence of genetic predictions for these traits by US beef breed associations (Rumph, 2005). The apparent lack of interest in selecting cattle based on economically relevant cost traits has probably been due to relatively low-priced feed inputs (at least up until late 2006) and high costs associated with individually measuring feed intake in cattle.

Because of inherent physiological differences, beef cattle are less efficient at converting grain to meat protein than other meat animal species (e.g., pork, poultry), thus each pound of beef protein requires a higher proportion of feed energy to produce it (Ritchie, 2001). Dickerson (1978) estimated that of all the dietary energy required to produce beef, only 5% is used for protein deposition in progeny that are slaughtered. Granted, most of the life-cycle energy used by beef cattle is acquired via forages unusable by monogastrics. However, the beef industry's efficiency is unfavorable when compared to 14% and 22% of dietary energy going to protein deposition in slaughter progeny in the pork and poultry production industries, respectively.

As a result, beef producers began to recognize the importance of identifying cattle that are genetically superior at converting feedstuffs to pounds of meat product. However, Ritchie (2001) pointed out that it's unreasonable for beef producers to expect to achieve the feed efficiency levels of competing monogastric species. Significant changes started to occur when feed prices began increasing in late 2006 when the US beef seedstock industry began a genetic evaluation program for feed intake and efficiency (BIF, 2010). It is assumed that this was caused by the fact that feed is the largest variable cost associated with the production of beef. Such genetic evaluation programs included the development of a uniform set of procedures for collecting individual feed intake data on seedstock cattle during a postweaning growth phase for use in the development of genetic predictions for feed intake and efficiency (BIF, 2010). A more comprehensive description of the feed intake guidelines being used by scientists working in genetic improvement of feed efficiency is

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presented in Chapter 2. However, it remains unclear how quickly and aggressively beef producers will increase emphasis on the importance of selecting for improved feed efficiency. If effective improvement in feed efficiency is to occur through genetic selection strategies, it is necessary for the industry to routinely collect raw feed intake data, to use these data to develop genetic predictions, and to incorporate predictions into selection programs.

Influence of Input and Feed Costs on the Beef Production Industry

Profitability within the beef production system requires maximizing outputs (revenues) while minimizing inputs (costs). The profitability equation can be denoted as:

$$\text{Profit} = \text{Revenue} - \text{Cost}$$

Profitability of cow/calf producers has become a concern within the US beef industry, based on the consistent loss of cow/calf producers from the industry. From the mid-1980s to the early 2000s, nearly a quarter million cow/calf producers left the industry—approximately 9,000 per year (Figure 1.1).

Historically, cow/calf profitability was driven more by the revenue side of the profitability equation than the cost side. This can be seen in the comparison of estimated cow/calf returns with total cattle inventory from 1982 to 2011 (Figure 1.2). Prior to 2006, the average cow/calf producer was consistently unprofitable (light gray bars) during times when the US cattle inventory was near a peak (thin black line), due to a reduction in income resulting from an oversupply of calves and beef in the marketplace and thus lower cattle prices. Conversely, the average cow/calf producer was profitable (dark gray bars) when cattle inventory was relatively low, primarily due to higher calf

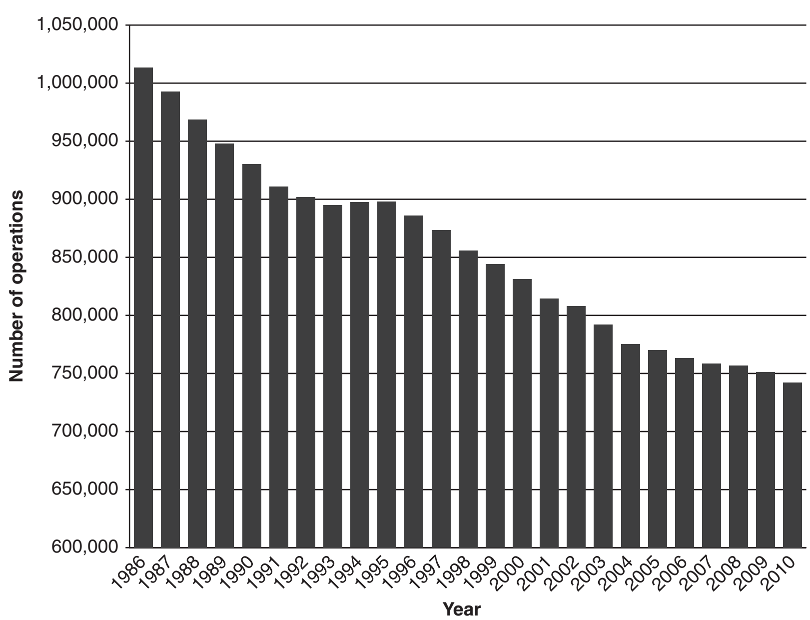

Figure 1.1 Number of beef cow/calf operations in the United States from 1986 to 2010 (USDA).

