DISTILLER'S GRAIN MARKET DEVELOPMENT AND PRICE RISK MANAGEMENT FY 2008

Ethanol production has expanded rapidly and even more aggressive growth is on the horizon. The vast majority of ethanol production expansion in the United States is corn based and produces the by-product of distiller's grain (DG). A recently published study conducted by the U.S. Department of Energy projects that more than 60% of the annual corn crop could be consumed for ethanol production by 2025, compared to 11% in 2005. DGs are used primarily for livestock feed to replace corn and protein sources. The largest market potential for DG is cattle (beef and dairy) in the United States and in export market development.

Despite the growing importance of the DG markets, there is little information about price discovery, pricing methods, industry product specification standards, mixture of product type being produced, current and potential global market access and development, and price risk management tools and needs. All of these are limiting overall market development for DG and reducing its market value which in turn directly reduces bio-refinery margins and the market value of corn.

The rate of expansion of the corn-based ethanol industry has created a major structural shift in corn usage. Forecasts of ethanol industry expansion suggest the largest single user of corn will soon be the bio-refinery industry. As the bio-refinery industry matures and margins become thinner, the amount ethanol producers will be willing pay for corn will increasingly depend more upon the value of distiller's grains and associated market risk present in distiller's grain markets. This research project provided a comprehensive and timely assessment of this emerging market opportunity.

FINAL REPORT

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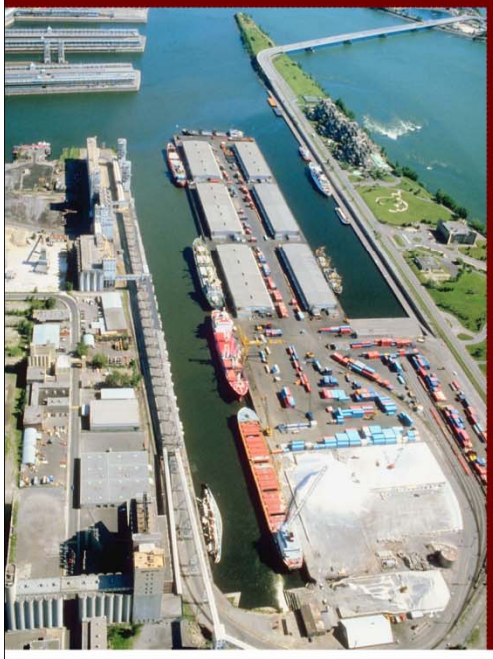

Distiller's Grain Market Development and Price Risk Management: Final Report

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September 15, 2010

Federal State Marketing Improvement Program
United States Department of Agriculture

Project Final Report for Project Titled:

Distiller's Grain Market Development and Price Risk Management

Funding Period:

September 1, 2008 – August 31, 2010

Agreement Number:

12-25-G0668

Date Final Report Completed:

September 15, 2010

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Project Completed for:

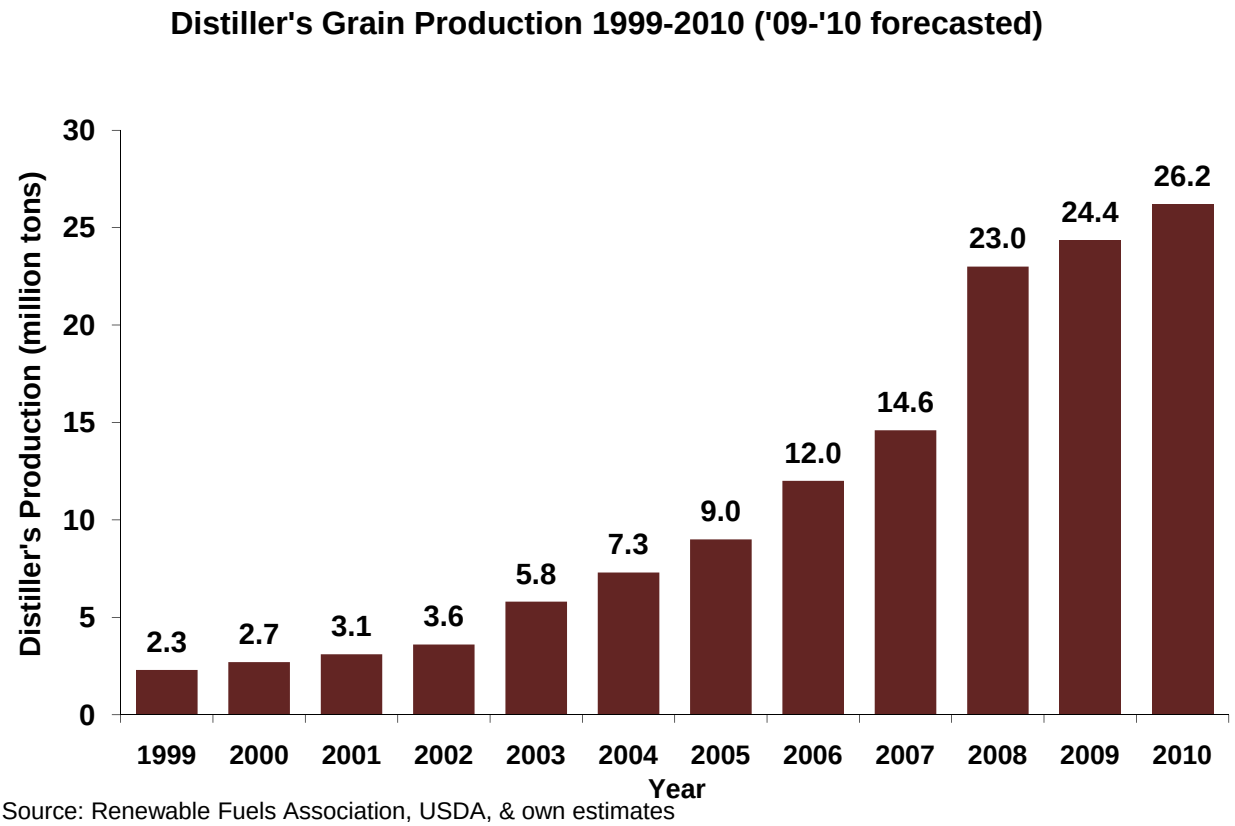
Federal State Marketing Improvement Program
United States Department of Agriculture

Acknowledgements:

Several individuals, firms, and organizations were instrumental in our successful completion of this study. We thank USDA-FSMIP for funding this project and we appreciate the project coordination efforts of Janise Zygmont. We are indebted to the numerous distillers grain merchandisers at ethanol plants as well as distillers grain brokers for taking time to share their time and information in our survey work related to this project. Their candid discussions and generous giving of their time is greatly appreciated and significantly increased the value of the information gleaned from this work. We also thank the Kansas City Board of Trade, especially Jeff Borchardt, for cooperating with us on this project and helping us to identify important information we needed to collect relative to evaluating development of a distillers grain futures contract. Several individuals also contributed to the success of this project through their work on various components of the study in addition to the principal investigators. We acknowledge the research assistance provided by Ann Conrad, Anikka Martin, and Anna Pesta.

Issue Outline

Ethanol production has expanded rapidly and even more aggressive growth is on the horizon. The vast majority of ethanol production expansion in the United States is corn based and produces the by-product of distiller's grain (dried at about 10% moisture and wet at 50-70% moisture). In the 2006/07 corn marketing year 2.12 billion bushels of corn were used in ethanol production yielding about 11.2 million metric tons of distiller's grains (DG) on a dry basis. In the 2007/08 marketing year DG production exceeded 14 million metric tons and dramatic expansion in production is expected in future years as illustrated in figure 1. A recently published study conducted by the United States Department of Energy projects that more than 60% of the annual corn crop could be consumed for ethanol production by 2025 compared to only 11% in 2005.[1] Distiller's grains are used primarily for livestock feed to replace corn and protein sources. The largest users of DG are the dairy and cattle feeding sectors because hog and poultry can only efficiently utilize small amounts of these products (typically less than 15%) in their diets. The largest market potential for DG is cattle (beef and dairy) in the United States and in export market development.



Source: Renewable Fuels Association, USDA, & own estimates

[1] U.S. Department of Energy. *Energy and Economic Impacts of Implementing Both a 25-Percent Renewable Portfolio Standard and a 25-Percent Renewable Fuel Standard by 2025*. SR/OIAF/2007-05. August 2007. Available at: http://www.eia.doe.gov/oiaf/servicerpt/eeim/pdf/sroiaf(2007)05.pdf

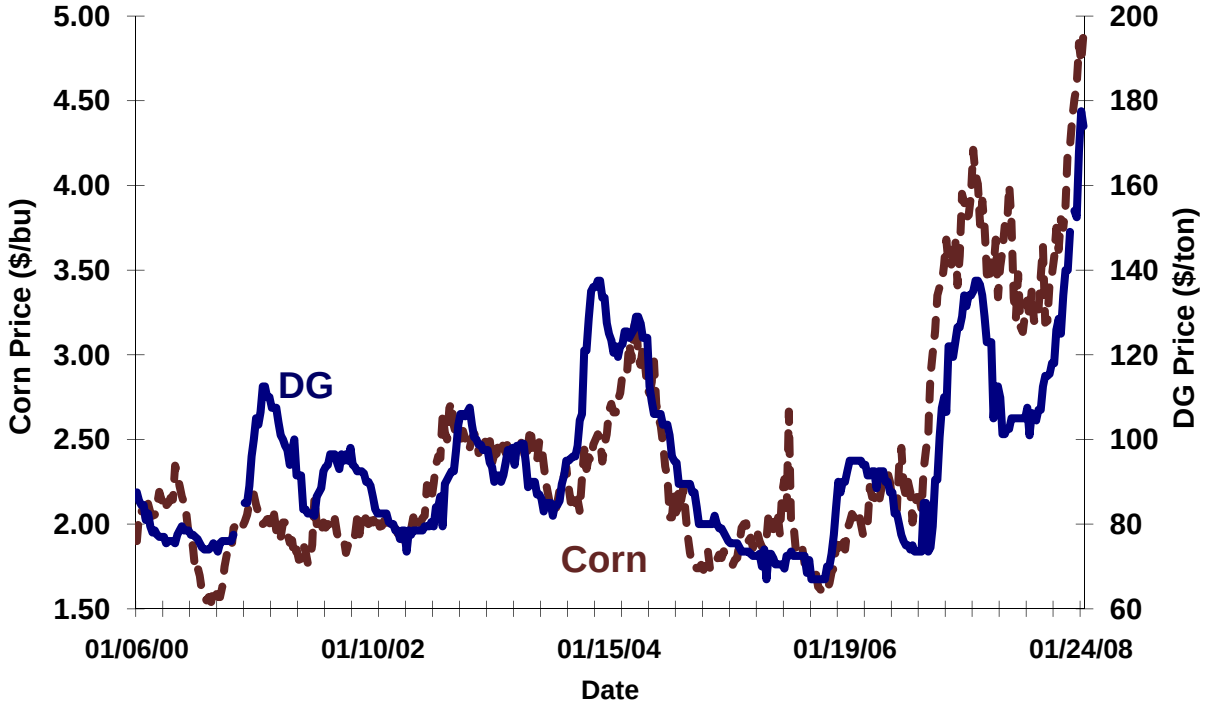
At the launch of this project, despite growing importance of the DG markets, there existed little information about price discovery, pricing methods, industry product specification standards, mixture of product type being produced, current and potential global market access and development, and price risk management tools and needs. All of these are limiting overall market development for DG and reducing its market value which in turn directly reduces bio-refinery margins and the market value of corn. Distiller's grain co-product is estimated to represent roughly 12% of an ethanol producer's gross revenue. Furthermore, many cattle feeders are including 30% or more of their feed ration in the form of distiller's grains. The 2007 national survey of livestock feeding users of ethanol co-products completed by the National Agricultural Statistics Service revealed several interesting aspects of the number of distiller's grains users and types of products being used.[2] The study demonstrated how important ethanol co-products have become in livestock feed rations with 70% of cattle feeders and 60% of dairy producers indicating they either currently are or have considered feeding co-products. However, in informal discussions with end users one quickly realizes that they know little about DG pricing, value, market information, and even what the nutrient content is of the DG product they feed. Considerable uncertainty about market fundamentals and lack of adequate information about DG markets makes some reluctant to enter this market and when they do, they are ill-equipped to assess the price offered.

The nutrient content of ethanol co-products vary and are important for determining optimal end use. Bio-refining processes generally fall within two broad categories - traditional fermentation processes and newer fractionation processes. The processes yield distinctly different DG co-product streams. Distiller's dried grains from traditional fermentation processes normally contain 24-30% protein, 10-12% moisture, 8-12% fat, and 8-12% crude fiber. The principal dried co-product of the fractionation process contains 8-10% moisture, 42-45% protein, 3-4% fat, and 6-8% fiber. DG from traditional fermentation is intermediate in terms of its protein content, and in many instances is used as a substitute for cereal grains in livestock diets. Consequently, traditional DG co-products might be expected to have a value that would follow corn price, but with some premium for its higher protein content. DG that are produced from the newer fractionation processes contain relatively high levels of protein (>40%), and are likely to have greater value as protein sources in international markets if positioned appropriately.

The price of distiller's grain is highly volatile. A graphic illustrating the price of DG at Chicago and corn in Kansas City over the past eight years is presented in figure 2. DG price fluctuated from $60/ton to $180/ton in just a few months. With the progressively greater importance DG price risk has on profitability of ethanol producers and the livestock industry and the substantial price risk present, development of a market institution to transfer price risk needs to be considered. Figure 2 also suggests weekly corn and DG prices are correlated but that the price relationship diverges considerably at times, implying that corn futures may not provide a viable cross hedging mechanism for distiller's grains. Furthermore, the price differential between DG and corn varies substantially in different regions of the country.

[2] National Agricultural Statistics Service. *Ethanol Co-Products Used for Livestock Feed.* NASS, USDA, June 2007.

Figure 2. Comparison of Kansas City Cash Corn and Chicago Dried Distiller's Grain (DG) Prices, Weekly 2000 - January 2008



The rate of expansion of the corn-based ethanol industry has created a major structural shift in corn usage. Forecasts of ethanol industry expansion suggest the largest single user of corn will soon be the bio-refinery industry. As the bio-refinery industry matures and margins become thinner, the amount ethanol producers will be willing pay for corn will increasingly depend more upon the value of distiller's grains and associated market risk present in distiller's grain markets (much like soybean crushers can only pay as much for soybeans as meal and oil markets dictate). This research project provided a comprehensive and timely assessment of this emerging market opportunity.

How the issue was approached in the project

The general purpose of this study was to provide essential analysis and information to enhance markets and improve market efficiency for the corn-based ethanol co-product, distiller's grains. This was accomplished by evaluating distiller's grain (DG) price discovery, developing product quality specification profiles, identifying and assessing market development potential, and determining feasibility of a distiller's grain futures contract. The work plan was:

1. Obtaining data on distillers grain volumes, prices, and related market trends.
   Distillers grain data on volumes, prices, and market trends were updated through 2008. These data were used to determine spatial and temporal distillers grain price relationship in Objective 4. We published a fact sheet summarizing this segment studying the distillers grain industry. The fact sheet is available at Appendix A and at: http://www.naiber.org/Publications/NAIBER/Distillers-Grain-Industry.pdf.

