Impact of the Ethanol Boom on Livestock and Dairy Industries: What Are They Going to Eat?

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Increased demand for corn for ethanol production has helped push grain prices to record levels. This has increased livestock production costs, and producers have responded with changes to production systems. This paper explores the degree to which costs can be mitigated with alternative feeds, the effect this might have on physical performance, and the impact of alternative feeds on the competitive position of different species.

Key Words: cattle feeding, corn, cost of production, ethanol

JEL Classifications: Q12, Q13

The use of corn in ethanol production has increased dramatically in recent years. As recently as the 2002/2003 marketing year, corn use in ethanol production amounted to less than 1 billion bushels. The most recent U.S. Department of Agriculture (USDA) projections estimate corn use in ethanol production at 3.2 billion bushels in 2007/2008—roughly one quarter of total production. Ethanol production is forecast to claim 4.1 billion bushels of the corn crop in 2008/2009—as much as one third of expected production (U.S. Department of Agriculture 2008).

The dramatic growth in the biofuels industry has created a demand-driven boom in corn (and, by extension, other crop) prices. Although this has been a most welcome development for grain producers, it has created a difficult situation for livestock producers. The livestock and dairy industries are facing higher feed costs as a result of the increased competition for grains created by ethanol demand. For livestock, dairy, and poultry producers, the hope since the beginning of this recent period of high corn prices has been that the impact of high grain prices would be offset, at least to a degree, by the increased availability of by-products such as distiller's dried grains (DDGs) and corn gluten feed. Although the by-products of ethanol production have surely helped to mitigate the impact of higher corn prices (especially for producers situated close to a plant), the relief provided by by-products to the feed market as a whole has been somewhat disappointing.

The potential of by-products as a feed resource across all livestock and poultry industries is a topic of much research right now. Several key questions remain to be answered. For example, what level of by-product is acceptable in livestock rations? Even with DDGs (or DDGS to denote "with solubles") in beef rations—a topic with which there is considerable experience—it appears that little consensus exists on this issue. Much less consensus exists with respect to by-products in rations for other species. What are the effects of feeding larger amounts of by-

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product feeds on key measures of animal performance: for example, feed conversion, carcass merits, milk production, etc.? Again, research into these issues is ongoing. In addition to these rather pressing production issues, the cost-effective use of by-products will likely require improvement in the distribution system for these by-products.

Despite these complicating factors, the potential for using the by-products of renewable fuels production, particularly DDG or DDGS, to reduce costs in beef and dairy operations seems great. On the other hand, these by-products present problems for poultry and hogs. How the ongoing impact of biofuel production on grain prices will affect different sectors of the livestock industry—and specifically, how the competitive position of different sectors of the livestock industry will be affected by each sector's relative ability to use lower-cost feedstuffs—is a very critical question as the biofuel industry develops.

This paper will discuss several different aspects of the biofuels boom as it relates to the livestock sector, focusing particularly on beef and dairy production. We begin with a discussion of major by-product feeds and a survey of what is known of their nutritional characteristics and other major considerations (e.g., storage/handling requirements) in their use as a feedstuff. This is followed by an examination of the history of DDG prices to evaluate how the increase in by-product production has influenced the relationship between corn and DDG prices. The central issue here is whether or not DDG has really become a lower-cost alternative to corn for livestock producers. This leads to an analysis of the impact of increased DDG use on the market. We explore this from a micro-level perspective, evaluating how the adoption of a DDG-based ration affects decision-maker utility in representative beef and dairy operations, and from a macro-level perspective, discussing the potential impacts of by-product use on the relative competitiveness of different livestock industries. Finally, we conclude with a discussion of emerging issues related to by-product production and use, focusing on the wider array of by-products available from newer-generation ethanol plants and their role in alleviating some of the current limitations of by-product feeds.