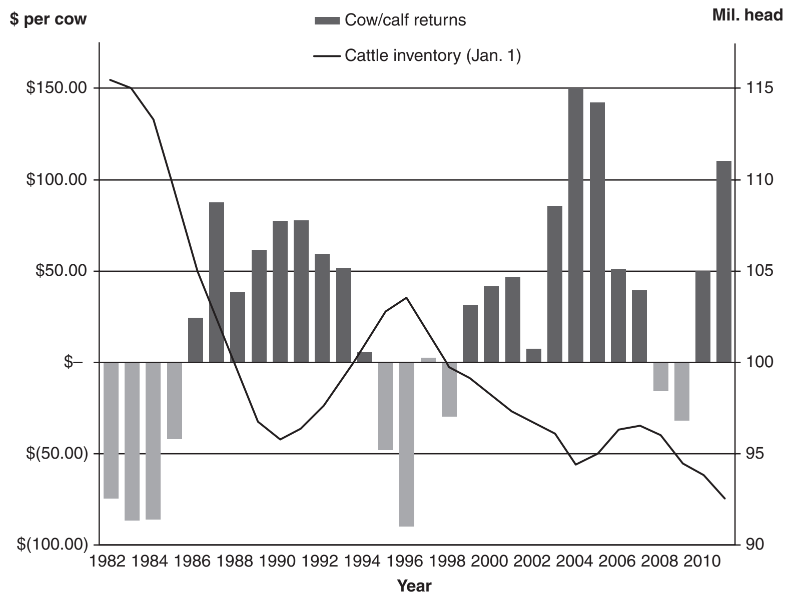

Figure 1.2 Total cattle inventory and estimated annual cow/calf returns in the United States (USDA, compilation and analysis by LMIC.)

prices caused by a reduced supply of calves to feedyards. However, beginning in 2006, this strong relationship between cow/calf profitability and total cattle inventory weakened. This can be seen in cow/calf profitability that was concurrent with peak inventory during 2006 and 2007. Since that time, financial losses during 2008 and 2009 have been attributed to elevated input costs.

As the predominant driver of cow/calf profitability moves from primarily supply and demand (and the historical "cattle cycle") and more toward input costs, the importance of evaluating beef production as a system becomes vital. Massey (1993) provided a sound synopsis of the importance of the "systems concept" of beef production in a Beef Improvement Federation Fact Sheet. He stated that the historical emphasis on increasing production (e.g., milk, gain, mature size) by performance-oriented seedstock and commercial cow/calf producers did not result in a parallel increase in profit over time. Those producers failed to consider additional aspects in the decision-making process for their operation—as would have otherwise been done within a systems approach where more than just outputs are included. Massey (1993) further stated that "overall efficiency of the enterprise—in other words, net return . . ." should be the most important consideration by a beef cattle operation. A true system should include all components that influence net return, including cost. The general absence of vertical integration within the beef industry, particularly at the cow/calf level, contributes to the beef industry's multifactorial production system. This has generally led cow/calf producers to be less likely to consider a systems approach in their decision-making process.

A great opportunity for cow/calf producers to reduce costs is through feed inputs. The USDA Economic Research Service reported that feed-associated costs have represented 56–71% of all nonfixed (operating) expenses on US cow/calf producers from 1982 to 2010 (Figure 1.3). The average percentage of 65.4% during 2006 to 2010, when feed prices were elevated above historical levels, is noticeably higher than the previous average of 62.0% from 1982 to 2005. In addition to