2. Determining how price discovery occurs and estimating mixture of co-products produced.
   Ethanol plant visits and phone interviews were conducted to gain information on the price discovery process as well as the co-products that are produced. Data from the interviews are summarized in the fact sheet available at Appendix B and at: http://naiber.org/Publications/NAIBER/Distillers-Grain-Price-Discovery&Risk-Management.pdf.

3. Determining export market potential for distillers grains.
   The foundational databank for this objective has been built. We have updated the data and published the fact sheet about distillers grain export market potential. The fact sheet is available at Appendix C and at: http://www.naiber.org/Publications/NAIBER/Export-Markets-for-Distillers-Grains.pdf.

4. Determining spatial and temporal distillers grain price relationship and cross hedging potential.
   Data have been compiled and statistical analyses have been conducted to determine the nature of distillers grain spatial price variability as well as assess market efficiency. Viability of cross hedging relationships and basis risk across locations for distillers grain has been determined. A fact sheet reporting the findings has been compiled and published. The fact sheet is available at Appendix D and at: http://www.naiber.org/Publications/NAIBER/Distillers_Grain_Prices.pdf.

5. Characterize range of nutrient specifications of co-product commodities produced.
   We collected data on distillers grain nutrient content from a variety of sources. Data from several ethanol plants was received. However, for several reasons the data were not summarized in a published document associated with this project. The data were all considered confidential and we found a wide variety of different forms of distillers grains being produced (e.g., dry, modified wet with varying moisture content, and wet) as well as a wide range in nutrient mixtures and a range in what was being measured. Small sample size, together with varied nutrient content and data confidentiality, resulted in our not being comfortable publishing this information. This issue is left for future work.

6. Results, recommendations, and implications.
   Results, recommendations, and implications have been compiled in each published fact sheet.

Contribution of public or private agency cooperators

A large number of private agencies cooperated with and assisted our team in completing this project. The Kansas City Board of Trade was instrumental in working with us to identify specific issues we would need to investigate relative to determining feasibility of developing a DG futures contract. We worked with, and shared information we gleaned, relative to this issue with the Kansas City Board of Trade (KCBOT). Interestingly, the KCBOT decided against launching a DG contract, though our analyses suggested potential demand for the contract existed. Following that decision, the Chicago Mercantile Exchange launched a DG futures contract that began trading in early 2010.

Numerous ethanol plants and companies provided substantial information and data for completed our study. In total 125 ethanol DG producing plants worked with us in providing information about distillers grain production, price discovery, merchandising, exports, transportation, and price risk management. We found DG merchandisers to be very interested in our work, candid and informative in their information sharing, and willing to give us time to visit about issues in DG markets.

Results, conclusions, and lessons learned

Several important things were learned from our project:

1. Price and related fundamental information on distillers grain markets are sparse relative to feed grains. As such, evaluating price offers and bids is often done without a lot of market information which can contribute to variation across transaction prices.
2. Dry (10% moisture), modified wet (50-55% moisture), and wet (65-70% moisture) distillers grain prices vary relative to each other. For example, dry DG in Nebraska has been priced at from a $10/ton dry matter discount to a $30/ton dry matter premium to wet DG over an 18 month period in 2008-09. Similar price differences are seen in other locations. The different moisture DG product markets are segmented. Significant value exists to compare dry, modified wet, and wet prices on a dry-matter basis for buyers who can substitute across these product forms.
3. Spatially separated dry DG markets do not have strong price relationships. Prices tend to follow similar patterns across location, but they diverge from each other at times as well. Analysis of prices across different markets suggests buyers could gain by shopping around for DG across different locations at any point in time. The DG market appears to have limited geographic price information flowing.
4. Dried distillers grain does not appear to be able to be effectively cross hedged using traditional corn or soybean meal futures markets. Basis and hedge ratio relationship risk has often been more than 30% of the underlying price of DG. As such, currently available futures markets do not appear to offer viable price risk transfer for distillers grain. Development of a DG futures contract appears worth investigating and of course was developed during this project.
5. Due to volatility in the ethanol industry, market shares of ethanol and DG producers have changed considerably over the past year few years.
6. The main consumers of ethanol co-products are beef, dairy, swine, and poultry.
7. The estimated market value of feed distillers grain in 2007-2008 was $3 billion.
8. Exports have grown rapidly over the past few years and now account for over 20 percent of DG production.
9. Exports of 4.5 million metric tons in 2008 were valued at close to $1 billion.
10. The top two foreign markets for DG are Mexico and Canada, accounting for 43 percent of exports.
11. Turkey emerged in 2007 as the 3rd largest export market for DG, and cemented that position for 2008 as its imports tripled to 465,000 metric tons.

12. Rapid growth in exports to Mexico, South East Asia, Central and South America and the Middle East/North Africa region have compensated for markets lost in Europe due to new EU labeling laws.
13. Five of the top seven DG importers in 2008 were also among the top seven importers of US corn. However, because DG can also be fed as a protein source, the overall pattern of DG exports is correlated with both corn and soybean meal exports.
14. Survey results of ethanol plants indicated distillers grain are very important to plant profitability.
15. Survey results indicated that 74% of plants market at least some of their DG themselves and nearly half use an external broker or merchandiser to market some of all of their DG produced.
16. More than 70% of ethanol plants export as least some DG produced.
17. Trucks are the only source used to transport wet and modified wet DG whereas, truck, rail, and barge are all used to transport dry DG.
18. Wet and modified wet DG is largely marketed within 100 miles of the plant (>90%) whereas, only about 50% of dry DG is marketed within 100 miles of the plant.
19. Multiple sources of information are used by DG plants to establish prices for DG. Corn and soybean meal future prices are common reference points.
20. Forward contracting is common in DG pricing by plants as is using corn futures to try to cross hedge (though as noted earlier corn future are not a very good cross hedge instrument for DG). More than a third of DG plants do nothing to try to manage temporal DG price risk.
21. Half of DG plants indicated that a DG futures market would provide an important risk management tool for them.

Current or future benefits to be derived from the project

Several direct and indirect benefits accrued from this project. A graduate student completed his MS degree working on this project and he is now employed in the feedlot industry where, procurement in the DG market is part of his responsibilities. Three undergraduate students helped with the survey work in this study and all three young ladies went on to graduate programs in agricultural economics or animal nutrition. This project helped support them in their undergraduate work and contributed to their interest in pursuing graduate degrees.

While we were completing this project, a DG futures contract was launched which our study results strongly suggested was needed for DG risk management. The information we collected was relevant in the new futures market development and launch. We are not suggesting the contract was launched solely because of our work, but our work was part of the information set considered. Whether the contract is successful and generates sufficient volume over time is to be determined, but if it does, this project certainly provided information to support the development of such a contract. Third, we have also built a data base of DG prices that is more comprehensive than any other source we have found. At least updating it is much less costly than creating it from scratch for future work along these lines. Fourth, we increased our industry contacts in the DG market through our survey work and reporting and distribution of important summary information back to the industry. We have become a source of expertise and information for the industry.

Additional information available (e.g. publications, websites)

A web page posting fact sheets developed from this project (and other projects) is at: http://naiber.org/publications.html
Specific publications to date from this particular project include:

Fox, J.A. *Export Markets for Distillers Grains*. Distillers Grain Market Development & Price Risk Management Series FS3, North American Institute for Beef Economic Research, Kansas State University Agricultural Experiment Station and Cooperative Extension Service, August 2009. Available at: http://naiber.org/Publications/NAIBER/Export-Markets-for-Distillers-Grains.pdf

Fox, John. A. "The Value of Distiller's Dry Grains in Large International Markets." Chapter 6 in *Using Distillers Grains in the U.S. and International Livestock and Poultry Industries*, edited by B.A. Babcock, D.J. Hayes, and J.D. Lawrence. Midwest Agribusiness Trade Research and Information Center (MATRIC) Iowa State University. November 2008. Available online at http://www.matric.iastate.edu/DGbook

Schroeder, T. *Distillers Grain Prices: Spatial Relationships, Arbitrage Opportunities, & Risk Management*. Distillers Grain Market Development & Price Risk Management Series FS2, North American Institute for Beef Economic Research, Kansas State University Agricultural Experiment Station and Cooperative Extension Service, May 2009. Available at: http://naiber.org/Publications/NAIBER/Distillers-Grain-Industry.pdf

Schroeder, T. "Economics of Ethanol Policies: Food vs. Fuel." Kansas State University Agronomy Department Guest Speaker, Manhattan, KS, March 9, 2009.

Schroeder, T. "Price Discovery in Distillers Grains Markets: Implications for Cattle Feeding Industry." Kansas State University Animal Nutrition Seminar, Manhattan, KS, October 2009.

Stroade, J., A. Martin, and A. Conrad. *Distillers Grain Industry: Production, Use, Structure, and Trends*. Distillers Grain Market Development & Price Risk Management Series FS1, North American Institute for Beef Economic Research, Kansas State University Agricultural Experiment Station and Cooperative Extension Service, July 2009. Available at: http://naiber.org/Publications/NAIBER/Distillers-Grain-Industry.pdf

Stroade, J., A. Martin, and A. Conrad, and T. Schroeder. *Distillers Grain Industry Price Discovery & Risk Management*. Distillers Grain Market Development & Price Risk Management Series FS4, North American Institute for Beef Economic Research, Kansas State University Agricultural Experiment Station and Cooperative Extension Service, January 2010. Available at: http://naiber.org/Publications/NAIBER/Distillers-Grain-Price-Discovery&Risk-Management.pdf

Recommendations for future research needed

The DG market continues to grow and evolve and price reporting, risk management, and international market development opportunities in DG will be important issues for some time to come. We have certainly not answered all the industry's questions or addressed all issues relative to DG market development. How DG export markets can continue to be expanded, where the best options rest for DG markets, and what product nutrient assurances need to be in place are examples of critical questions going forward for more market development. The ethanol industry expanded very rapidly and faced significant challenges in profitability and volatility appears to be returning to this industry as corn prices have increased substantially this fall 2010. Undoubtedly, challenges with tight or negative margins are likely to be present again in the ethanol production industry and this will have impacts on the DG market. Finally, several important policies related to ethanol blending requirements, blender subsidies, and import tariffs on ethanol will affect ethanol production and thus DG production. Analysis of impacts on DG market development of alternative policy scenarios would be a valuable exercise as part of the information supporting policy analysis and decision making.

Brief description of the project beneficiaries including the number, type and scale of producers

Beneficiaries of this project are first and foremost ethanol producers because of the increasingly important role of DG in firm profitability. We contacted 171 ethanol producers during the course of this study from the largest to small firms. As a co-product in the ethanol industry, the value of DG to overall firm profitability, for firms of all size, has become more apparent.

Developing new markets for DG, designing and introducing new market risk management options for DG sellers, and gaining improved information about the DG market benefits all corn producers in the US by providing increased value and expanded markets for DG. That is, information that enhances DG market development and/or enables better DG market risk management, directly increases ethanol producer demand for corn which directly enhances corn producer profit. Overall, the US has some 340,000 corn producers ranging in size from small farms selling less than $10,000 in annual sales to very large farms selling well over $1 million annually. In addition to corn producers, grain sorghum producers also benefit because grain sorghum is used in some ethanol plants and is also a strong substitute for corn.

Information from our study relative to DG regional prices that identified opportunities for DG buyers to shop around for DG prices (that is, price differences that appeared able to be arbitraged were identified) provides DG buyers, especially cattle producers and dairies, with information they can use to reduce input costs and increase profits. A USDA study discussed in one of our on-line publications from this project revealed that in 2007 about 38% of dairies, 36% of beef cattle operations, 13% of cattle feeders, and 12% of hog producers were feeding ethanol co-products (http://naiber.org/Publications/NAIBER/Distillers-Grain-Industry.pdf). These operations directly benefit from better information and risk management about DG.

Distillers Grain Market Development & Price Risk Management Series FS1

Distillers Grain Industry: Production, Use, Structure and Trends

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July 2009

North American Institute for Beef Economic Research

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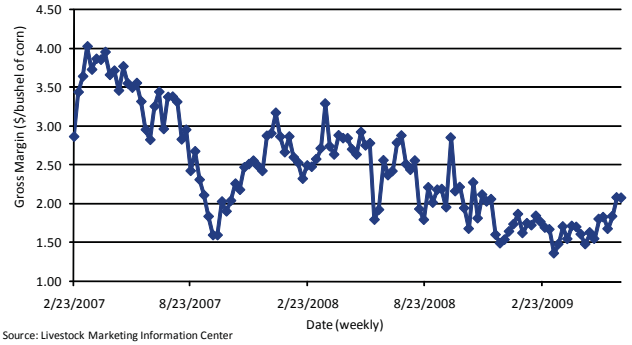
The authors gratefully acknowledges funding provided by the Agricultural Marketing Service-USDA Cooperative Agreement 12-25-G-0668 through AMS' Federal-State Marketing Imrovement Program (FSMIP). The views expressed here are the author's and should not be attributed to AMS or USDA.

Background and Purpose

As the ethanol industry has expanded in recent years, distillers grain (DG) production has gained importance both as an output for ethanol producers and as an input for livestock producers. As figure 1 illustrates, margins for ethanol plants have tightened considerably since 2007. Estimated gross margin for ethanol plants per bushel of corn declined from a high of $4.03 in March 2007 down to less than $1.50 in late 2008 and early 2009 and back to $2.08 in June 2009. Gross margin is the value of ethanol plus the value of distillers grain produced per bushel of corn less the price of corn per bushel. Decline in ethanol value is responsible for most of this tightening margin. These difficult economic conditions have elevated the importance of DG value in ethanol producer profitability.

Figure 1. Estimated Weekly Gross Margin (Ethanol Price + DG Price - Corn Price) for a Nebraska Ethanol Plant, Feburary 2007-June 2009

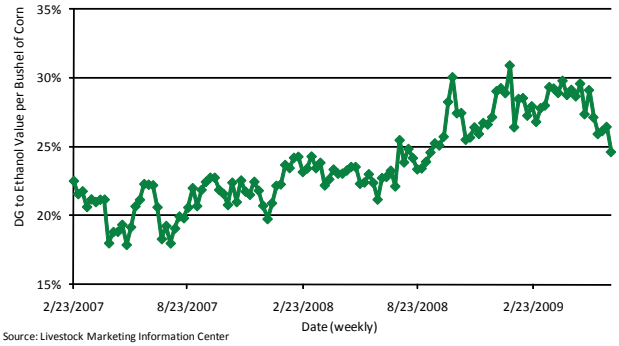


Source: Livestock Marketing Information Center

As ethanol margins have tightened, DG value has increased relative to ethanol value. As figure 2 shows, the value of distillers grain produced from one bushel of corn was 23% of the value of ethanol produced from one bushel of corn in February 2007. This figure dropped to a low of 18% in May 2007 and rose to a high of 31% in January 2009. In June 2009, DG value was 25% of ethanol value. In general, from 2007 to 2009 DG gained value relative to ethanol. Both the narrowing of margins in the ethanol industry and this increase in DG value relative to ethanol value emphasize the need for a sound understanding of DG's role in the ethanol industry.