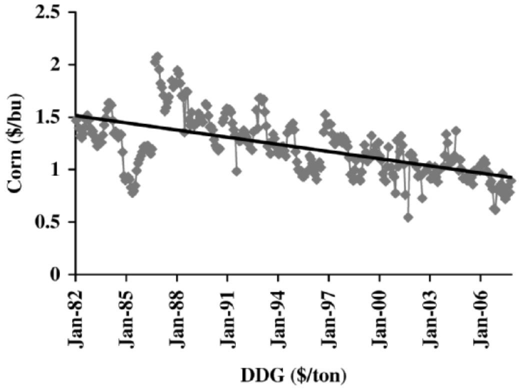
Characteristics of By-Product Feeds

The major by-product feeds from current corn-based ethanol are corn gluten feed, from wet-mill ethanol plants, and distiller's grains from dry-grind ethanol plants. Distiller's grains may be wet or dry and may be combined with solubles to yield the more commonly discussed distiller's grains with solubles (DGS).

The dry-grind ethanol process yields about 2.75 gallons of ethanol and 17–18 lbs. of distiller's grains per bushel of corn. The removal of starch for ethanol concentrates the remaining nutrients in the distiller's grains. The distiller's grains contain a higher level of protein, energy (from the fat), phosphorus, and sulfur than are found in corn grain.

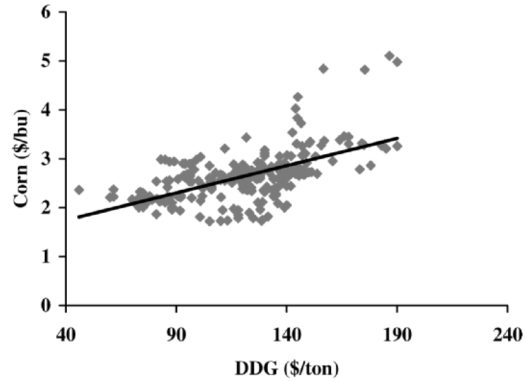
Several issues confront livestock producers when feeding distiller's grains. It is a highly variable product that may require testing for nutritional content to maintain ration balance. It is costly to dry given natural gas prices, but in its wet form is costly to ship. Flowability, the ability of the product to flow out of the container, has been a problem when shipping distiller's grains in rail cars and trucks long distances because of the product compacting during travel. Wet distiller's spoils in a short period (couple of days) and so must be fed quickly.

There are limits to how much distiller's grains can be fed to different species. Research indicates that they can make up 35–40% (dry matter) of feedlot cattle rations. Dairy cow rations can contain 10–20% distiller's grains. Hog, broiler, and turkey rations may contain up to 10%. The limiting factor varies by species, but often includes the type and source of the fat in distiller's grains and its interactions with meat quality, fat characteristics, and milk components. Regardless of the issues in feeding distiller's grains, these by-products have been fed successfully by many livestock producers for years.



Source: USDA –Agricultural Marketing Service. All prices converted to $/lb.

Figure 1. Distillers' Dried Grain Prices as a Percentage of Corn Price: 1982–2007



Source: USDA –Agricultural Marketing Service

Figure 2. Corn and Distillers' Dried Grain Prices: 1982–2007

By-Product Price Behavior

By-products of ethanol production are not new to the feed market. What is new is their perceived importance as an alternative feedstuff in this environment of historically high corn prices. The conventional wisdom has been that the impact of high corn prices on costs of production in livestock operations could be largely offset by the availability of relatively inexpensive by-products—primarily DDG or DDGS. The behavior of DDG prices in relation to corn prices is a simple-enough empirical question.

With respect to the level of DDG prices in comparison with corn prices, Figure 1 plots DDG price as a percentage of corn price (with both prices converted to $/lb., as fed) January 1982 through October 2007. DDG prices are wholesale prices for Lawrenceburg, IL, and corn prices are Texas Triangle prices received by farmers for corn—both reported by USDA-Agricultural Marketing Service. Clearly, over time—or at least since about mid-1985—the price of DDG as a percentage of the corn price for the same period has trended lower. This supports the notion that by-products have become relatively cheaper with increased availability.

Another aspect of the relationship between corn and DDG prices is the responsiveness of DDG prices to corn price changes. If DDGs are a good substitute for corn, one would expect their prices to be closely correlated. Figure 2 is a scatter diagram of corn and DDG prices from January 1982 through October 2007. These are the same price series as discussed in the previous figure. As the simple linear equation shows, there is a generally positive relationship between corn and DDG prices; however, the association between the two series over the entire time period presented here does not appear to be all that strong. The correlation coefficient between the two series is only about 0.44.