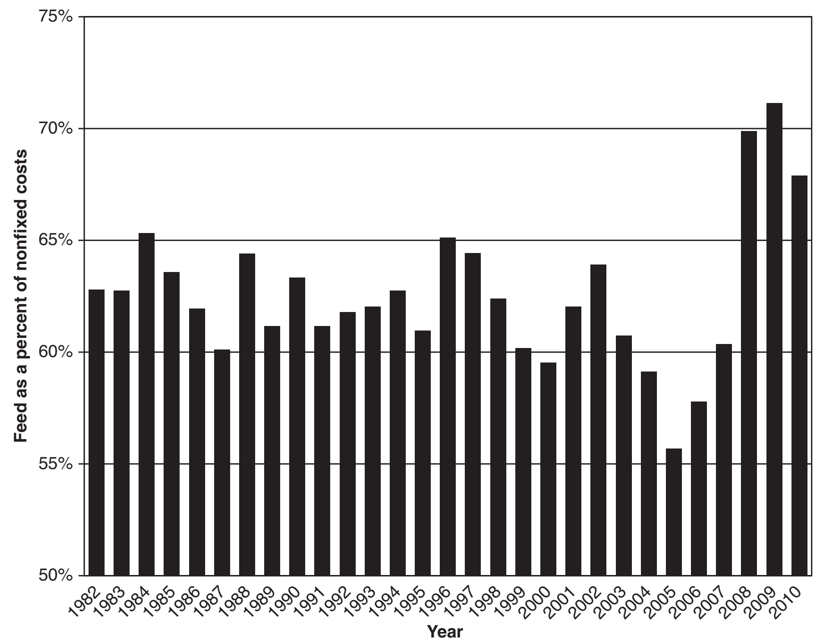

Figure 1.3 Percent of nonfixed costs that feed-associated costs make up on US cow/calf operations (USDA-ERS, 2011).

comprising a larger percentage of nonfixed costs in recent years, the amount that feed-associated costs made up has been more volatile (both the lowest and highest percentages occurred within the 5-year period from 2005 to 2009).

It has been estimated that 55 to 75% of total costs associated with beef cattle production are feed related (NRC, 2000), suggesting that emphasis on improving feed efficiency in beef cattle is a tremendous opportunity for producers (Lamb et al., 2011). Additionally, more than half of the feed required by the US beef production industry is utilized by the breeding cowherd, compared to their progeny, which are fed out until harvest (Carstens and Tedeschi, 2006; Lamb et al., 2011). Because of the large amount of animal-to-animal variation present in the maintenance energy (ME) requirements among cattle (Johnson et al., 2003), selection for feed efficiency is logical.

Beyond native range and improved grass pastures, harvested feedstuffs serve as the primary feed inputs for most of the US beef industry: hay (grass and alfalfa) for the breeding cowherd and corn for feedyard cattle. Corah (2008) identified major challenges facing the US beef industry and its infrastructure of corn feeding. Historically, the US feedyard industry has evolved in an environment in which both energy and corn have been relatively inexpensive. Since 2006, these conditions appear to have begun to change and the trend may be one that will be a permanent and an ever-increasing challenge that must be faced and addressed by the industry.

According to USDA-NASS data, prices for alfalfa and other hay increased gradually but steadily for a 30-year period until 2006 (Figure 1.4). However, the rate of price increase, and associated volatility, increased dramatically in late 2006.

Much of the increase in hay price has been driven by elevation in corn price. During the same time period, the per-bushel price of corn actually remained flat, although somewhat volatile, until 2006 (Figure 1.5).

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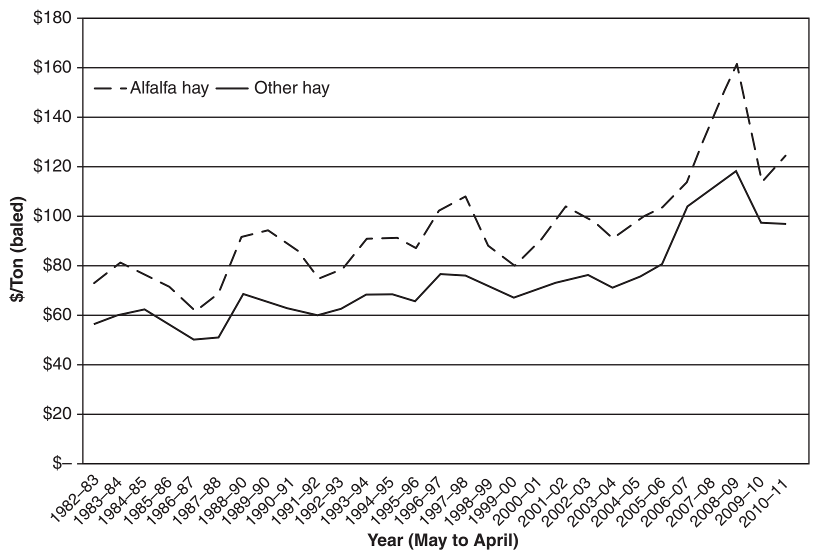

Figure 1.4 US average annual prices for alfalfa and other hay. (USDA-NASS Monthly Agricultural Prices, summarized by LMIC.)