In a similar manner, the growing use of DG in the livestock industry has increased their importance to livestock producers. The increasing significance

Figure 2. Value of DG Relative to Ethanol per Bushel of Corn for a Nebraska Ethanol Plant, Feburary 2007-June 2009



Source: Livestock Marketing Information Center

of distillers grain to both the ethanol and livestock industries elevates the need to better understand the distillers grain industry and associated issues.

The purpose of this factsheet is to overview the distillers grain industry and highlight factors affecting its future. This factsheet, which is the beginning of a series exploring aspects of distillers grain market development, price discovery, and risk management, includes an overview of distillers grain production, market structure, and consumption.

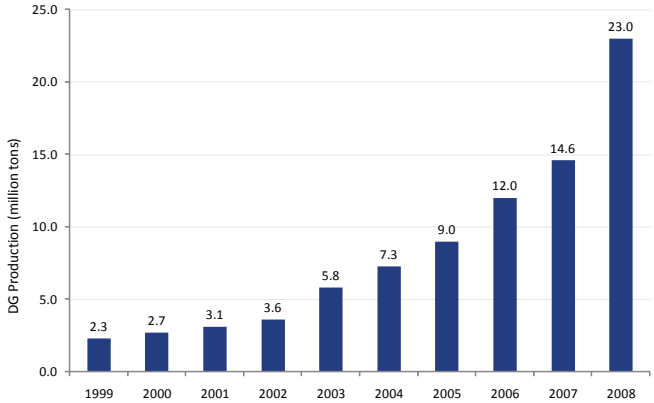
Industry Volume & Growth

The ethanol industry has experienced rapid growth in recent years. Ethanol production expanded from 1.5 billion gallons in 1999 to 9 billion gallons in 2008. Distillers grain production during the same period increased from 2.3 million metric tons to 23 million metric tons. Figure 3 shows the ten-fold increase in DG production over the past ten years. In 2008 DG production increased 57% over the previous year. In 2007, just less than 25% of the corn crop was used for ethanol production whereas, 30% of the crop was used for ethanol in 2008.

Distillers Grain Production Process

Ethanol in the United States is primarily produced from corn using either or a dry milling or wet milling process. Dry milling produces co-products of distillers grain (DG) and condensed distillers solubles. Feedstocks besides corn (i.e. sorghum) can also be used to produce ethanol. Dry milling plants are more common because

Figure 3. Distillers Grain Production 1999-2008



Source: Renewable Fuels Association

they are lower cost to build and operate compared to wet milling plants. Distillers grains are sold as dried (10% moisture), modified wet (50-55% moisture), or wet distillers grain (65-70% moisture). On average, a bushel of corn with 56 pound test weight produces 2.8 gallons of ethanol, 18 pounds of dried distillers grain with solubles, and 18 pounds of carbon dioxide. Ethanol plants generate approximately 6 pounds of distillers grain for every gallon of ethanol produced. Figure 4 illustrates how distillers grain is produced in a dry milling process. First, the feedstock (corn and/or sorghum) is ground into a fine flour or meal. The meal is then soaked in water and enzymes, which break down the starch into simple sugars as the mixture is heated. Ammonia is also added to control pH and act as a nutrient for the yeast (added later). This mixture, or mash, is heated to activate the enzymes and to control bacteria during the fermentation process.

After the starch is broken down, the mash undergoes fermentation in which yeast is added to convert the sugar to alcohol. As the yeast feeds on the sugars and produces alcohol, it emits carbon dioxide. The carbon dioxide is removed from the fermentation tanks with a CO_2 scrubber.

After the carbon dioxide is removed, the products of fermentation (alcohol, water and solids) are transferred to distillation columns where the alcohol is purified. In the distillation columns, the solid part of the mixture is pumped out of the bottom where it settles. These solids are distillers grains. As they are pumped from the bottom of the distillation column, the water and alcohol are heated to 170 degrees which causes the alcohol to evaporate. The alcohol is collected in its gaseous form and transferred to a second distillation column. This heating and purifying is repeated several times in a series of columns until enough water is removed to result in 190 proof alcohol. In order to purify the alcohol further, it is run through a molecular sieve to separate the water molecules from the alcohol molecules. Since alcohol molecules are larger than water molecules, the sieve (porcelain balls filled with tiny beads) absorbs the water molecules, but not the alcohol molecules. The product that comes out of the molecular sieve is 200 proof alcohol or ethanol. The ethanol is then denatured, stored and shipped to market.

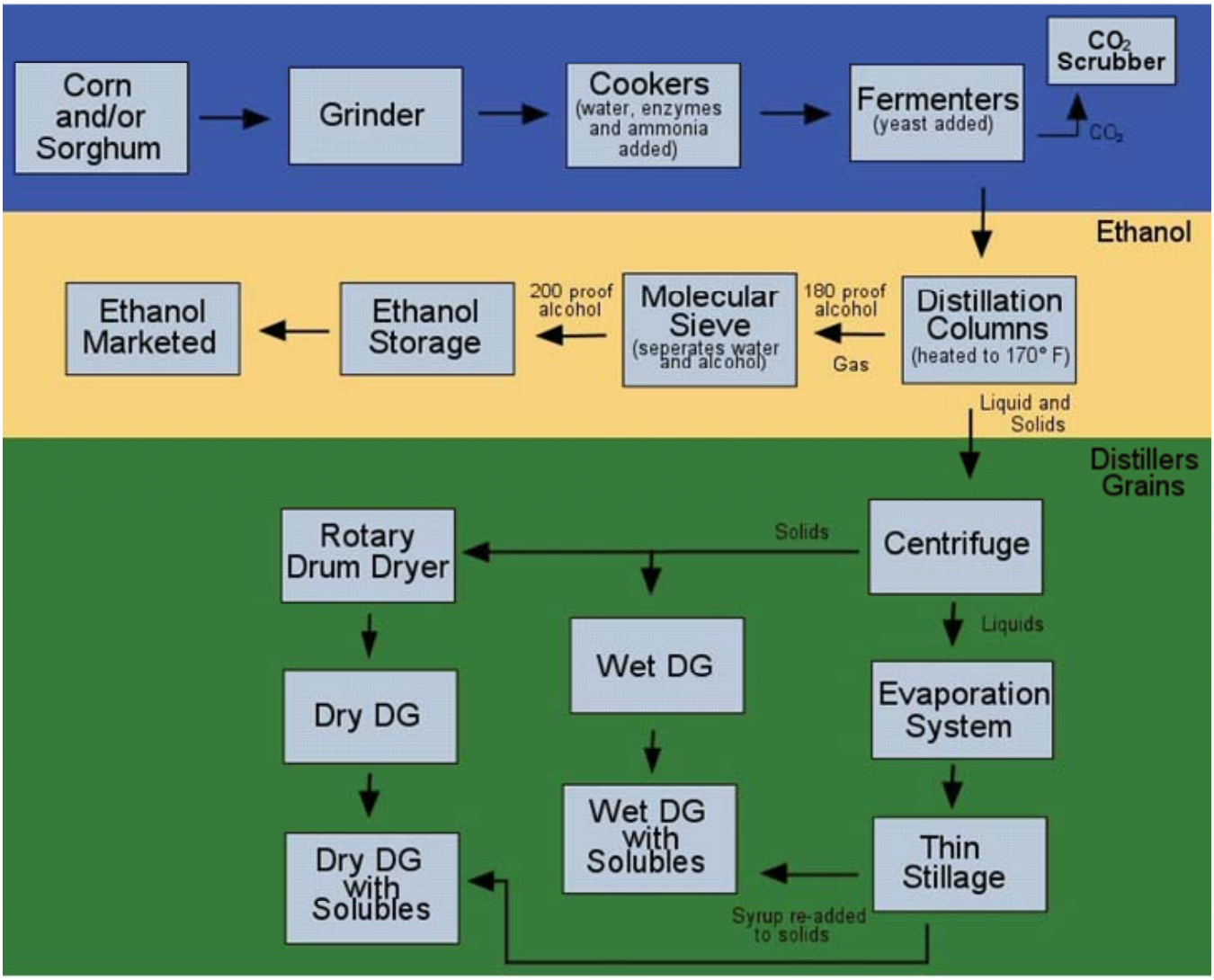
After the distillers grain solids are pumped from the distillation column, they are run through a centrifuge to separate the liquid from the solids. The solids from the centrifuge are wet distillers grains having about 65% moisture. This product is either marketed as wet DG or dried and marketed as dried DG. The water from the liquid that was separated by the centrifuge is evaporated producing a thickened syrup with high nutritional value for livestock. This syrup is added back into the final (wet or dry) DG product to produce distillers grains with solubles.

Distillers grain production during the same period increased from 2.3 million metric tons to 23 million metric tons. In 2008 DG production increased 57% over the previous year. In 2007, just less than 25% of the corn crop was used for ethanol production whereas, 30% of the crop was used for ethanol in 2008.

Distillers Grain Production Locations

Since distillers grains are a co-product of ethanol production, DG production is primarily located near ethanol bio-refineries. Table 1 shows ethanol production by state as of June 2009. Iowa ethanol plants represent the largest percentage of the market at 29%. Illinois plants represent the second largest capacity at 11%. The top four ethanol producing states generate 60% of total

Figure 4. Dry Mill Ethanol and Distillers Grain Production Process



ethanol production while the top ten producing states represent 87% of ethanol production.

As of July 2009, 173 ethanol plants were operating in the United States. Figure 5 shows the ethanol plants that are currently operating, those that are idled and those under construction as of January 2009. As can be seen from the map, the concentration of currently operating ethanol plants is the highest in Iowa, Southern Minnesota and Eastern South Dakota. Also, while ethanol plant expansion is concentrated in the Midwest, 28% of new capacity is being added in other areas of the US. The major corn producing states of Illinois, Iowa, and Nebraska contain the largest amount of expansion in the ethanol industry based on the capacity of plants under construction. In total these states contain 58% of the new production capacity.

New construction will add 14% to the current production capacity. As of July 2009, 23 ethanol plants were idle, almost all of them because of difficult economic conditions. Sixteen of these 23 plants were either in bankruptcy or have been purchased from a bankrupt company and have yet to start operations. These 23 plants account for approximately 13% of current production capacity, which has been idled.

Market Share

Due to recent volatility in the ethanol industry, market shares have changed considerably over the last year and will continue to evolve. Table 2 compares the estimated market share of the largest ten ethanol refineries in 2009 with their market share in 2008. The ten largest ethanol firms account for 48% of the total

Table 1. Ethanol Production by State, June 2009

Rank	State	Ethanol Production Capacity (Million Gallons/Year)	Share of Total Capacity (%)	Cumulative Share of Capacity (%)
1	Iowa	3,176.0	29.4%	29.4%
2	Illinois	1,183.0	11.0%	40.4%
3	Nebraska	1,161.0	10.8%	51.1%
4	South Dakota	906.0	8.4%	59.5%
5	Minnesota	837.6	7.8%	67.3%
6	Indiana	706.0	6.5%	73.8%
7	Wisconsin	498.0	4.6%	78.4%
8	Kansas	411.5	3.8%	82.2%
9	Missouri	261.0	2.4%	84.7%
10	Ohio	246.0	2.3%	86.9%
11	North Dakota	233.0	2.2%	89.1%
12	Michigan	215.0	2.0%	91.1%
13	Tennessee	167.0	1.5%	92.6%
14	Texas	140.0	1.3%	93.9%
15	Colorado	125.0	1.2%	95.1%
16	Georgia	100.4	0.9%	96.0%
17	Arizona	55.0	0.5%	96.5%
18	Mississippi	54.0	0.5%	97.0%
19	New York	50.0	0.5%	97.5%
20	Oregon	40.0	0.4%	97.9%
21	California	39.5	0.4%	98.2%
22	Kentucky	35.4	0.3%	98.5%
23	New Mexico	30.0	0.3%	98.8%
24	Wyoming	6.5	0.1%	98.9%
25	Idaho	4.0	0.0%	98.9%
26	Louisiana	1.5	0.0%	98.9%
	All Others	115.0	1.1%	100.0%
	United States Total	10,797.4	100.0%	

Source: Nebraska Energy Office

Figure 5. US Ethanol Biorefinery Locations, January 2009

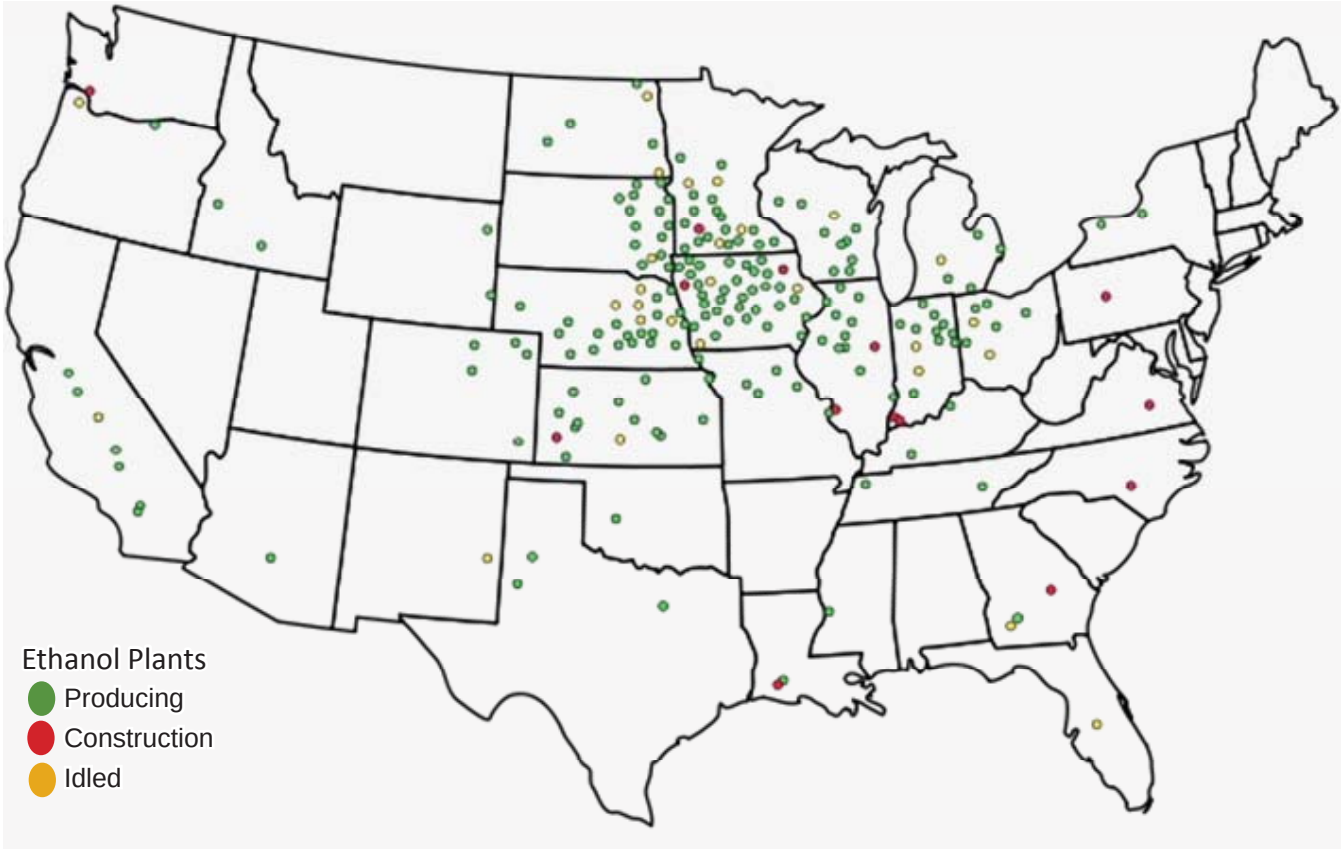


Table 2. Market Shares Based on Capacity of 10 Largest Ethanol Biorefineries, July 2009

