The Ethanol Industry, Dried Distiller's Grains with Solubles (DDGS), and Their Impact on Pork Production

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The Impact of the Ethanol Industry on Pork Production

The ethanol industry is the fastest growing segment of American agriculture and is consuming an increasing proportion of the annual corn crop. Industry experts are predicting that about 20% of the 10.745 billion bushel 2006 U.S. corn crop will be used for ethanol production. As a point of reference, the U.S. livestock and poultry industries consume about 5 billion bushels of corn annually. Therefore, as the ethanol industry continues to grow, there will be increasing competition between the ethanol industry and the livestock and poultry industries for corn supply. This competition for corn has many people in the animal production industry worried about what it will mean to future corn prices and availability.

Researchers at the Food and Agricultural Policy Research Institute at the University of Missouri, have estimated ethanol production and corn use by marketing year from 2006 to 2010/11 (FAPRI, 2006, Table 1). By the year 2010/11, ethanol production is projected to increase by 86% of what is projected to be produced in 2006/07, and this will require a 61% increase in corn use for fuel ethanol production compared to current levels. Assuming that there will be no weather problems that affect corn production and yields, the annual U.S. corn crop is also projected to increase by an average of 23% per year through 2010/11, which requires an increase in corn acres planted and a gradual average annual improvement in yield of about 21%. Presumably much of the increase in corn acreage will be at the expense of soybean acreage. The net result of increased ethanol production is increased corn price, increased corn acreage, decreased corn exports, and increased feed use of ethanol by-products (i.e. DDGS).

Table 1. Projected ethanol and by-product production, and corn acreage, yield, and usage for ethanol by marketing year through 2010/2011 (FAPRI, 2006).

	2006/07	**2007/08**	**2008/09**	**2009/10**	**2010/11**
Ethanol produced, billion gal.	4.95	6.29	7.33	8.39	9.20
Corn required, billion bu.	2.15	2.51	2.91	3.22	3.46
Ethanol by-product feeds (dry basis), million tons	14.37	17.40	20.82	23.41	25.45
Corn crop, billion bu.	10.74	11.48	11.99	12.27	12.50
% corn crop	20.01	21.86	24.27	26.24	27.68
Acres planted, millions	79.4	82.9	85.6	86.5	87.0
Yield/acre, bu.	149.0	150.9	152.6	154.5	156.4

One of the major concerns for pork producers is whether they will have access to ample quantities of reasonably priced corn in the future. The rapid growth of the U.S. ethanol industry has turned some corn surplus regions in the Corn Belt into corn deficit areas due to the high quantities being used by ethanol plants in those locations. This is good news for corn farmers because the price basis has increased in these areas, and if they are shareholders of local ethanol plants, they have been earning excellent return on their investment by adding value to each bushel of corn they supply to their ethanol plant. However, pork producers who purchase corn must compete with the ethanol industry for supply and price. Based upon current ethanol prices and production costs, many modern ethanol plants can afford to pay more than $4 to $5 per bushel of corn to breakeven. It is understandable why pork producers are nervous about their current and future feed costs.

If 25.45 million tons (23.08 metric tonnes) of distiller's by-products are produced in 2010 (Table 1), it could all be consumed by the U.S. livestock and poultry industries if there was 63% market penetration at the maximum dietary inclusion rates for each species shown in Table 2. Although each segment of animal production offers potential for consuming more DDGS, the swine and poultry sectors have the greatest potential for increased DDGS usage. Currently, the North American pork industry is using about 1.1 million metric tonnes annually, which is only about 13% of the theoretical maximum use at 100% market penetration. If some of the barriers for DDGS use in swine diets can be overcome, it may be possible to achieve 50% or more in potential market penetration in the pork industry. Some of the barriers limiting the use of DDGS in swine diets include:

- Variability in nutrient content and digestibility
- Low particle size and flowability problems of some DDGS sources
- Perceived risk of mycotoxins (sows)
- Ability to pellet DDGS diets and maintain throughput of pellet mills
- Understanding and managing effects corn oil in DDGS on pork fat quality
- Controversy over palatability and negative effects on feed intake at high dietary inclusion rates
- Fast, accurate, and inexpensive *in vitro* methods to estimate amino acid digestibility among sources
- Net energy values of DDGS sources need to be determined

Table 2. Theoretical Potential of Distiller's By-Product Use in the U.S. Livestock and Poultry Industries (Cooper, 2006).

	Grain-Consuming Animal Units, millions	Maximum Dietary Inclusion Rate, %	1000 Metric Tonnes by % Mkt. Penetration		
			50%	75%	100%
Dairy	10.2	20	1,887	2,831	3,774
Beef	24.8	40	9,176	13,764	18, 352
Pork	23.8	20	4,348	6,521	8,695
Poultry	31.1	10	2,877	4,315	5,754
Total			18, 288	27,431	36, 575

Our research group of agricultural economists (B. Buhr, V. Eidman, D. Tiffant) and animal scientists (J. Shurson, S. Noll, J. Linn, and A. DiCostanzo) at the University of Minnesota have conducted preliminary evaluations to estimate the impact of higher corn prices as a result of increased corn demand from the ethanol industry, and DDGS use in livestock and poultry diets on various economic costs in the animal industry. An Equilibrium Displacement (Supply and Demand) model was used for this analysis. Preliminary estimates from this economic model, based upon a December corn futures price of $3.46/bu and soybean meal price of $166.77/ton, suggest that under a most likely scenario, there would be a 12% increase in total cost of pork production compared to a historical corn price of $2.15/bu and soybean meal of $192.48/ton. Adding DDGS to grower-finisher diets at a 10% inclusion rate would have a moderate benefit of reducing feed costs by about 18%. However, there would also be a 5.7% increase in pork price at the farm level. The increase in total cost of production could cause a 2.03% reduction in the quantity of pork (carcass basis) produced, and the net quantity of pork imported into the U.S. could increase by 0.67% and consumer cost for pork at the retail level would increase by about 2.5%. These changes appear to be significant and will change the economic dynamics of the entire food chain.