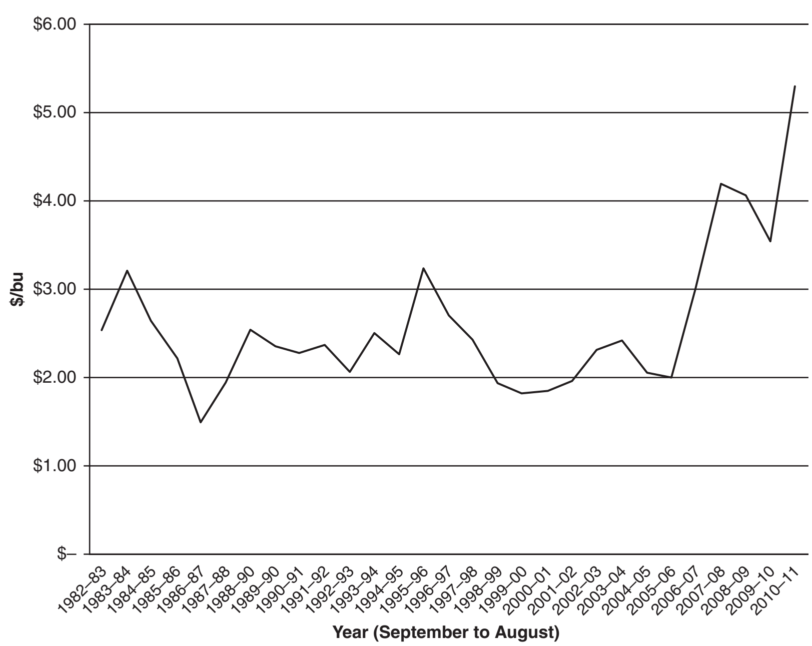

Figure 1.5 US average annual price for corn. (USDA-NASS Monthly Agricultural Prices, summarized by LMIC.)

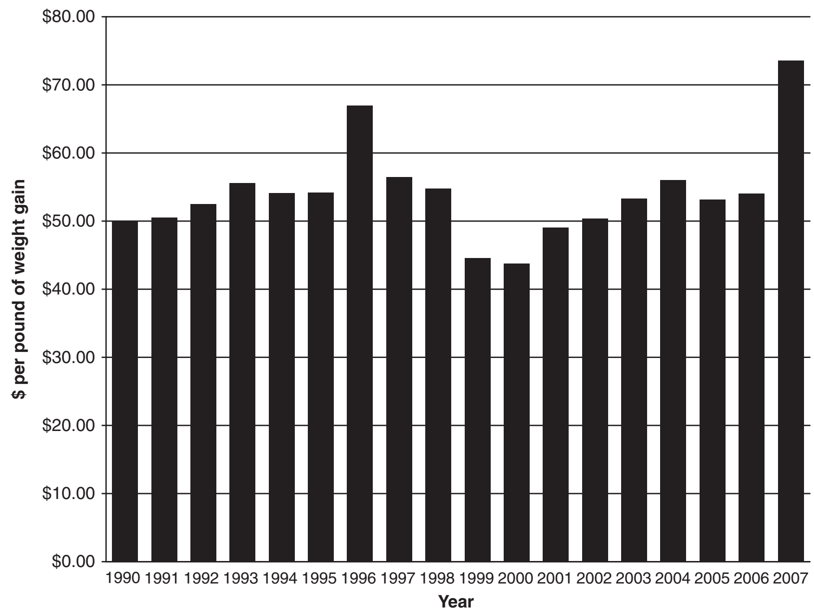

Figure 1.6 Feedyard cost of gain among 190 Kansas feedyards. (Focus on Feedlots, http://www.asi.ksu.edu/p.aspx?tabid=302.)

As the primary component of feedyard diets, the price of corn has influenced feedyard cost-of-gain based on summarized data by Kansas State University (Figure 1.6).

A discussion of historical profitability in the cow/calf and feedyard sectors, as well as main drivers of profitability, will help to clarify the importance of feed efficiency to the beef industry. As discussed earlier, cow/calf profitability during the 1980s, 1990s, and early 2000s generally responded to the cattle cycle and total inventory of cattle in the United States. On the basis of the cow/calf estimates reported in Figure 1.7, after significant losses occurred in the early 1980s, short periods of sustained profitability occurred from 1986 to 1994 and from 1999 to 2007. These periods were interrupted by short periods of losses during the mid-1990s and 2007 to 2008.