Rank	Firm	Market Share as of July 2008	Market Share as of July 2009	Cumulative Share as of July 2009
1	POET Biorefining	13.0%	13.3%	13.3%
2	Archer Daniels Midland	11.7%	9.7%	23.0%
3	Valero Renewable Fuels	N/A	7.1%	30.0%
4	Green Plains Renewable Energy	1.1%	4.3%	34.4%
5	Hawkeye Renewables, LLC	2.3%	4.0%	38.4%
6	The Andersons Ethanol, LLC	2.9%	2.5%	40.9%
7	BioFuel Energy, LLC	N/A	2.1%	42.9%
8	Aventine Renewable Energy, LLC	2.2%	1.9%	44.8%
9	Glacial Lakes Energy, LLC	2.2%	1.9%	46.7%
10	Advanced Bioenergy, LLC	1.1%	1.6%	48.3%

Source: Calculated from data obtained from Renewable Fuels Association & Nebraska Energy Office

Table 3. Operations Feeding Ethanol Co-Products, 2007

	Feeding Co-Products	Not Feeding Co-Products but Considering Feeding Them	Not Feeding Co-Products and Not Considering
	(% of respondents)		
Dairy Cattle	38	22	40
Beef Cattle	36	34	30
Cattle on Feed	13	30	57
Hogs	12	35	53

Source: USDA, NASS, Ethanol Co-Products Used for Livestock Feed

production of ethanol in the United States as of July 2009. The largest firm, POET Biorefining, has 13% of the market share followed by Archer Daniels Midland (ADM) with 10% market share. Valero Renewable Fuels holds the third largest market share with 7%. As table 2 shows, Valero Renewable Fuels did not hold any of the top ten market shares in 2008. However, when VeraSun Energy Corporation, who held 7% of the market, declared bankruptcy in late 2008, Valero Renewable Fuels purchased several of their plants. These purchases gave Valero Renewable Fuels 7% of the market and the third largest spot among ethanol biorefineries.

Distillers Grain Consumers

Currently the main consumers of ethanol co-products are beef, dairy, swine, and poultry. The estimated market value of feed distillers grain in 2007-2008 was $3 billion (RFA). A 2007 USDA survey of 9,400 livestock operations in Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin identified the number of operations feeding ethanol co-products. Table 3 summarizes co-product use by survey respondents. Figure 6 depicts the domestic user distribution of distillers grain consumption during 2007 as reported by the 2008 Yearbook of the Renewable Fuels Association. Beef and dairy cattle each represent 42% of consumption for a total of 84% of North American DG consumption. Swine and poultry consume far less distillers grain representing 11% and 5% of total consumption, respectively.

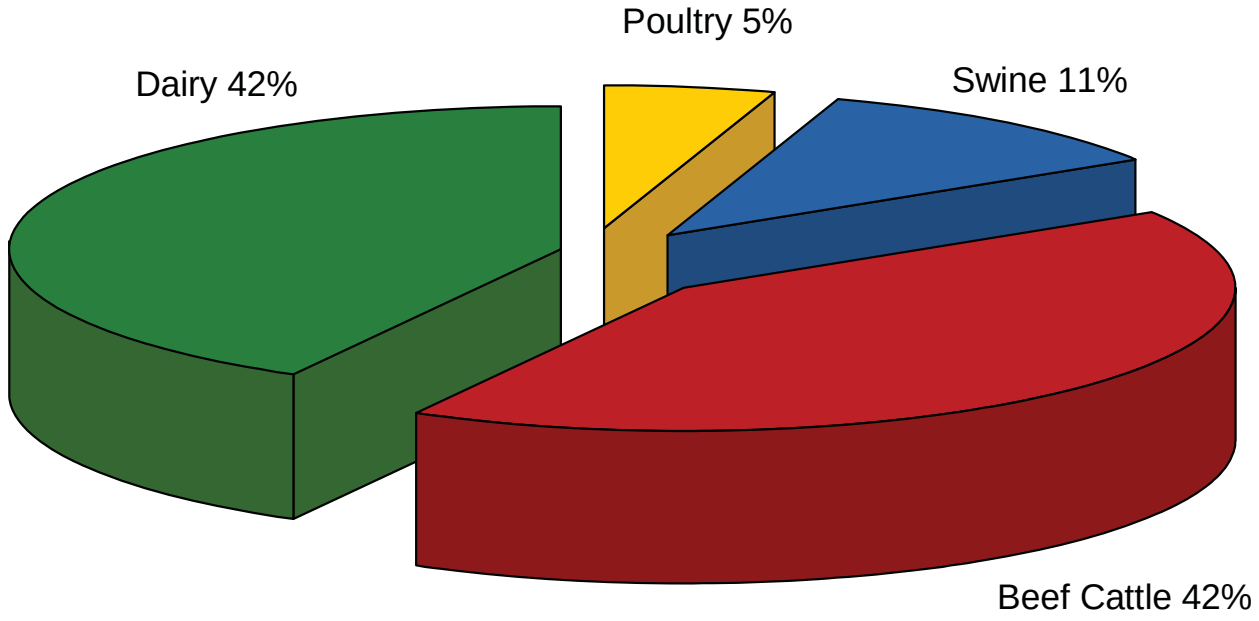
Export markets for distillers grain continue to expand, increasing 91% between 2007 and 2008 (RFA). Distillers grain exports totaled 4.51 million metric tons in 2008, roughly 20% of total distillers grains production. The top three foreign markets for DG in 2008 were Mexico, Canada, and Turkey, respectively.

Industry Growth

Economic and regulatory conditions have afforded rapid expansion for the ethanol industry in recent years. Specifically, blending requirements established by the Renewable Fuel Standards Act, high crude oil prices, an ethanol blending credit, and the tariff on ethanol imports combined to make the industry attractive to new entrants. However, within the last year margins in the industry have narrowed considerably. Since the summer of 2008, high corn prices along with lower oil, and subsequently, ethanol prices have

The difficult market conditions have forced companies out of business resulting in a significant amount of production capacity being idled and plants changing hands within the last year. This is leading to a consolidation of the industry as well as oil companies buying ethanol plants at a discount.

Figure 6. North American Distillers Grain Consumers, 2007



Source: Renewable Fuels Association

decreased ethanol margins. Further, the blender's credit was reduced from $0.51 per gallon to $0.45 per gallon of ethanol in January 2009.

These factors have made survival in the ethanol industry more difficult and caused shifts in industry structure. The difficult market conditions have forced companies out of business resulting in a significant amount of production capacity being idled and plants changing hands within the last year. This is leading to a consolidation of the industry as well as oil companies buying ethanol plants at a discount.

The rapid expansion in capacity for ethanol production has led to concern over reaching a "blend wall" for gasoline blended with 10% ethanol. If ethanol production reaches the blend wall, the point at which ethanol production equals 10% of the nation's gasoline, the domestic demand for ethanol will be exhausted. The Environmental Protection Agency (EPA) estimates that the blend wall will be reached by 2013. At an ethanol blend rate of 10%, the blend wall in 2013 would be 14.5 billion gallons of ethanol. This figure will vary based on E10 distribution and gasoline use. If ethanol cannot be distributed nationwide or if gasoline use declines, the blend wall will be reached before 2013. The EPA is currently considering raising ethanol blending allowances to 15% which would ease concerns over reaching the blend wall and provide additional domestic outlets for ethanol supply. The EPA's decision will affect the ethanol industry significantly. If the blending allowance is raised, domestic demand will have expansion potential. If the allowance is not raised, increases in domestic demand will depend on an increase in flex-fuel vehicle demand or on technological innovations that will find new uses for ethanol.

Another factor affecting the industry's future is policy. On May 5, 2009, President Obama issued a biofuels directive highlighting the importance of biofuels as a tool to lessen dependence on foreign oil, insulate consumers from oil price shocks, create jobs and tax revenue, as well as the importance of research and development for utilizing a variety of non-grain feedstocks to create ethanol. The current administration's decisions regarding ethanol will impact the industry's future. Ethanol is required as an oxygenate for gasoline and there are government subsidies and mandates for ethanol fuel production which means this will contribute to the demand for ethanol increasing in years to come.

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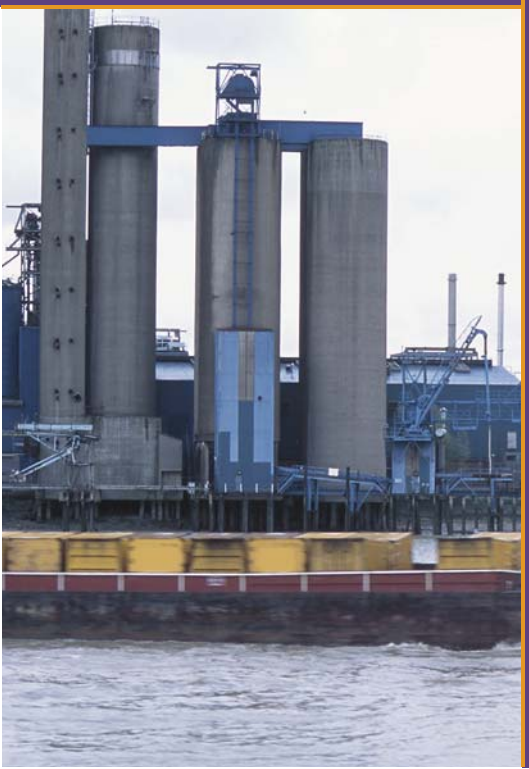

Distillers Grain Market Development & Price Risk Management Series FS4

Distillers Grain Industry Price Discovery & Risk Management

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January 2010

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Kansas State University Agricultural Experiment Station and Cooperative Extension Service

The authors gratefully acknowledge funding provided by the Agricultural Marketing Service-USDA Cooperative Agreement 12-25-G-0668 through AMS' Federal-State Marketing Imrovement Program (FSMIP). The views expressed here are the author's and should not be attributed to AMS or USDA.

Background

The distillers grain (DG) industry developed rapidly nearly quadrupling in output from 2003 to 2008 as ethanol production increased dramatically. As with any market that evolves quickly, methods to discover prices are still developing. For a number of reasons, the DG market is somewhat thinly traded and has limited information available about prices and market supply and demand fundamentals. The DG market tends to be a localized market for many ethanol plants, especially those that produce wet DG that is costly to transport long distances. Readily available DG pricing information is limited because many DG transactions are private treaty between the seller and buyer. Therefore they are not reported to the U.S. Department of Agriculture or other parties or published in public price reports. Furthermore, formula pricing of DG using other commodity markets is also common resulting in limited cash negotiated pricing.

DG prices have become an important part of ethanol plant profitability as margins in the DG industry have narrowed over the past few years. In addition, as DG production has increased, its importance as an ingredient in livestock feeds has escalated. At the same time as DG has increased in importance for both ethanol plants and livestock producers, its price has seen substantial volatility. In order for the DG market to further develop, become more widely understood, and increase in overall price discovery efficiency, more information is needed about how DG prices are discovered and risk management methods being used by DG merchants. The purpose of this fact sheet is to better understand the nature of DG price and value discovery, pricing methods, risk management techniques being used, and opportunities for development of additional price discovery methods.

Survey Methods and Respondents

To accomplish the objectives of this study, in July 2009, a survey of ethanol plants and distillers grain merchandisers was conducted to determine the importance of distillers grain to ethanol plant profitability, the DG price discovery process, and mechanisms used to manage price risk in the distillers grain industry. The surveys were conducted via a combination of telephone calls and email. Ethanol plants listed on the Renewable Fuels Association web site were asked to participate. Plants that produced less than 10 mgy were excluded as were plants that used a feedstock other than corn or milo. In total, 171 plants were asked to participate and 125 completed surveys were received yielding a response rate of 73%. Plants were asked questions regarding their merchandising, exporting, transportation, pricing and risk management of distillers grain.

DG prices have become an important part of ethanol plant profitability as margins in the DG industry have narrowed over the past few years. In addition, as DG production has increased, its importance as ingredient in livestock feed has escalated. At the same time as DG has increased in importance for both ethanol plants and livestock producers, its price has seen substantial volatility.

Survey respondents were producing a total of 7.5 billion gallons of ethanol per year, representing 65% of total industry production as of July 2009. Almost all of the respondents (96%) were dry milling plants. Dried distillers grain was the most widely produced co-product with 106 of the plants producing dried distillers grain, 79 plants producing wet distillers grain and 37 plants producing modified wet distillers grain. The average ethanol production of respondents was 62.3 million gallons of ethanol per year (mgy).

Distillers Grain Importance to Plant Profitability

Plants were asked to rate the importance of DG to plant profitability on a scale from 1 to 5, 1 being not important to 5 being very important. Of the total survey respondents, 70% responded to this question. Respondents deemed distillers grain very important to plant profitability, with an average rating of 4.6.

As Figure 1[1] shows, only 11% of respondents rated DG's importance to profitability as a 1, 2, or 3. In contrast, 89% of respondents rated DG's importance to profitability as a 4 or 5. The approximate volume-weighted responses are also specified in Figure 1. The volume-weighted and simple average responses are similar indicating regardless of plant size, DG production and sales are very important to ethanol plant profitability. These responses reveal how important distillers grain is as an output for ethanol plants.

Figure 1. Ethanol Plant Ratings of Importance of DG to Plant Profitability

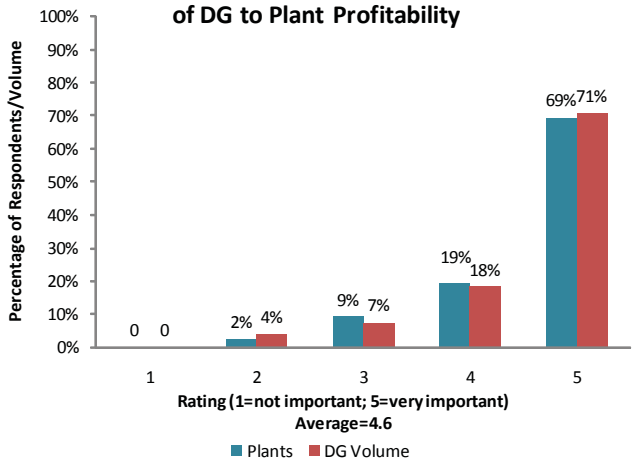


Figure 2. Plant responses to: "Has the importance of DG to the profitability of the plant increased, decreased, or stayed the same over the last three years?"