Further investigation of the relationship between corn and DDG prices suggests that the relationship between the two price series has not been all that consistent over time. Table 1 shows correlation coefficients for each 5-year period from 1982 through 2006 as well as for the 2005–2007 time period. These data indicate, in general, a closer relationship between corn and DDG prices in about the latter half of the data, with a very close relationship over the last 2 or 3 years.

To provide further insight into the relationship between corn and DDG prices—and in particular, into any changes in that relationship over time, a vector error correction model (VECM) of corn and DDG prices was estimated. The general form of the VECM(p) with cointegration of rank ($\leq k$)

Table 1. Correlation between Corn and Distillers' Dried Grain Prices: 1982–2007

Time Period	Correlation Coefficient
1982–2007	0.510
1982–1986	0.483
1987–1991	0.480
1992–1996	0.710
1997–2001	0.794
2002–2006	0.602
2005–2007	0.849

can be expressed as

$$(1) \quad \Delta \mathbf{y}_t = \boldsymbol{\delta} + \prod \mathbf{y}_{t-1} \sum_{i=1}^{p-1} \boldsymbol{\Phi} \Delta \mathbf{y}_{t-i} + \boldsymbol{\varepsilon}_t.$$

In this context $\mathbf{y}_t$ is a matrix including corn and DDG prices. A Johansen cointegration test indicated cointegration of rank 1 for these two series. A Chow test of a simple linear regression of corn prices on DDG prices indicated a significant structural change in this relationship at about the end of 1998. Thus, the VECM was estimated separately for the entire time period and for the two separate time periods 1982–1988 and 1989–2007. Parameters of these separate VECM(3) models with cointegration rank 1 are presented in Table 2. These results confirm and quantify the significant and positive relationship between changes in corn and DDG prices. With respect to changes in that relationship over time, it is interesting that in the later time period, DDG price changes are more closely related to recent corn prices (and price changes) than in the earlier time period.

The evaluation of DDG and corn prices presented here suggests that DDG prices have become somewhat less expensive relative to corn over time. However, there is some evidence to suggest that DDG and corn prices are more closely related now than in earlier years of DDG production. The significance of this information for livestock producers is twofold. First, DDGs may be an inexpensive feed in a relative sense; however, they will not likely be an inexpensive feed in any absolute sense. Second, DDG prices may become more volatile, with DDG prices more closely following the movement of corn price, as more and more producers enter the DDG feed market.

The foregoing evaluation of DDG and corn prices reflects on the national market for corn and DDG. Clearly, there will be some producers more advantageously situated than others with respect to using DDG as a feed source. Producers able to source wet distiller's grain, for example, may in fact find access to a feed that is inexpensive not only relative to corn but in absolute terms as well. Of course, transporting and handling this type of feed involves special considerations and will only be an option for producers situated very close to a source of supply. A second and related caveat to the preceding analysis is that using DDG wholesale prices reported by USDA masks the significant transportation costs that most producers will incur in obtaining DDG. Corn is widely produced around the country, and a well-developed infrastructure for storing and moving corn efficiently around the country currently exists. The same is not true for DDG. DDG production is still largely concentrated in the Corn Belt. Getting DDG to other parts of the country involves considerable transportation expense that, for producers in many parts of the country, will quickly erode any relative price advantage of DDG compared with corn.

Impact of By-Product Feeding on Livestock Costs of Production

As noted earlier, the availability of by-products from ethanol production has been viewed as an important resource for helping livestock producers deal with the increased competition for grain. Considerable work has been done on the feasibility of feeding the by-products of distillation, and some of this work predates the current surge in ethanol production. For example, Larson et al. were exploring the feeding value of distillery by-products in the early 1990s. Of course, recently, interest in by-product feeds has intensified greatly. This has spurred considerable research into the technical aspects of effectively using these feed sources. (For a fairly current review of this work, see Cole et al.)