To determine the key factors that have affected cow/calf profit, Miller et al. (2001) used standardized performance analysis data to evaluate several variables that may affect profitability (measured as return to unpaid labor and management per cow (RLM)). The researchers used data from 225 cow/calf producers in Iowa and Illinois collected from 1996 to 1999. Using a correlation analysis, it was determined that feed cost was the largest factor influencing return to RLM compared to 12 other economic and production traits and in two models explained 52% and 57% of the variation in profit. Further, the authors reported that factors associated with cost explained more variation in profit than traits related to production, reproduction, and marketing.

Similarly, using financial records from North Dakota cow/calf producers, Hughes (1991) also documented that total feed cost explained the most variation in profit. More recent research also verifies that cost differences across cow/calf producers account for more variation in profit than income differences (Dhuyvetter, 2011).

Unlike profitability in the cow/calf sector, average estimated returns to feedyards since the early 1980s has not been cyclic and has been fairly unprofitable (Figure 1.8). For much of the 1980s, estimated returns to the average feedyard were positive. However, for a 20-year period beginning in

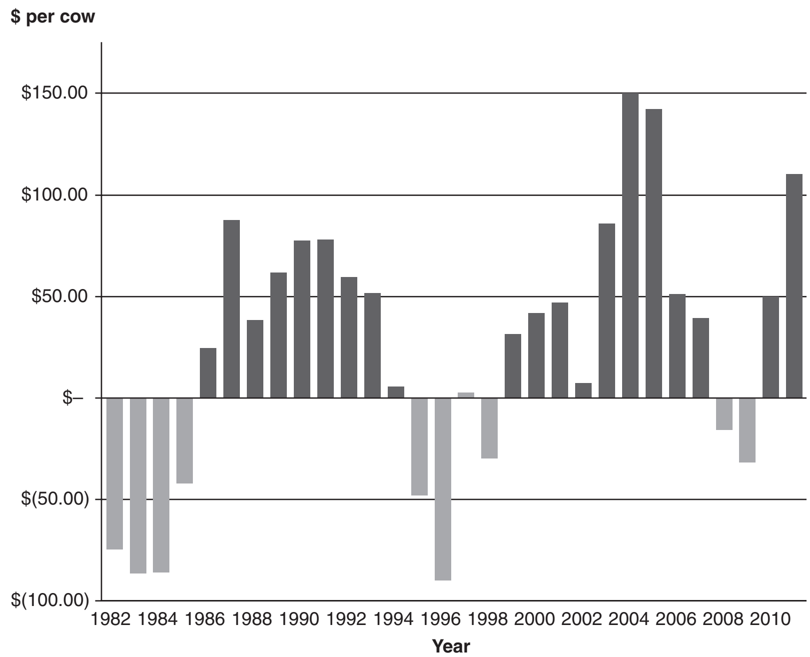

Figure 1.7 Estimated average annual returns for US cow/calf producers over cash cost. (Includes pasture rent; LMIC.)

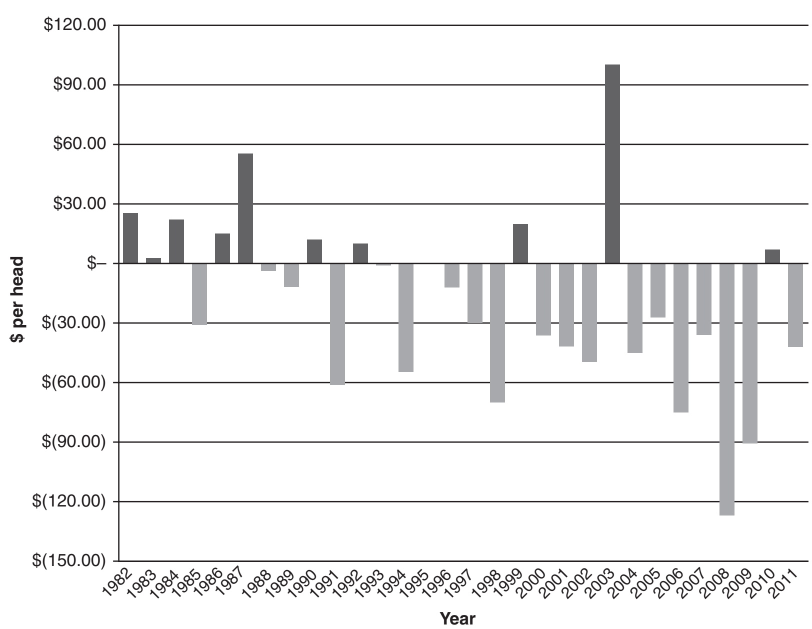

Figure 1.8 Estimated average annual returns to US feedyard operations based on feeding 725 lb steers in the southern plains (LMIC).