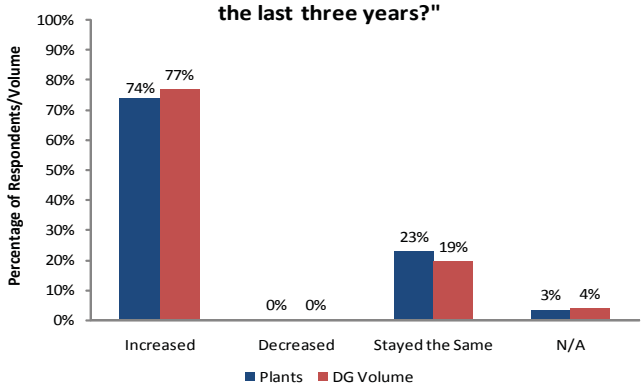


Figure 2[2] illustrates plants' responses to whether distillers grain's importance to plant profitability has increased, decreased, or stayed the same over the past three years. A large majority of respondents, 74%, indicated that distillers grain's importance to profitability has increased. No plant indicated that DG importance has decreased, and 23% indicated that it has stayed the same. The responses to these two questions suggest that in recent years, as the ethanol industry has become more mature, distillers grain co-product and value have become more vital to ethanol plant profitability.

Merchandising

Plants were asked about their method of marketing distillers grain. All plants that were surveyed responded. While almost three-fourths of plants (74%) market at least some DG themselves, a significant number (48%) also use a merchandiser. Table 1[3] shows the number of plants marketing distillers grain in each manner.

A large majority of respondents, 74%, indicated that distillers grain's importance to profitability has increased. No plant indicated that DG importance has decreased, and 23% indicated that it has stayed the same. The responses to these two questions suggest that in recent years, as the ethanol industry has become more mature, distillers grain co-product and value have become more vital to ethanol plant profitability.

About half (51%) of the respondents overall (including plants that produce dry DG, modified wet DG, and wet DG) market distillers grain solely by themselves. Plants that market DG in this manner produce 54% of the total ethanol produced by survey respondents. The average ethanol production of these plants is 66 mgy. The average amount of ethanol produced by plants in the survey is 62.3 mgy, so plants that market DG solely by themselves tend to be larger than average.

1 Question response rate: 70%

2 Question response rate: 70%

3 Question response rate: 100%

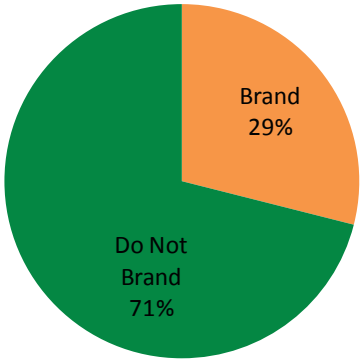
Approximately one-fourth (26%) of respondents only use a merchandiser to market their product (and do not market any product by themselves). Plants that market DG solely through a merchandiser produce 27% of the total ethanol produced by survey respondents. The average ethanol production for these plants is 63 mgy, only slightly larger than the average plant responding to the survey.

Finally, 22% of plants market some DG by themselves and some through a merchandiser. Plants that market distillers grain in this manner produce 19% of the total ethanol produced by survey respondents. The average ethanol production of these plants is 55 mgy, smaller than the average respondent.

Table 1[4] also shows how plants market the different type of DGs. Plants market more dry distillers grain through merchandisers than wet or modified wet DG. This is expected due to the longer shelf life and larger relevant geographic market of dry DG verses wet or modified DG. Markets for dry DG are less localized than markets for wet or modified DG. Also, as discussed above, larger plants market DG by themselves while smaller plants use merchandisers.

4 Question response rate: 100%

Figure 3. Branding Practices of DG Producers



Branding

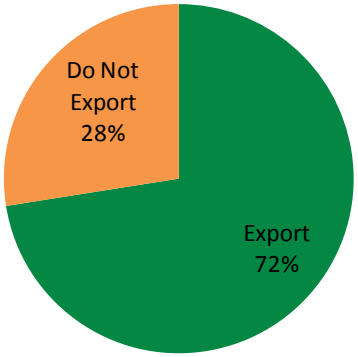
As feeding distillers grain has become a more common practice, some ethanol plants have begun to brand their DG. In the survey, plants were asked whether they brand their DG. Of total survey respondents, 91% answered this question. Their responses are shown graphically in figure 3[5]. While most plants (71%) do not brand the DG they produce, a significant number of plants (29%) brand their distillers grain. The average

5 Question response rate: 91%

Table 1. Who Markets Distillers Grain

Form of DG	Who Markets DG		
	Solely Plant	Solely Merchandiser	Plant & Merchandiser
Total all forms			
% of respondents	51%	26%	22%
% of ethanol produced	54%	27%	20%
Average ethanol production (mgy)	65.7	62.5	54.6
Dry DG			
% of respondents	53%	31%	16%
Modified Wet DG			
% of respondents	69%	22%	8%
Wet DG			
% of respondents	65%	30%	5%

Figure 4. Exporting Practices of DG Producers



ethanol production of plants that brand DG is 55 mgy, significantly smaller than the survey respondent average size of 62 mgy. Plants that brand DG may be doing so to target specific markets and are trying to differentiate themselves from the overall commodity market. Plants were also asked why they made the decision to brand. Most of the answers to this question focused on increasing the value of the product by differentiating it based on quality and consistency. As the ethanol and DG industries become more competitive, it is likely that plants will continue to look for ways to differentiate their product, thus branding of DG may become a more common practice.

Exporting

Exporting practices were also covered by the survey. Of total survey respondents, 96% responded to the questions regarding exporting. Their responses are shown in figure 4[6]. Of these, 72% export distillers grain. Plants that export DG are, on average, larger than those that do not. The average size of ethanol plants that export DG is 68 mgy, while the average size of plants that do not export is 49 mgy. Forty plants (32% of survey respondents) indicated their top export markets. Mexico, Canada and Asia are the top export markets for respondents. Of the plants that export DG, 65% indicated the percentage that they export. These plants export an average of 29% of their product.

6 Question response rate: 96%

Table 2. Percentage of Respondents Indicating they use each Transportation Mode for at least some DG Produced

	Transportation Mode		
DG Form	Truck	Rail	Barge
Dry	99%	69%	38%
Modified Wet	100%	0%	0%
Wet	100%	0%	0%

Table 3. Average Percentage of DG that Travels Each Distance

	Miles			
DG Type	0-50	50-100	100-200	200+
Dry	24%	25%	18%	34%
Modified Wet	59%	34%	8%	1%
Wet	76%	18%	6%	1%

Transportation

The survey also inquired about transportation of DG. Plants were asked about the mode of transportation by which they ship their product and the distance the product moves. Table 2[7] shows the percentage of respondents that move dry, modified wet, and wet DG by truck, rail, and barge. All of the modified wet and wet distillers grain produced by the respondents moves by truck, as does a majority of the dry DG. Producers commonly use multiple transportation modes. Almost one-third of respondents (30%) indicated that they transport dried DG via all three transportation modes, truck, rail and barge. A larger number of respondents (45%) use two of the three modes. In total, 75% of respondents use multiple transportation modes. From survey responses we received, we were not able to determine reliable volume-weighted percentages of dry DG that moves by truck, rail, or barge.

Corn and soybean meal futures are by far the most popular sources of information used to determine DG price. The sum of the percentages of responses indicates that 44% of respondents use multiple sources of information to price DG, signifying that they do not consider a single information source sufficient to make pricing decisions.

Table 3[8] shows the percentage of DG by form that is transported across various distance ranges. Dry DG is most likely to be transported greater distances. Respondents that produce dry DG transport an average of 24% of their product 0-50 miles. An average of 25% is transported 50-100 miles. An average of 18% is transported 100-200 miles. An average of 34% is transported over 200 miles. While a larger percentage of dry DG is transported farther distances, most modified wet and wet DG stays close to where it is produced. Respondents that produce modified wet DG transport an average of 58% of their production 0-50 miles. An average of 34% is transported 50-100 miles. An average of only 9% moves over 100 miles. Wet DG is even less likely to move large distances than modified wet DG is. Respondents that produce wet DG transport an average of 76% of it less than 50 miles from where it is produced. An average of 18% is transported between 50 and 100 miles. On average, only 7% of wet DG is transported over 100 miles. Figure 5 represents the distance each type of DG travels graphically.

Figure 5. Average Percentage of DG that Travels Each Distance

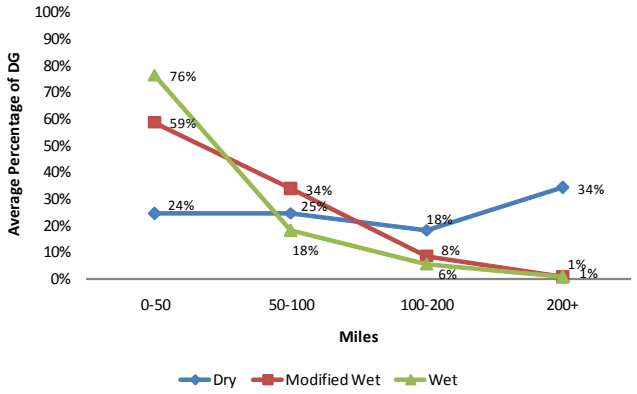
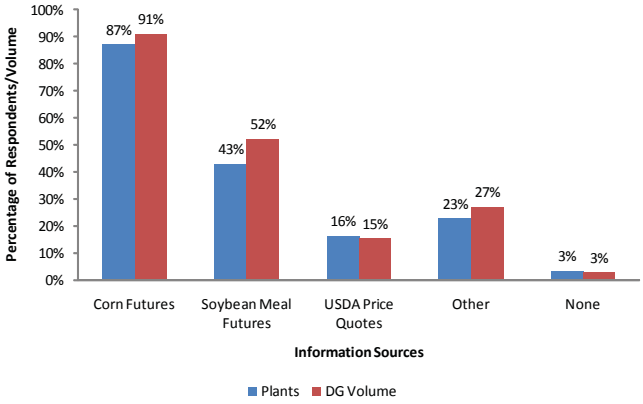


Figure 6. Pricing Information Sources used by DG Producers



Pricing

Plants were asked various questions regarding DG pricing and risk management practices. Specifically, plants were asked what types of information sources they use to establish DG transaction prices and 74% of survey respondents responded. Responses are

7 Question response rates: Dry: 73%; Modified Wet: 100%; Wet: 65%

8 Question response rates: Dry: 64%; Modified Wet: 78%; Wet: 63%

shown in Figure 6[9]. Corn futures prices were used by 87% of respondents to help set DG transaction prices. Plants that use corn futures to price DG produce 91% of the distillers grain produced by all respondents. Soybean meal futures are used as a price source by 43% of plants. These plants produce 52% of DG produced by respondents. The plants that use USDA DG price quotes (16%) produce 15% of DG produced by respondents. Other information sources are used by 23% of plants, and 3% of plants use no external information to set DG prices. Corn and soybean meal futures are by far the most popular sources of information used to determine DG price. The sum of the percentages of responses indicates that 44% of respondents use multiple sources of information to price DG, signifying that they do not consider a single information source sufficient to make pricing decisions.

A majority of respondents (64%) use a price risk management method, however, over one-third (36%) of respondents indicated that they do nothing to manage price risk for DG. Forward contracts are used to forward price DG by 40% of respondents who produce 40% of the total DG produced by respondents.

Plants were also asked what price discovery mechanisms they use to set prices for DG and 66% of survey respondents answered this question. Responses are shown in Figure 7[10]. Of those who answered the question, 65% indicated that they set DG price based on a formula. These plants produce approximately 56% of the DG produced by question respondents. Forward contract pricing is used by 21% of respondents, and these plants produce 20% of the total DG produced by respondents. Cash pricing is used by 54% of respondents who produce 61% of the total DG produced by respondents. Approximately 27% of question respondents use multiple methods of price discovery to set prices.

9 Question response rate: 74%
10 Question response rate: 66%

Figure 7. Price Discovery Mechanisms

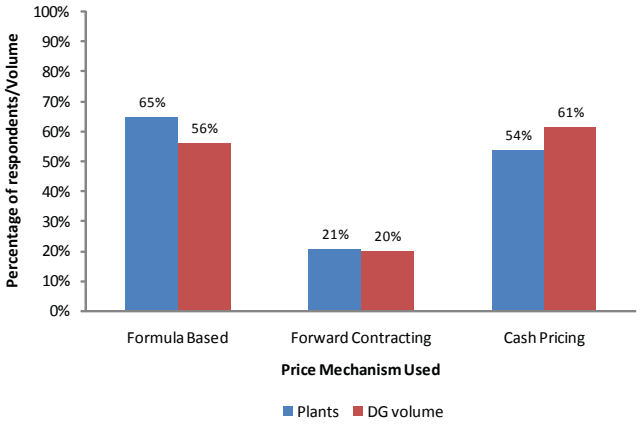
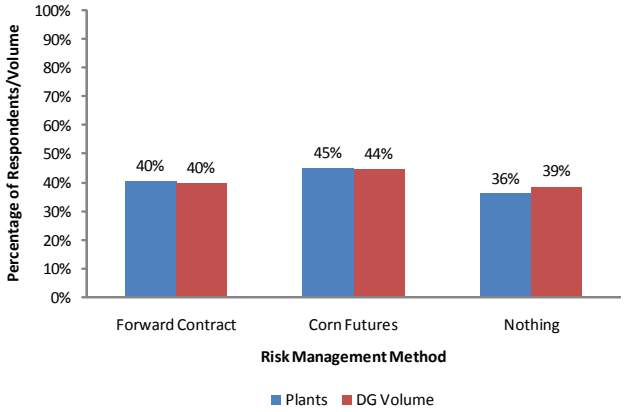


Figure 8. DG Price Risk Management Methods



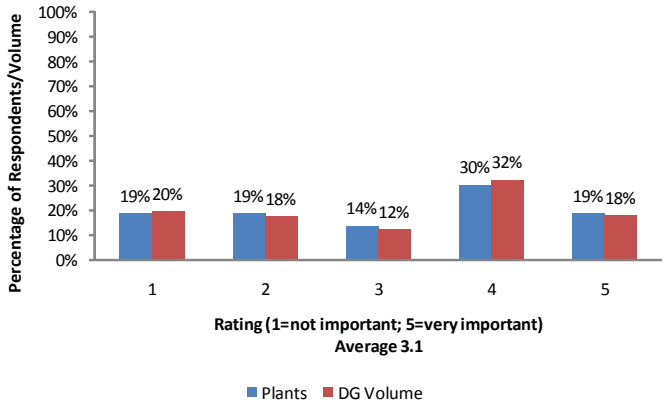
Plants were asked to identify methods they use for DG price risk management and 71% of survey respondents answered this question. Their responses are illustrated in Figure 8[11]. A majority of respondents (64%) use a price risk management method, however, over one-third (36%) of respondents indicated that they do nothing to manage price risk for DG. Forward contracts are used to forward price DG by 40% of respondents who produce 40% of the total DG produced by respondents. Corn futures are used to cross-hedge DG by 45% of respondents who produce

11 Question response rate: 71%

44% of the total DG produced by respondents. A significant number of respondents (21%) use both forward contracts and corn futures to manage DG price risk. Only one respondent indicated using Soybean Meal futures to cross hedge DG.