Table 2. Vector Error Correction Model of Corn and DDG Prices

		Parameter Estimates		
Equation	Variable Name	1982–2007	1982–1988	1989–2007
ΔDDG	DDG_{t-1}	−0.0629*** (0.0214)	−0.0445 (0.0358)	−0.0983*** (0.0302)
	$Corn_{t-1}$	2.6456*** (0.9003)	2.1898 (1.7957)	3.8826*** (1.1932)
	ΔDDG_{t-1}	0.0548 (0.0586)	0.3197*** (0.1091)	−0.0072 (0.0687)
	$\Delta Corn_{t-1}$	15.0245*** (3.2096)	26.6395*** (7.0718)	12.0394*** (3.6242)
	ΔDDG_{t-2}	−0.0613 (0.0556)	−0.1473 (0.1044)	−0.0377 (0.0655)
	$\Delta Corn_{t-2}$	3.4716 (3.3745)	−12.5366* (7.6358)	5.4801 (3.7593)
ΔCorn	DDG_{t-1}	0.0004 (0.0004)	0.0011** (0.0005)	0.0002 (0.0006)
	$Corn_{t-1}$	−0.0183 (0.0169)	−0.0563** (0.0268)	−0.0092 (0.0240)
	ΔDDG_{t-1}	0.0015 (0.0011)	−0.0007 (0.0017)	0.0024* (0.0014)
	$\Delta Corn_{t-1}$	0.3399*** (0.0602)	0.4132*** (0.1077)	0.3136*** (0.0730)
	ΔDDG_{t-2}	−0.0010 (0.0010)	−0.0017 (0.0016)	−0.0008 (0.0013)
	$\Delta Corn_{t-2}$	−0.0735 (0.0633)	−0.1779 (0.1163)	−0.0599 (0.0757)

Note: Single, double, and triple asterisks denote significance at the 10%, 5%, and 1% levels, respectively.

Economic evaluation of by-product feeding systems remain, for the most part, very preliminary. Anderson, Daley, and Outlaw develop budgets to compare cattle feeding returns with and without the inclusion of by-products (wet and dry distiller's grains). In their study, they find that including wet distiller's grains with solubles (WDGS) in a ration with dry rolled corn results in the lowest cost of gain. Interestingly, WDGS fed in conjunction with steam-flaked corn results in the highest cost of gain of the alternatives considered. They note that their results depend rather critically on assumptions related to feed conversion and average daily gain for each of the rations considered. At this point, these assumptions must be based on quite limited information. Thus their work underscores the vital importance of research aimed at developing a more complete understanding of the relationship between by-product feeds and animal performance.

To provide further insight into the effect of by-product feeding on producer returns, we simulated feeding returns for a Texas and Nebraska feedlot using DDGS (Texas) and WDGS (Nebraska) in their rations. Rations and associated average feed conversion rates were taken from Anderson, Daley, and Outlaw. Prices for ration components were simulated from a log-normal distribution of prices using parameters (mean and standard deviation) calculated using price data from 2000 to 2007. For each year, May through September average prices were used to be consistent with a spring placement/fall slaughter feeding scenario. All prices were correlated using a procedure described by Naylor et al. (See Anderson and Zeuli for a similar application of this procedure.)

Feed conversion rates were simulated from a triangular distribution with the mode taken to be the feed conversion rate associated with each ration in Anderson, Daley, and Outlaw. Minimum and maximum feed conversion rates were taken from Kansas State University feedlot closeout data (Livestock Marketing Information Center). Minimum and maximum feed conversion rates from the past 10 years of August through October monthly closeouts were calculated as a percentage of the mean. These percentages were applied to the mode used for each ration to define minimum and maximum values for simulation from the triangular distribution.

Simulated returns over variable costs were converted to utility values using a constant relative risk aversion (CRRA) utility function, represented mathematically as

$$(2)\quad \begin{aligned} E(U)_r &= \sum_{t=1}^{n} \omega_t \frac{W_t^{1-r}}{1-r} \quad \text{if } r \neq 1 \text{ and} \\ E(U)_r &= \sum_{t=1}^{n} \omega_t \ln(W_t) \quad \text{if } r = 1 \end{aligned}$$

Table 3. Comparison of Cattle Finishing Returns in Texas and Nebraska Feedlots Using By-Product Feeds