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1990, feedyards were only profitable during about 1 in 4 years (based on estimated annual returns). Further, with the exception of 2003 (where annual profit exceeded $100/head for the only time in 30 years), average annual profit was about $20/head or less. In contrast, during years when a financial loss for the year occurred, 7 of those years had losses in excess of $50/head. As a result of sustained losses in the feedyard sector for a 6-year period (2004 to 2009), a massive amount of equity was lost by cattle feeders.

Factors that affected the profitability of feedyard cattle were evaluated using 5,286 head of steers and heifers enrolled in the University of Idaho's A-to-Z Retained Ownership Program over an 11-year period (1992 to 2003; Glaze et al., 2004). The authors reported that profit would increase $33.95/head if feed conversion ratio decreased by 1 unit (i.e., from 7 to 6 lbs feed for 1 lb gain), suggesting the importance of feed efficiency on feedyard profitability.

Similarly, using a computer model, Fox et al. (2001) reported that a 10% improvement in rate of gain increased profit by 18% (due to fewer days on feed and less yardage, as well as less feed required for maintenance due to fewer days on feed). Conversely, a 10% improvement in feed efficiency due to more efficient use of metabolizable energy increased profit by 43%. As with the Idaho data, both scenarios reported by Fox et al. (2001) utilized feed (i.e., corn) prices more reflective of historical averages ($2.50/bu), rather than two- and threefold higher prices since 2006. Thus, if we assume that all other factors remain relatively constant, the effect of feed efficiency on feedyard profitability at a time of higher feed cost would be even larger.

When evaluating the opportunity that each beef industry sector has in terms of capitalizing on genetically improving feed efficiency in beef cattle, it would seem that cow/calf operations have the most to gain, primarily due to the significant feed input required to maintain a cowherd year round. However, during the 1990s and early 2000s, cow/calf producers were generally more profitable than feedyards, and thus better equipped to withstand elevated feed costs (primarily hay). In contrast, feedyards have suffered financially in the high-priced corn markets from 2006 to 2011. Thus, it appears that there may in fact be more opportunity among cattle feeders for cattle that are genetically superior for feed efficiency, even though less than half of the feed inputs required to produce a pound of beef are in the form of a high concentrate feedyard ration. Feedyards that have the opportunity to utilize less high-priced corn may be able to overcome major financial losses that have plagued the feeding industry. However, it should be noted that increased demand by the ethanol industry has focused on corn. If (and probably when) cellulosic ethanol becomes a reality, it's likely that low-priced feedstuffs typically fed to cowherds during winter (e.g., cornstalks, straw, etc.) may increase costs to cow/calf producers so that cowherd feed efficiency is a greater opportunity than in the feedyard. Regardless, mature cows will likely continue to consume the majority of their annual caloric needs via pasture grazing. In contrast, feedyard demand for feed efficiency is unlikely to decline, assuming days on feed do not substantially decrease.

Evolving Factors Affecting Feed Cost in the Beef Production Industry (the Changing Marketplace for Feed Grains)

In addition to the consistent trend of increasing prices for feed input, the volatility associated with input prices has dramatically increased since late 2006. Similarly, volatility associated with output prices (i.e., weaned calves, feeder cattle, fed steers, market cows, etc.) has similarly increased. Producers are realizing that they need to focus on low-cost production strategies, as well as market risk mitigation strategies.

A quick review of factors that influence the higher cost of inputs is relevant toward understanding the likelihood that input prices will remain high or even continue to increase. Since the prices of typical feedstuffs utilized by cowherds (hay, corn stalks, pasture, etc.) are mainly driven by feedgrains (primarily corn), it is logical to focus on the factors that are driving the increased price of corn.

The major users of corn include ethanol, livestock, and commercial food production. Additionally, there is strong demand for the exportation of corn out of the United States, primarily for livestock and commercial food uses. Such international demand is largely the result of sustained economic growth among Asian countries. However, US biofuels policy has provided unwavering support to the corn-based ethanol production industry. Such policies include the Energy Independence and Security Act of 2007, as well as the Renewable Fuel Standard. Westcott (2007) indicated that demand for corn by the ethanol industry has caused an increase in both corn and land prices, which will ultimately lead to a reduction in the US production of corn-dependent livestock species including pork, poultry, and beef. Finally, uncertainty associated with agricultural production—typically due to variation in crop yields due to highly variable weather, disease incidence, and so on—is contributing to the rise in corn price.