Distillers grain merchants were asked the importance of a DG futures market for managing risk on a scale of 1 (not important) to 5 (very important). Of the survey respondents, 69% responded to this question. Figure 9[12] summarizes the responses. The average of their responses is 3.1, indicating neutrality in regards to the helpfulness of establishing a DG futures market. The distribution of responses indicates that some respondents are satisfied with their current risk management strategies while others (those who responded with a 4 or a 5) would like more tools to manage DG price risk. Almost half (49%) of respondents believe that a DG futures contract would be an important risk management tool.

Figure 9. Ethanol Plant Ratings of the Helpfulness of a DG Futures Contract for Risk Management



12 Question response rate: 69%

Distillers Grain Market Development & Price Risk Management Series FS3

Export Markets for Distillers Grains

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August 2009

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The author gratefully acknowledges funding provided by the Agricultural Marketing Service-USDA Cooperative Agreement 12-25-G-0668 through AMS' Federal-State Marketing Imrovement Program (FSMIP). The views expressed here are the author's and should not be attributed to AMS or USDA.

Executive Summary

Spurred by the introduction of renewable fuel standards and the elimination of MTBE as a gasoline additive, U.S. production of fuel ethanol expanded from about 1.6 billion gallons in 2000, to 9 billion gallons in 2008. This increase has led to questions about whether markets could absorb the concomitant increase in production of distillers grains (DG). To date most DG has been used in the domestic cattle and hog sectors, but DG exports have been growing. This fact sheet examines recent trends in DG exports from the U.S. The analysis indicates:

- Exports have grown rapidly over the past three years and now account for over 20 percent of DG production.
- Exports of 4.5 million metric tons in 2008 were valued at close to $1 billion.
- The top two foreign markets for DG are Mexico and Canada, accounting for 43 percent of exports.
- Turkey emerged in 2007 as the 3rd largest export market for DG, and cemented that position for 2008 as its imports tripled to 465,000 metric tons.
- Rapid growth in exports to Mexico, South East Asia, Central and South America and the Middle East/North Africa region have compensated for markets lost in Europe due to new EU labeling laws.
- Five of the top seven DG importers in 2008 were also among the top seven importers of US corn. However, because DG can also be fed as a protein source, the overall pattern of DG exports is correlated with both corn and soybean meal exports.

Background

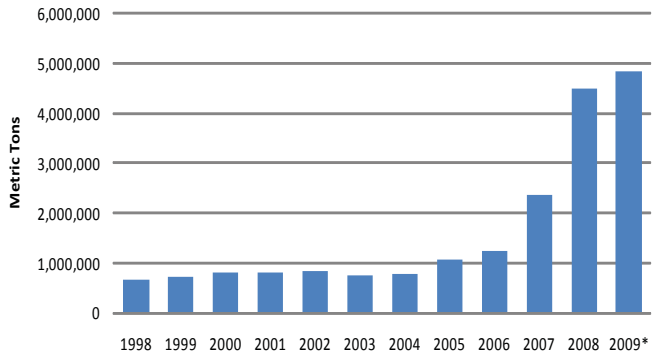
Since 2002, U.S. ethanol production has increased by an average of about 26 percent per year reaching 9 billion gallons in 2008. As a by-product of dry-mill ethanol production, distillers grains (DG) production also increased rapidly, reaching approximately 20 million metric tons (mmt) in 2008. Under the terms of the Energy Independence and Security Act of 2007 the U.S. renewable fuel standard sets a target of 36 billion gallons of fuel ethanol by 2022, of which 15 billion gallons can be derived from grain. Because the expansion in ethanol production is from new dry-mill facilities, it follows that if grain-based ethanol production reaches 15 billion gallons (uncertain given the current downturn in ethanol profitability) there will be significant additional production of DG in the upcoming years. Applying some conversion factors – i.e., 2.8 gallons of ethanol and 18 lbs of DG per bushel of corn, 2204 lbs/metric ton – indicates that 15 billion gallons of ethanol would use 5.3 billion bushels of corn (over 40 percent of the record crop harvested in 2007), and result in the production of over 44 mmt of DG. Domestic use of DG in animal feed rations has increased as supplies have become more reliably available and as producers become familiar with the product. The dairy and beef cattle sectors account for over 80 percent of domestic consumption, and the domestic market still accounts for the bulk of DG use – over 85 percent in 2007. Various studies have estimated potential DG consumption in the U.S. using livestock inventories and assumptions about usage and inclusion rates. Those studies generally estimate maximum usage between 38 and 60 mmt, indicating that, under optimistic assumptions, the domestic market may have the capacity to absorb almost all of the likely increase in DG production. Using less favorable assumptions however, the numbers suggest that export markets will be vital to maintain competitive prices for DG.

Distillers Grain Exports

From 1995 to 2004, DG exports averaged 740,000 mt, ranging from 526,000 mt in 1996 to 842,000 mt in 2002 (figure 1). Exports exceeded 1 mmt for the first time in 2005, and increased by 18% to 1.25 mmt in 2006. In 2007, exports almost doubled to 2.35 mmt, and almost doubled again in 2008 to reach 4.5 mmt, representing over 20 percent of production. Data for the first five months of 2009 suggests that exports are continuing to increase but at a much slower pace. Exports during the first 5 months of 2009 were only 7 percent higher than in the same period in 2008, despite significantly lower bulk shipping rates.

Table 1 contains data on export quantities to the top

Figure 1. US Exports of Distillers Grains, 1995-2009



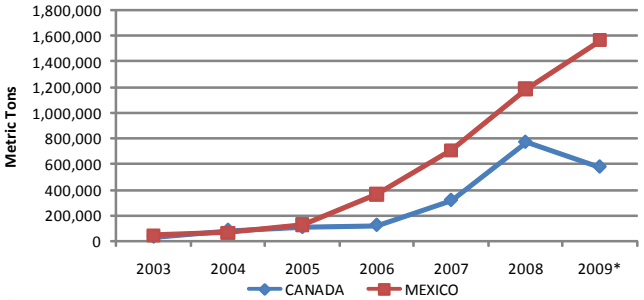
*Projected based on Jan-May
Source: USDA-FAS http://www.fas.usda.gov/ustrade/USTExHS10.asp?QI=

25 export markets during 2008. Mexico has been the top export market for the past three years, accounting for between 25 and 30 percent of exports. Canada and Turkey were the 2nd and 3rd largest markets in 2007 and 2008, followed by several South East Asian countries. The table documents the decline in exports to Ireland and Spain, the only EU member countries on the list.

North America

Mexico and Canada accounted for approximately 43 percent of DG exports in 2007 and in 2008. Exports to both countries grew rapidly in recent years facilitated by the option to ship by rail and the absence of tariffs (figure 2). Exports to Canada tripled between 2005 and 2007, while exports to Mexico increased over five times in the same period. In 2006, Mexico surpassed Ireland to become the largest export market for DG. Exports continued to grow in 2008 increasing by 68 percent to Mexico, and by 143 percent to Canada.

Figure 2. US Exports of DG to Canada and Mexico



*Projected
Source: USDA-FAS http://www.fas.usda.gov/ustrade/USTExHS10.asp?QI=

During the first five month of 2009, exports to Mexico increased by 32 percent over the same period in 2008, projecting total imports of over 1.5 mmt for the year. The continued growth is associated with steady expansion in Mexican livestock and poultry production. Between 2007 and 2009, both the calf crop and broiler production are estimated to increase by more than 4 percent compared to 2007. While production systems are less reliant on compound feeds compared to the U.S., animal inventory numbers suggest a potential market for DG of around 3 mmt (Fox, 2008). Exports to Canada during the first part of 2009 fell by 25% compared to 2008, despite a slight increase in cattle on feed numbers. The reduction is attributed to increased availability of competing feeds including barley and feed wheat.

South East Asia

In 2008, seven South East Asian countries were among the top eleven DG importers, accounting for 25% of U.S. exports, up from 4% in 2004. Taiwan, Japan, South Korea, and Thailand each imported between 180 and 200,000 metric tons in 2008 (figure 3). Exports to these four countries are projected to rise by about 25 percent in 2009, with increased quantities to Japan and Thailand offset by reductions to Korea. Exports to Japan increased by almost 40% in the first five months of 2009, and are on target to exceed 275,000 metric tons for the year. Japan is the number one export market for U.S. corn and has significant potential to increase its DG imports. Fox (2008) estimated the potential DG market at around 2.4 mmt, or over 8 times the projected 2009 level. Japan also imports DG from China and Canada but the U.S. is the dominant supplier with over 90 percent of the market.

Japan is the number one export market for US corn and has significant potential to increase its DG imports. Fox (2008) estimated the potential DG market at around 2.4 mmt, or over 8 times the projected 2009 level.

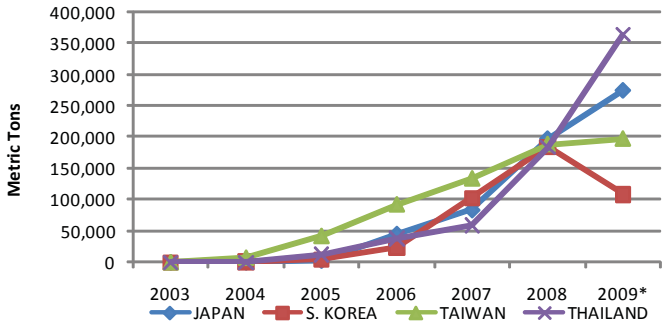
Table 1. Top 25 Export Markets for DG in 2008 (metric tons)

Country/Region	2004	2005	2006	2007	2008
Mexico	66,894	128,271	367,386	708,216	1,188,766
Canada	83,984	105,929	123,022	318,864	771,797
Turkey	0	216	416	136,519	465,212
Japan	0	2,824	45,248	83,586	198,014
Israel	6,366	47,935	17,668	62,315	195,045
Taiwan	7,431	42,249	92,824	134,404	189,451
Korea	625	4,843	24,587	102,529	184,723
Thailand	10	12,802	38,140	59,346	183,611
Indonesia	11,516	46,523	43,764	69,099	118,183
Vietnam	633	19,869	17,979	58,260	117,248
Philippines	958	11,758	62,465	79,153	113,017
Cuba	0	10,043	0	84,646	106,080
Costa Rica	6,600	0	10,432	15,149	93,527
Ireland	185,007	206,222	145,225	75,711	86,926
Morocco	0	5,499	27,858	46,246	80,936
Chile	0	3,607	3,011	37,488	78,866
Malaysia	12,475	34,410	29,970	39,576	57,659
Colombia	3,849	2,565	4,945	12,440	44,188
Egypt	0	0	0	0	42,901
Guatemala	3,998	0	4,970	3,500	39,609
Honduras	8,024	5,039	7,141	5,433	28,537
El Salvador	129	0	2,451	2,143	26,185
Spain	77,176	110,052	23,458	65,497	25,467
Panama	1,184	0	2,648	5,247	24,527
Jamaica	1,490	774	1,199	9,078	11,742
Rest of World	309,357	267,781	156,846	143,803	38,166
TOTAL	787,706	1,069,211	1,253,653	2,358,248	4,510,383

Source: USDA-FAS (http://www.fas.usda.gov/ustrade/USTExHS10.asp?QI=)

The beef sector in Korea has expanded in recent years, partly a consequence of restrictions on imports following the discovery of mad cow disease in the U.S. in 2003. From 2003 to 2009, beef cow inventories grew by over 65 percent from 532,000 to 882,000. Slower exports to Korea in early 2009 are attributed in part to credit constraints following the maxing out of U.S. export credit guarantees. With livestock inventories around two thirds those of Japan, and corn imports approximately half as large, the maximum potential market for DG in Korea is estimated at around 1.6 mmt. In Taiwan, while the hog sector is comparable in size to that of Korea or Japan, the dairy and beef cattle sectors

Figure 3. US Exports of DG to Japan, Korea, Taiwan and Thailand



*Projected
Source: USDA-FAS http://www.fas.usda.gov/ustrade/USTExHS10.asp?QI=

are much smaller. Total cow inventory as of January 2008 was estimated at about 150,000 hd., compared to about 1 million in Korea and 1.5 million in Japan. Thus the market potential for DG in Taiwan is more limited. Exports to Thailand more than tripled between 2007 and 2008, and are on track to double between 2008 and 2009 to over 350,000 metric tons. At that level Thailand could become the third largest market for U.S. distillers grains behind Mexico and Canada. The rapid increase in exports to markets such as Thailand is due in part to education and marketing efforts by the U.S. Grains Council which conducts seminars, feeding trials and training programs for feed mills on the use of DG's in several countries, and also to lower bulk shipping rates.

The other major export markets in South East Asia are Indonesia, Vietnam and the Philippines. Their combined DG imports totaled around 350,000 metric tons in 2008, spread equally among the three. Exports are projected to increase for all three in 2009 – by 35 percent in Vietnam, 70 percent in the Philippines, and by 110 percent in Indonesia.

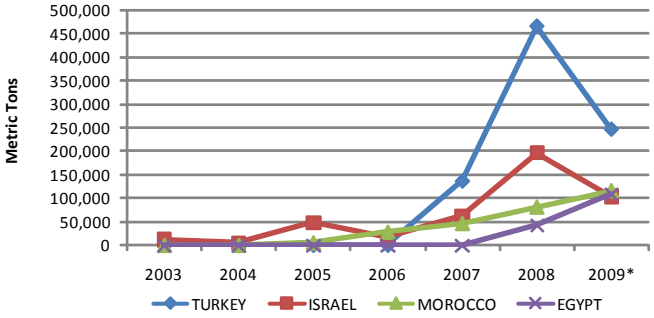
Until recently most DG moved to Pacific Rim markets by container shipment, taking advantage of back-shipments of otherwise of empty containers. Container shipment presents some logistical problems because in Japan, for example, most container traffic goes to major ports that do not routinely handle animal feed. However, following a dramatic collapse in dry bulk shipping rates in the latter half of 2008 from what had been record high levels in May, bulk shipments of DG have been increasing. Cheaper bulk shipping rates compared to early 2008 are contributing to the growth in exports and should facilitate continued growth in Asian markets.

Middle East

Turkey emerged in 2007 as a major market for DG exports taking 136,000 metric tons, up from only 400 tons the previous year (figure 4). Quantities more than tripled in 2008 to 465,000 mt, ranking Turkey as the 3rd largest export market. Similarly, Israel tripled its imports between 2006 and 2007, and again between 2007 and 2008 to reach 195,000 mt. Exports to both countries have been lower in the first part of 2009 due to a larger than expected corn crop in Turkey and increased imports of cheap feed wheat by Israel from the Black Sea region.