The Impact of DDGS and other Distiller's By-Products on Pork Production

Nutrient composition, digestibility, and physical characteristics vary among DDGS sources. The energy value of DDGS is equal to or greater than corn making a very good partial substitute for corn in practical swine diets. Recent studies have shown that DDGS sources that have a light, golden color are preferred for swine feeds because the light color is indicative of less heat damage to protein during drying, resulting in higher lysine digestibility. The phosphorus digestibility of DDGS is very high for swine and much higher than in corn or soybean meal. This means that DDGS can replace most of the inorganic phosphorus supplements added to swine diets which will reduce cost, and potentially reduce manure phosphorus excretion, while supporting optimal performance. Therefore, DDGS is an economical partial replacement for corn, soybean meal, and inorganic phosphate in swine diets.

Unfortunately, variability in nutrient content and digestibility is high among DDGS sources compared to soybean meal sources. In order to manage this variability when selecting a DDGS source, purchasers should limit the number of DDGS sources used, question generic nutrient specification values provided by the supplier when formulating diets, and request current and complete nutrient profiles from source(s) being considered. The University of Minnesota DDGS web site has nutrient profile information for a number of DDGS sources www.ddgs.umn.edu. Information about the Quality Assurance procedures used by ethanol plants should also be requested and considered when selecting DDGS suppliers, particularly for mycotoxins.

Research studies conducted at the University of Minnesota have shown that high quality corn DDGS can be added at levels up to 25% of the diet for nursery pigs (> 7 kg in body weight), and up to 30% in diets for grower-finisher pigs to obtain optimum performance. However, diets should be formulated on a digestible amino acid basis at dietary inclusion

rates above 10% to avoid deficiencies of some amino acids. For gestating sows, DDGS can be included at levels up to 50% of the diet, and lactating sows can be fed up to 30% DDGS in the diet to achieve good performance.

DDGS feeding limitations have also been identified.

Up to 10% DDGS can be added to swine diets with excellent results even if diets are formulated on a total lysine basis. However, if higher dietary inclusion rates are used, diets should be formulated on a digestible amino acid basis to achieve satisfactory performance.

Feeding diets containing DDGS affects manure nutrient content and output. Due to the relatively high fiber content in DDGS, dry matter digestibility is slightly reduced resulting in a slight increase in manure output. The high protein to lysine ratio of DDGS results in an increase in nitrogen excretion, but formulating diets on an available phosphorus basis and accounting for the high phosphorus digestibility in DDGS, will reduce the phosphorus concentration in manure.

Corn DDGS contains approximately 10% corn oil. As increasing levels of DDGS are added to grower-finisher swine diets, carcass yield is slightly reduced and belly firmness appears to be reduced. Studies are currently underway at the University of Minnesota to evaluate optimal DDGS feeding levels and length of feeding time on pork fat quality.

A few studies have suggested that palatability, feed intake, and growth rate may be reduced when increasing levels of DDGS are to corn-soybean meal diets. However, other studies have shown that DDGS can be added to swine diets at levels up to 50% of the diet without negative effects on feed intake. It is unclear why these different responses may occur, but it may be due to differences in DDGS quality, amount of supplemental fat in the diet, and methods used in formulating diets containing DDGS.

Unique, value-added attributes of DDGS have been identified.

Adding DDGS to grower-finisher diets may improve gut health. In a recent study conducted at the University of Minnesota, adding 10% DDGS to a finishing diet reduced the length, severity, and prevalence of intestinal tract lesions caused by *Lawsonia intracellularis.*

Feeding diets containing DDGS to sows has resulted in positive effects as well. We conducted a sow study to evaluate feeding diets containing high levels of DDGS (50% in the gestation diet and 20% in the lactation diet) on reproductive performance over two reproductive cycles and observed an increase in litter size weaned for sows fed DDGS diets during the second reproductive cycle. In a subsequent study, pig growth rates tended to be higher as increasing levels of DDGS (up to 30% DDGS) were added to the lactation diet.

New distiller's by-products

As the U.S ethanol industry continues to grow, there are going to be increasing supplies of multiple types of by-products that will be available for use by the feed and livestock industries. There is increasing interest among ethanol plants to modify ethanol production processes to increase the amount of ethanol that can be produced from each bushel of corn as well as lower the cost of production. Due to high natural gas prices and the challenges of "getting rid of" the syrup or solubles that are produced, one Minnesota ethanol plant has modified their process in order to burn the solubles as a fuel source for the plant, and consequently, are producing dried distiller's grains (DDG). Other upper Midwestern ethanol plants are using various fractionation processes to remove the germ, bran, and other components of the corn kernel before fermentation in order to increase efficiency of ethanol production. Along with fractionation, changes in enzymes and heat used in the ethanol production process also are altering the nutrient composition and digestibility of distiller's by-products. The challenge for the feed and food animal industry will be to determine the feeding value and best applications for this growing portfolio of corn based by-products. Depending upon the nutrient composition of these by-products, some of them will have limited value in swine diets, whereas others may provide significant lower cost nutrient contributions to practical swine diets.

Literature Cited

Cooper, G. 2006. A brief, encouraging look at theoretical distiller's grains markets. Distillers Grains Quarterly, First Quarter, p.14-17.

FAPRI July 2006 Baseline Update for U.S. Agricultural Markets. FAPRI-UMC Report #12-06, http://www.fapri.missouri.edu/outreach/publications/umc.asp?current_page=outreach, 12 pages.