In addition to governmental support for renewable fuels production, ethanol-based demand for corn has also resulted from an elevated and volatile global oil market. Whether global unrest among some oil-rich countries or production strategies by major oil exporting countries intended to keep oil price high (i.e., OPEC), the general price of energy is elevated. Finally, the fact that the number of available acres of farmland has peaked further suggests that future food production costs will be substantially higher.

Moving forward, the US agriculture industry will be faced with a huge challenge. As United States and global populations increase, while land resources stagnate and demand for animal-derived protein increases among developing countries (i.e., China), it's unclear how production levels can increase to meet supply in a sustainable manner. The world population is projected to exceed 8.3 billion by 2030 (FAO, 2002) and demand for agricultural products is growing by 1.5% per year. Thus, competing demands on corn for human consumption, as feed for livestock, and as a source of energy (for ethanol production) will play out in a complex dance. Further, water availability issues in the semiarid and arid portions of the United States are expected to be nearly insurmountable obstacles.

As a result, there will be a changed landscape of beef production in light of sustained elevation and volatility of feed costs. Historically, the beef industry has focused on output traits (e.g., weight, gain, percent pregnant cows, percent calf crop, carcass traits, end-product quality, and yield), primarily due to the successful reliance on relatively cheap input costs (i.e., feed). Low-cost corn enabled beef producers to generate a product with amazing palatability compared to pork and poultry, but only at a slightly higher price. In the future, assuming feed grain prices remain much higher than historical averages, the beef industry will adopt a major emphasis on reducing input costs associated with the outputs it produces.

Drivers for Increased Focus on Feed Efficiency within the Beef Industry

There is a huge opportunity for the beef industry to genetically select for feed efficiency based on the fact that a considerable amount of animal-to-animal variation exists for feed efficiency. A relatively new measure of feed efficiency is calculated as the difference between the amount of feed consumer by an animal and the amount of feed that it is predicted to consume (for its size (weight) and rate of gain). It is known as residual feed intake (RFI), named for the mathematical relationship between actual feed consumed versus predicted (the difference being the mathematical residual in a regression or average prediction value). The measurement was originally described by Koch et al. (1963) and its advantage is that it appears to be independent of many other performance traits. There is also a large range of variation in RFI—more than 35%. Further, the heritability of RFI is estimated to be low ($h^2 = 0.16$) to moderate ($h^2 = 0.43$; Herd et al., 2003), indicating that significant genetic progress can be achieved through performance-based breeding programs.

The use of RFI in a breeding program offers a genetic selection method to improve beef cattle feed efficiency without also increasing growth rate and mature size (Johnson et al., 2003). Selection for efficiency using the RFI trait could potentially improve feed efficiency in cattle through reduced feed intake (Herd et al., 2003). Animals that are more RFI-efficient eat less than predicted and have RFI values that are expressed as a negative number (the difference between actual and predicted feed intake). Animals that are RFI-inefficient eat more than predicted and have RFI values that are positive. It has been reported that selection of parents with low RFI values (considered more feed efficient) resulted in progeny that consumed less feed as yearlings but weighed the same at harvest as offspring from high-RFI parents (Richardson et al., 2001). In addition, preliminary evidence suggests that selection for RFI probably does not negatively affect mature cow weight or carcass quality of progeny, but can offer an advantage in selection for reduced cow maintenance requirements (Johnson et al., 2003).

ME requirements are likely contributing to the relatively high cost (and energy requirements) for the production of beef (Ritchie, 2001). Johnson (1984) estimated that approximately 50% of the total energy required to produce beef is for maintenance of the beef cow. This calculation is based upon assumptions that 71% of dietary energy needed by the beef industry goes only to maintenance, and 70% of that ME is required by the cowherd.

Unfortunately, throughout all of the twentieth century, the maintenance requirements of cattle have really not changed, even as a result of some selection pressure placed on maintenance requirements (Johnson et al., 2003). However, due to the general lack of individually measured feed intake and efficiency data, likely due to low and consistent feed prices, the US beef industry did not seek to specifically improve the efficiency of feed utilization among cattle that were growing or at maintenance.