Following promotions by the U.S. Grains Council, a

Figure 4. US Exports of DG to Turkey, Israel, Morocco and Egypt



*Projected
Source: USDA-FAS http://www.fas.usda.gov/ustrade/USTExHS10.asp?QI=

When new labeling and traceability requirements for animal feed were introduced in 2004, DG exports to the EU declined. Between 2005 and 2008, shipments fell from over 560,000 mt to about 260,000 mt, and from 72 percent of total exports to only 2 percent.

number of other Middle Eastern countries have begun to import DG. Exports to Morocco began in 2005 on a limited scale and have grown steadily, while Egypt began to import DG in 2007. Both are on track to import around 100,000 mt in 2009. A number of other Middle Eastern countries imported limited quantities, some for feeding trials, during 2008, including Syria, Tunisia, Libya and Oman.

European Union

During the 1990's the EU was the dominant export market for both DG and corn gluten, another by-product of corn milling. Each year between 1995 and 2000, more than 90 percent of U.S. exports of DG went to EU countries, as did over 80 percent of corn gluten exports. Following the introduction of labeling requirements for genetically modified plants, and a 1998 moratorium on approval of new GM crop varieties, the EU effectively ended its imports of US corn. But because the labeling requirements did not initially apply to by-products, the EU continued, until 2005, as the largest market for DG and corn gluten. Within Europe, the largest market was Ireland, which, between 1995 and 2005, was consistently the largest individual export market for DG, taking in some years, as much as 35 percent of U.S. exports. Irish agriculture is dominated by grass-based beef and dairy production, but those sectors rely heavily on imported grain for feed supplementation during winter months. Other important EU markets were the UK, Spain, and Portugal.

When new labeling and traceability requirements for animal feed were introduced in 2004, DG exports to the EU declined. Between 2005 and 2008, shipments fell from over 560,000 mt to about 260,000 mt, and from 72 percent of total exports to only 2 percent. The primary reason for the loss of this market is the fact that, due to the length and complexity of the EU approval process, many of the GM corn varieties grown in North America have not yet been approved by the EU. Furthermore, the fact that the U.S. grain systems does not facilitate effective segregation of varieties, coupled with the EU's zero tolerance for non-approved GMs creates a risk that shipments may be returned if any trace of non approved GM material is found. This risk creates a significant disincentive for trade. Additionally, under what are termed "safeguard clauses," individual EU countries have the ability to continue to ban GM varieties that may have been approved by the EU commission.

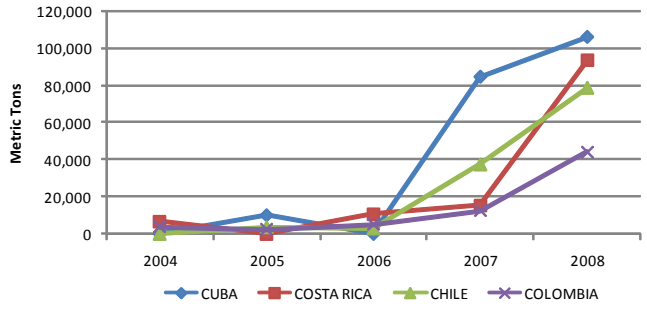
Some European countries, notably, Ireland and Spain, continue to import limited quantities of DG from the US, with pre-load testing used to verify that shipments contain only EU approved varieties. Shimpments are subject to additional testing on arrival in Europe. But because new GM corn varieties continue to be developed and adopted in the US, it appears unlikely that the EU will be a significant market for DG in the immediate future.

Central and South America

Central and South America countries have been importing DG from the U.S. since 2000 when Columbia imported 40,000 mt, with smaller quantities going to Guatemala, Honduras, Jamaica and Venezuela in the same year. Since then, DG have also been exported in varying quantities and at varying times to Belize, Chile, Costa Rica, Cuba, Dominican Republic, El Salvador, Nicaragua, and Panama. From 2006 to 2008, exports to the region increased from 36,000 mt to 467,000 mt, with the bulk of the increase attributable to purchases by Cuba's state trading entity, Alimport, which imported over 100,000 mt in 2008. Chile and Columbia are the main markets for DG in South America, importing a combined 120,000 mt in 2008, while exports to Costa Rica in 2008 approached 100,000 mt.

Argentina and Brazil, South America's largest livestock producers, are net exporters of both feed grains and thus unlikely to import DG. Using livestock inventory

Figure 5. US Exports of DG to Cuba, Costa Rica, Chile and Columbia



Source: USDA-FAS http://www.fas.usda.gov/ustrade/USTExHS10.asp?QI=

numbers, and excluding Brazil and Argentina, Paulson (2008) estimated the potential DG market in South America at around 1.5 mmt, and in Central America/ Caribbean at around 3.0 mmt.

Outlook for DG Exports

Early indications are that the rapid growth in export markets seen in 2007 and 2008 will not be sustained in 2009, as exports for the first five months of the year were only 7 percent higher than in 2008. As new markets are developed the distribution of DG exports has become more diverse. While the top three markets continue to account for more than half of exports, the share for the top three is down from 69 percent in 2003 to 54 percent in 2008. Similarly, in 2003 seven countries accounted for over 90 percent of exports, while in 2008 it took fifteen countries to account for the same total share. Growing diversity in the market is also evidenced by the increasing number of countries importing DG. In 2008, the U.S. exported DG to a total of 46 countries, twice as many as in 2003. Fifteen percent of total exports in 2008 went to countries that imported either no DG or only limited trial quantities (less than 500 mt) in 2006.

In economics, Say's law refers to the idea that income generated from the production of one good provides the means to purchase other goods. It is often summarized in the phrase "supply creates its own demand." In a different, and more direct, sense the same idea applies to distillers grains given that production of 1lb of DG is a consequence of removing approximately 3 lbs of corn from the market. Thus, if permissible DG inclusion rates in animal feed are sufficiently high, there will be a ready-made demand for that 1lb of DG. With recommended inclusion rates as high as 30 to 40 percent for beef cattle, and up to 25 percent for dairy cattle, that demand will exist, and so it follows that as long as sellers of DG have access to the same markets as sellers of corn there should be no more concern about oversupply of DG than about oversupply of corn. The correlation between corn and DG prices documented by Schroeder (2009) suggests that DGs are indeed being used to replace corn in livestock rations. It follows that the most likely potential export markets for DG will be in countries that import U.S. corn. The pattern of exports for DG appears to bear this out, and in 2008 for example, five of the top seven export markets for DG were also in the top seven export markets for corn. Those five countries – Mexico, Canada, Japan, Taiwan, and Korea – accounted for 56 percent of DG exports and 71 percent of corn exports. But because distillers grains have much higher protein content than corn (approx 30 percent versus 10 percent), DG can also be used as a substitute for soybean meal (44 percent protein) in certain situations. Given this potential use as a protein source, the distribution of DG exports may also correlate with exports of soybean meal and so should not be expected to exactly reflect those of corn. Figures 6a and 6b show the distribution of DG exports to different countries/regions and the distribution of (equally weighted) average corn and soybean meal exports to the same markets. With some exceptions (more DG to Mexico and Other South East Asia) the pattern of exports in the two figures are broadly similar. As export markets for DG mature we would expect exports to continue to be correlated with both corn and soybean meal exports.

While the top three markets continue to account for more than half of exports, the share for the top three is down from 69 percent in 2008 to 54 percent in 2008. Similarly, in 2003 seven countries accounted for over 90 percent of exports, while in 2008 it took fifteen countries to account for the same total share.

Figure 6a. Distribution of DG Exports, 2008

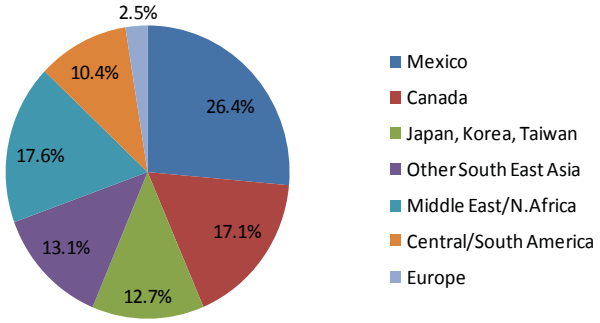
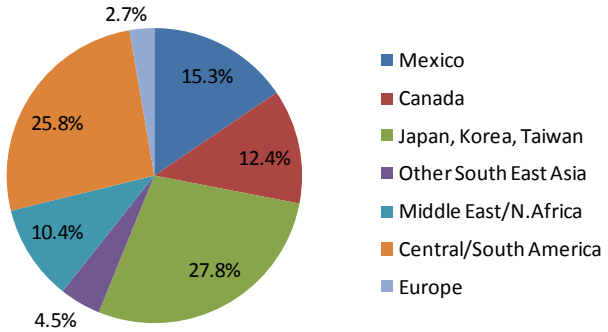


Figure 6b. Average Distribution of Corn & Soybean Meal Exports, 2008



For More Information

Fox, John. A. "The Value of Distiller's Dry Grains in Large International Markets," and Paulson, Nicholas D. "International Demand for U.S. Distillers Dried Grains with Solubles in Small Markets." Chapters 6 and 7 in Using Distillers Grains in the U.S. and International Livestock and Poultry Industries, edited by B.A. Babcock, D.J. Hayes, and J.D. Lawrence. Midwest Agribusiness Trade Research and Information Center (MATRIC) Iowa State University. November 2008. Available at http://www.matric.iastate.edu/DGbook

Schroeder, Ted C. "Distillers Grain Prices: Spatial Relationships, Arbitrage Opportunities & Risk Management." North American Institute for Beef Economic Research. May 2009.

Distillers Grain Prices: Spatial Relationships, Arbitrage Opportunities & Risk Management

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May 2009

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The author gratefully acknowledges funding provided by the Agricultural Marketing Service-USDA Cooperative Agreement 12-25-G-0668 through AMS' Federal-State Marketing Imrovement Program (FSMIP). The views expressed here are the author's and should not be attributed to AMS or USDA.

Executive Summary

Distillers grain (DG) production in the US has increased from less than 5 million metric tons at the start of the decade to more than 20 million metric tons in 2008. This rapidly expanding market has increased the need to better understand price relationships, determine how price discovery occurs, and to assess price risk management alternatives. This fact sheet was completed to address these specific issues. Results reveal:

1. Price and related fundamental information on distillers grain markets are sparse relative to feed grains. As such, evaluating price offers and bids is often done without a lot of market information which can contribute to variation across transaction prices.

2. Dry (10% moisture), modified wet (50-55% moisture), and wet (65-70% moisture) distillers grain prices vary relative to each other. For example, dry DG in Nebraska has been priced at from a $10/ton dry matter discount to a $30/ton dry matter premium to wet DG over the past 18 months. Similar price differences are seen in other locations. The different moisture DG product markets are segmented. Significant value exists to compare dry, modified wet, and wet prices on a dry-matter basis for buyers who can substitute across these product forms.

3. Spatially separated dry DG markets do not have strong price relationships. Prices tend to follow similar patterns across location, but they diverge from each other at times as well. Analysis of prices across different markets suggests buyers could gain by shopping around for DG across different locations at any point in time. The DG market appears to have limited geographic price information flowing.

4. Dried distillers grain does not appear to be able to be effectively cross hedged using traditional corn or soybean meal futures markets. Basis and hedge ratio relationship risk has often been more than 30% of the underlying price of DG. As such, currently available futures markets do not appear to offer viable price risk transfer for distillers grain. Development of a DG futures contract appears worth investigating.

Background and Purpose

Distillers grains (DG) are a co-product of grain-based ethanol production. DG production in the US has increased from around 3 million metric tons in 2001 to more than 20 million metric tons in 2008 paralleling the rapid expansion of the ethanol industry. As distillers grain production has increased, DG has become a valuable output of the ethanol industry and an important feed ingredient replacing primarily corn in the livestock industry. Tight margins in ethanol production have elevated the importance of DG in ethanol producer profitability. As such, DG producers are highly interested in distillers grain markets and associated prices. With growing use of DG in the livestock industry, DG buyers have greater need for understanding market conditions and prices. Despite its growing importance, little public information is available regarding DG market fundamentals, making market outlook challenging. In addition, sparse DG price reporting makes monitoring market prices both spatially and temporally difficult. Furthermore, recent volatility of agricultural and energy markets has been reflected in highly variable DG markets.

DG production in the US has increased from around 3 million metric tons in 2001 to more than 20 million metric tons in 2008 paralleling the rapid expansion of the ethanol industry. As distillers grain production has increased, DG has become a valuable output of the ethanol industry and an important feed ingredient replacing primarily corn in the livestock industry.

The purpose of this fact sheet is to summarize distillers grain market price relationships. In particular, price relationships across DG markets are analyzed over time, prices of wet and dry DG are compared, and assessment is made of how well existing futures markets for corn and soybean meal appear to work as a cross hedge for distillers grains. The information contained in this fact sheet is intended for anyone involved in DG markets.

Distillers Grain Price Sources

The Renewable Fuels Association as of March 2009 lists 193 nameplate refineries in the US producing ethanol. These refineries are located in some 27 states across the nation, with the highest concentration of production located in the corn-belt states of Iowa, Nebraska, Illinois, Minnesota, Wisconsin, and South Dakota. Despite the large number of plants and dispersion of production, only a sparse amount of DG price information is publicly reported. Currently, USDA reports daily distillers grain prices for several moisture levels (dry 10%, modified wet 50-55%, and wet 65-70%) for Iowa, Illinois, Nebraska, and South Dakota. Over the last two years, these price series are generally available, though Nebraska prices are only available since late 2007 and similar problems of non-reported prices are apparent across other locations. In addition, USDA has begun price reporting of weekly prices for dry DG in Chicago; Lawrenceburg, Indiana; Kansas; and Northern Missouri. However, aside from Chicago, these price series generally only go back in time with consistent reports to about early 2008 with numerous non reports prior to that time.

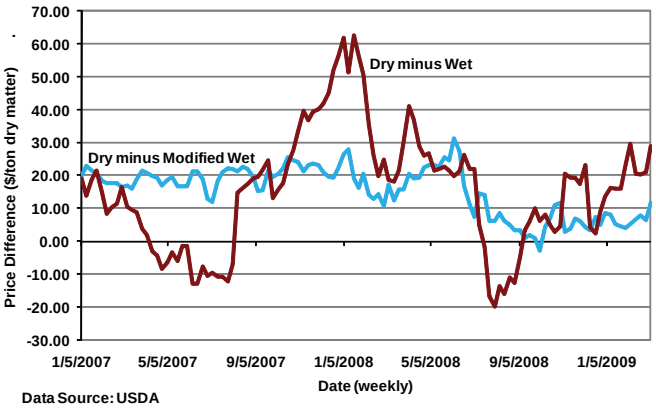
A few local or private sources report DG prices on a weekly basis. For example, University of Missouri Dairy Extension collects prices from selected DG plant locations via weekly telephone surveys and reports these on their web site. Feedstuffs magazine has reported weekly dry DG prices from brokers with several locations primarily in markets quite distant from the core ethanol production areas (e.g. east and west coast market locations). DTN reports weekly DG prices they collect on their private news service for selected locations. With a variety of sources, different collection and reporting methods and price availability, and generally limited time series of data available, analysis of DG prices is a challenge. Certainly DG price information is considerably less readily available than prices for major feed grains.