	Return over Variable Costs ($/Head)			
	Base Ration	15% DDGS	15% WDGS	30% WDGS
Texas				
Average	$87.06	$87.74		
Std. Dev.	$17.89	$17.30		
Certainty Equivalent	$84.62	$87.14		
Nebraska				
Average	$41.10		$65.91	$83.26
Std. Dev.	$34.41		$22.62	$17.15
Certainty Equivalent	$38.86		$64.88	$82.67

Notes: Base ration for Texas includes steam-flaked corn as the primary energy feed. Base ration for Nebraska includes dry rolled corn as the primary energy feed. Certainty equivalents are reported for a constant relative risk-aversion coefficient of 2 (moderately risk averse) (Hardaker Huirne, and Anderson).

where r is a risk-aversion coefficient and ω_t is the weight associated with each possible wealth outcome t. If W_0 represents initial wealth, then $W_t = W_0 + \text{NR}_t$ where NR_t is the stochastic return over variable costs from the feeding operation. In this simulation, initial wealth is assumed at $425/head, corresponding to roughly 50% equity in the value of a feeder steer at the time it is placed on feed. Utility values associated with each feeding system were converted to certainty equivalents (CEs). The equations for calculating the CE from the CRRA utility functions used here are:

$$(3)\quad \begin{aligned} &\text{CE}_r = \left[\bar{U}(1-r)\right]^{[1/(1-r)]} - W_0 && \text{if } r \neq 1 \\ &\text{and } \text{CE}_r = e^{\bar{U}} - W_0 && \text{if } r = 1 \end{aligned}$$

$\bar{U}$ is a value for utility calculated from Equation 4.

Comparison of CEs permits consideration of the impact of by-product feeding not only on the level of returns but also on their variability. This could be an important consideration if the distribution of by-product prices is notably different from that of corn. It should be noted that the data available for this analysis did not include different distributions for feed conversions for each different ration. Although the means for feed conversion did vary across rations, higher moments of the distributions did not.

Results of this simulation are presented in Table 3. The most significant feature of these results is that the availability of wet distiller's grains in Nebraska appears to convey a considerable competitive advantage. This is evidenced by the rather significant improvement in CEs in moving from the base ration to the 30% WDGS ration. WDGS could be fed in Texas, of course, and a preliminary calculation of the effect of a 30% WDGS ration on the profitability of the Texas feedlot did show a positive impact on profitability. However, as noted above, WDGS appears not to fit well into rations with steam-flaked corn. This is the primary concentrate feed in Texas feedlots, and considerable fixed investment is in place to accommodate steam flaking. Thus, for Texas feedlots, transitioning to WDGS is probably a longer-term proposition than it is in some other regions. The ability to feed DDGS does confer some benefit in terms of profitability, but this benefit appears at this point to be marginal in comparison with that that can be obtained from introducing WDGS to a dry rolled corn feeding system.

The southern dairy industry has been declining in milk production, operations, and cows for many years. The primary cause has been higher production costs relative to the rest of the United States. Although distiller's grains can be fed to dairy cows, the industry is largely out of position to effectively use them and still faces higher feed costs.

Using the representative dairy farms developed by the Agricultural and Food Policy Center at Texas A&M, a snapshot of the effects of the ethanol boom on southern dairies can be examined (Richardson et al.). The increase in feed costs over the last 2 years has added $3–4 in total dairy cash expenses per cwt of milk produced on these representative farms in the South. That is an increase in cash costs ranging from 25% to 35% of cash expenses. Although higher feed costs affect dairies nationwide, the location of southern dairies farther away from ethanol production limits their ability to source distiller's grains. The end result is a less-competitive southern dairy industry.

Summary and Conclusions

The ethanol boom has caused sharply higher corn and other feed prices. The livestock industry, as the largest user of corn in the United States, has borne the brunt of higher prices. Distiller's grains, as the major by-product of corn-based ethanol production, provides an additional feed source for producers. But, it is clear that distiller's grains are not a cheap alternative to help producers mitigate rising corn prices. In fact, distiller's grains and corn prices have become correlated over time.

Higher feed costs due to the ethanol boom are increasing feeding costs across the country. It is likely that producers in the South will be placed at a competitive disadvantage because of their location relative to producers closer to the by-product feeds.

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