For the first time in 2002, the seedstock industry (via the Red Angus Association of America (RAAA)) developed its first genetic prediction for the ME required by future daughters of a sire—the ME EPD (Evans et al., 2002). This genetic prediction was meant to help bull buyers match their cows' feed requirements with their environment and reduce winter supplementation of beef cows without negatively affecting body condition score, reproductive performance, growth, or carcass traits. A prototype EPD was created to predict these differences in energy requirements among mature cows and was published on a megacalorie per month (Mcal/mo) basis. This was the first opportunity for producers to select females based on ME requirements, which contribute significantly to differences in feed efficiency. However, the EPD values were based on the only readily available data related to cow energy requirements (mature cow body weight adjusted to a common body condition score, and a small adjustment using milk EPD) and does not include any actual feed intake data from cattle on test (Evans et al., 2002).

A few years later, the American Angus Association (AAA) added a similar genetic prediction—the Cow Energy Value ($EN). In contrast to the Red Angus ME EPD, $EN is expressed in dollars saved per cow per year based on estimates for energy density and price of hay. Also, a negative ME EPD value is considered favorable by RAAA, while a negative $EN is unfavorable by AAA. Even with these initial genetic predictions for daughters' ME requirements, limited individual feed intake data has been collected or utilized to generate genetic predictions for feed intake and efficiency in feedyard steers and heifers or mature cows. This has been the result of generally low feed input prices coupled with high costs associated with the technology, facilities, and labor necessary to collect individual feed intake data in beef cattle.

It has been reported that improving beef cattle feed efficiency via genetic selection, which can be accomplished readily based on reasons discussed earlier, could greatly overshadow improvements in ADG. For instance, Gibb and McAllister (1999) estimated that the economic benefit of improving feed efficiency by 5% could be approximately fourfold higher than a similar improvement in ADG.

Beyond the cost reduction effects that result from selecting for improved feed efficiency, benefits related to the environmental effect on beef cattle production have been reported. Scientists from Canada (Okine et al., 2001) and Australia (Hegarty et al., 2007) reported reductions in manure production and methane emissions from cattle selected for low net feed efficiency (another term used instead of RFI, but identical to RFI). These reductions included a 9–12% reduction in methane and a 15–17% reduction in the production of manure.

Beyond reductions in by-products, improvements to feed efficiency in beef cattle may have a larger influence on the increasingly important "carbon footprint" calculation associated with the production of beef. Concern among end-product consumers about beef's sustainability, due to its overall efficiency (pounds of feed in vs. pounds of product out), may be addressed mostly effectively via improvements to the both efficiency of carbon utilization as well as carbon-related outputs as greenhouse gases, per pound of output.

Implications for Improved Efficiency of Feed Utilization in the United States (Based on Number of Beef Cattle in United States—Cow/Calf, Stocker, and Feedyard)

Ultimately, the beef industry's ability to accurately identify and propagate cattle that are efficient in converting feed into body weight could result in significant changes to the beef industry. These are likely to include:

1. *Improved profitability* among cow/calf, stocker, and feedyard sectors due to reduced input costs without negative consequences to productivity. Operations will be more able to manage within a climate of elevated feedstuff prices, as well as highly volatile markets, if less feed inputs are needed.
2. *Expansion of the US cowherd inventory* by increasing productivity while using the same feed resources available. Reducing inputs (per animal) will enable cow/calf producers to have more cows and more efficiently manage their overhead.
3. *Increased net beef supply* for domestic and international consumers through increased beef production using the same available feed resources.
4. *Reduced end-product price* at retail for consumers due to cost savings resulting from a reduction in input cost. Such a price reduction will enable beef to be more price competitive with competing animal proteins (pork and poultry).
5. *Stronger rural agricultural communities* and the agricultural economy in general due to enhanced profitability of cow/calf operations.
6. *Enhanced environmental sustainability* of beef production practices due to greater efficiency (fewer inputs vs. outputs) of production and reductions in the production of manure and greenhouse gases. A beef industry driven by consumer demands for sustainability could result in greater demand for beef.

Improving feed efficiency in beef cattle will have numerous wide-reaching positive effects on the environment, consumers, and agricultural communities, particularly since beef cattle are less efficient at converting grain to meat protein compared to pork and poultry. As a result, high feed costs will be the key driver for the beef industry's focus on feed efficiency (Corah, 2008). Since feed efficiency directly affects the unit cost of production for beef, altering it will improve the US beef industry's competitiveness with other meat producers, profitability, and long-term sustainability (Ritchie, 2001).

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