Dry, Modified Wet & Wet DG Prices

Distillers grains are generally produced in one of three different forms: 1) dry which is 10% moisture, 2) modified dry at 50-55% moisture, and 3) wet at 65-70% moisture. If the dry, modified wet, and wet distillers grain markets are closely linked with each other and efficient, the difference in prices on a dry-matter basis across these product forms, would essentially equal the cost of drying DG. That is, if dry price is greater than modified wet or wet price by more than the cost to dry DG, this would encourage more drying which would tend to reduce the dry price and increase the wet prices bringing the prices back in line with each other. If the dry price is less than the drying costs for modified wet or wet product, firms would reduce the amount of drying they do which would increase the dry and reduce the wet DG prices to realign the market prices. Because drying DG includes added fixed costs (in addition to variable drying costs), we might expect dry DG to be more likely priced at a premium relative to wet, on a dry matter basis, even after adjusting for energy costs to dry. We would certainly not expect to see moisture-adjusted dry DG price to be below wet price in well-integrated markets.

Over the past couple of years USDA has reported dry, modified wet, and wet distillers grain prices for selected locations. Converted to a 100% dry-matter basis, these price series, for the same market locations have shown considerable variation. For example, dry DG prices in Northeast Iowa have ranged from about the same as modified wet DG prices to more than $30/ton dry-matter basis higher over the 2007-March 2009 period (figure 1). Dry relative to wet DG prices have seen

Figure 1. Dry Matter Adjusted Differences in NE Iowa Dry, Modified Wet, and Wet Weekly Average DG Prices, 2007-March 2009



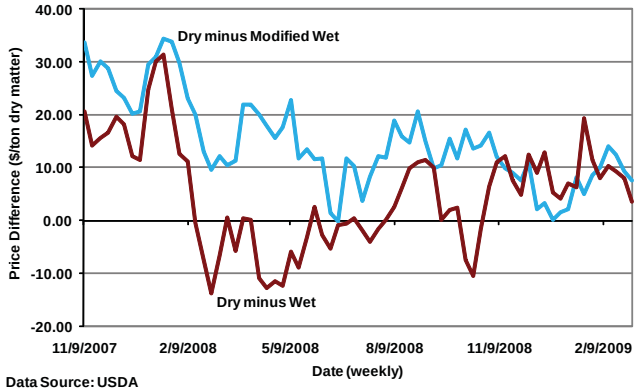
Data Source: USDA

even much greater variation with dry ranging from $20/ton dry-matter basis lower than wet, to about $60/ton dry-matter basis greater than wet DG.

Nebraska prices of dry, modified wet, and wet DG have also exhibited wide variation relative to each other on a dry-matter basis over the past year (figure 2). For example, relative to modified wet, dry DG has ranged from about the same price to more than a $30/ton dry-matter basis price premium. Dry DG has ranged from a $10/ton dry-matter discount to a $30/ton dry-matter premium to wet product in Nebraska. Other locations show similar variation as Iowa and Nebraska in dry, modified dry, and wet DG prices.

The implication of the amount of variation is prices across DG product moisture levels for the same general market location suggests the markets for dry, modified wet, and wet are somewhat segmented. Drying costs undoubtedly changed over the 2007-2009 period as energy prices rapidly increased in 2008 and then substantially declined into early 2009. However, the DG price differences observed are not highly correlated with energy price patterns over time suggesting other forces are contributing to price divergence among dry, modified wet, and wet distillers grain prices. The fact that moisture-adjusted dry DG prices even drop below modified wet or wet at times reveals that across DG product moisture level in the same location these markets are not strongly linked or well integrated. Buyers can gain by comparing dry, modified wet, and wet prices (on a moisture-adjusted level) if these are feasible substitutes. Similarly, ethanol plants appear at times to be losing money when they dry DG and they could gain by closer evaluation of market opportunities for producing alternative product forms.

Figure 2. Dry Matter Adjusted Differences in Dry, Modified Wet, and Wet Weekly Average DG Prices in Nebraska, November 2007 - March 2009



Data Source: USDA

Long Term Spatial DG Price Relationships

Over time, prices for a commodity in a market that is well integrated across location should differ by no more than transportation costs between the markets. Flow of market information should help to ensure markets are spatially linked and that they quickly respond to each other. The concept of integrated markets is best carried out using time series data over several years. This is because, for a variety of reasons, during short time periods market prices at different locations can diverge from other. For example, information flow across market locations is not perfect or instantaneous and it takes time to physically move product across locations as well as secure buyers. Thus, while market prices might diverge from each other for a short period of time, well integrated markets will come back in line with each other after an adjustment time. There are a host of ways to analyze the extent to which commodity markets across location operate in linked markets. One of the more widely used methods is to statistically evaluate the degree of integration in market prices across locations over time. This concept is used here to assess the degree of long term market price relationships across spatially separated DG prices.

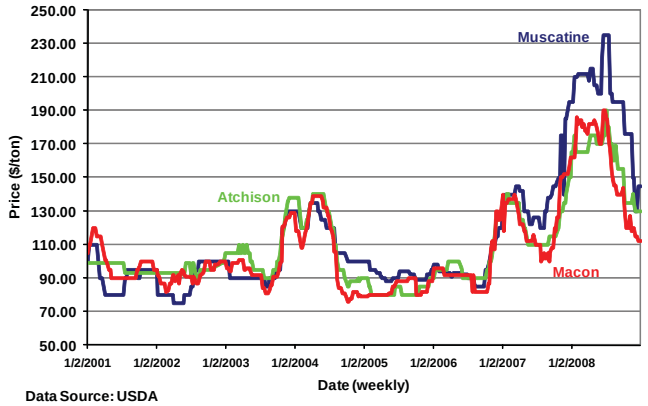
Because the concept we are testing is long run in nature, long run time series (several years) of weekly market prices for DG were needed across locations. This is challenging because with the recent expansion of the ethanol industry and its relatively small presence just a few years ago, locating consistent time series data for a variety of DG markets is difficult. We were able to collect from several sources an eight-year weekly time series of DG prices for 12 different market locations. The price series were collected from USDA, University of Missouri Dairy Extension, and Feedstuffs magazine. All DG prices evaluated in these long term series are for dry product form. The market locations for which consistent weekly time series DG price data were available over the eight-year period

were 1) Muscatine, IA; 2) Atchison, KS; 3) Macon, MO; 4) Lawrenceburg, IN; 5) Atlanta, GA;, 6) Boston, MA; 7) Buffalo, NY; 8) Chicago, IL; 9) Los Angeles, CA; 10) Minneapolis, MN; 11) Portland, OR; and 12) Okeechobee, FL. Some of these market locations represent the heart of major DG production centers in Iowa, Indiana, Illinois, Missouri, and Minnesota. Other market locations are export market centers such as Portland and Los Angeles.

An illustration of selected locations of weekly DG prices over the 2001-2008 period is provided in figure 3. The price series tend to follow similar overall trends. However, as is apparent at times, the prices across these locations diverge from each other. For example, Muscatine, IA price was lower than Atchison, KS and Macon, MO by about $20/ton in 2001 and was nearly $40/ton higher than the other two markets during several weeks in 2008. Macon and Atchison prices tend to track each other more closely over the time period, though even they have prices that diverge by more than 10% at times. Another graphic summary of weekly DG prices is provided in figure 4 for Chicago, IL, Portland, OR, and Atlanta, GA prices. Chicago price, much like the other prices near ethanol production regions, tends to be lower than DG prices at port locations. Despite the price level differences, the prices across these locations tend to follow similar patterns.

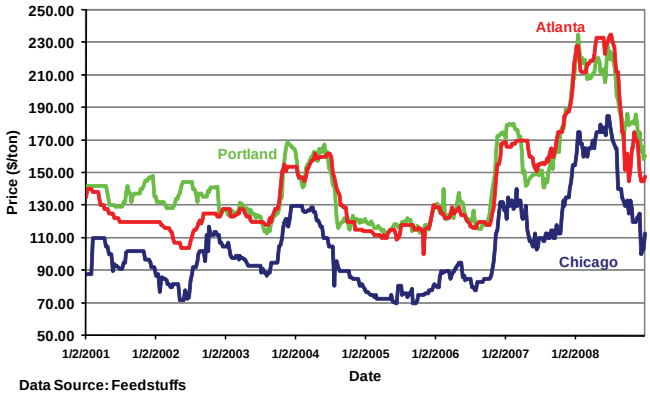
To determine statistically whether the set of 12 markets are linked, as set of pair-wise cointegration tests were conducted on each pair of combinations of the 12 price

Figure 3. Weekly Dry DG Prices, Muscatine, IA; Atchison, KS; and Macon, MO, 2001-2008



Data Source: USDA

Figure 4. Weekly Average Dry DG Prices, Atlanta, GA, Chicago, IL, and Porland, OR, 2001-2008



Data Source: Feedstuffs

series. In addition, a multivariate cointergration test using all the 12 markets at once was conducted. Pair-wise cointegration tests provide evidence of the extent to which two markets move together. If two markets are linked, they will be cointegrated which means the price series do not diverge from each other and tend to return to a stable relationship relative to each other. If two markets are not cointegrated, they diverge from each other and do not necessarily systematically return to a stable relationship.

The cointegration test results revealed relatively limited cointegration among the 12 spatially separated DG markets. In total of the 66 pair-wise comparisons, only 26 (39%) were cointegrated. Some markets were not cointegrated with any other markets. In particular, Chicago, Muscatine, and Okeechobee markets were not cointegrated with any of the remaining DG markets over the 2001-2008 period. This suggests that these markets are not closely linked with markets in the other locations and that

Information flow across market locations is not perfect or instantaneous and it takes time to physically move product across locations as well as secure buyers. Thus, while market prices might diverge from each other for a short period of time, well integrated markets will come back in line with each other after an adjustment time.

prices for DG in these markets are likely discovered somewhat independent of the other locations. Macon, Minneapolis, Lawrenceburg, Boston, Buffalo, and Portland were conitegrated with at least half of the 12 markets. This suggests that these markets tend to be more closely linked with DG markets in other locations. The generally low levels of cointegration across DG markets reveals the need for buyers and sellers to monitor prices at different locations because no one price point tends to be a strong indicator of DG price at other locations. In other words, there is not a single representative national price for DG as price variation across location over time is notable.

DG Price Risk Management

Given the variability over time in DG prices, of interest is ways to reduce price risk. In particular, one way to potentially reduce price risk is through hedging. No DG futures contract currently exists, so one possibility to it cross hedge distillers grains However, to cross hedge effectively, requires first determining whether existing futures markets are viable cross hedging instruments for DG. Given the nature of the DG product and its uses, the most probable markets to consider for cross hedging are corn or soybean meal futures.

First consider corn futures as a potential cross hedge. Figure 5 shows the weekly Macon, MO, dry distillers grain price and the nearby contract corn future price over the 2001-2008 period. The two prices follow similar long run patterns, however, considerable divergence is also apparent.

One particularly interesting pattern in DG and corn futures are revealed in figure 6 where the ratio of DG ($/ton) to corn futures ($/bu) is illustrated. From 2001 to 2008, the ratio of DG price to corn price varies substantially from more than 55 to less than 25. Furthermore, there is a distinct trend over time where DG price relative to corn was much greater prior to 2006 than it has been since that time. Prior to 2006, DG ($/ton) price was generally at least 35 times the corn ($/bu) price. However, since 2006, the ratio is more in the 25-30 range. Nonetheless, even during

Figure 5. Weekly Macon, MO DG and Nearby Corn Futures Prices, 2001-2008

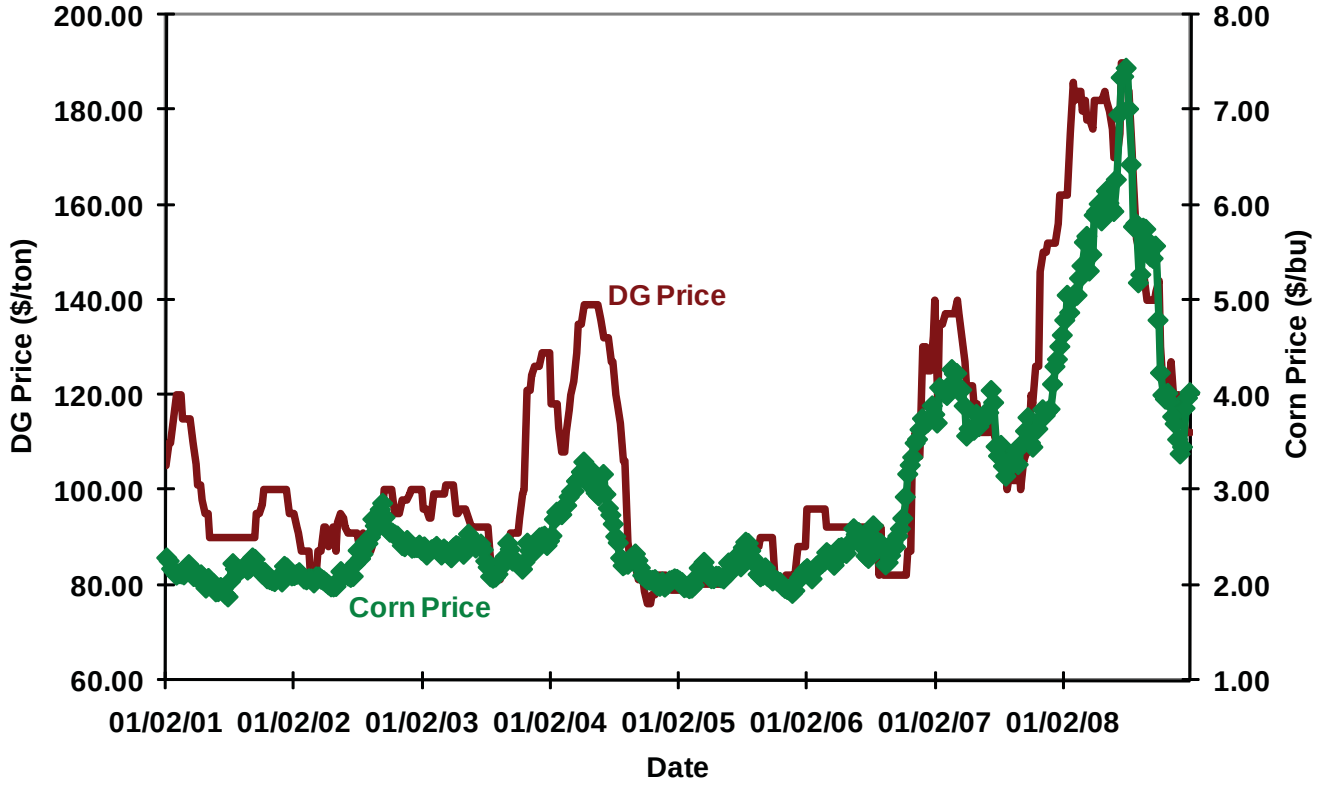


Figure 6. Ratio of Weekly Macon, MO DG and Nearby Corn Futures Prices, 2001-2008

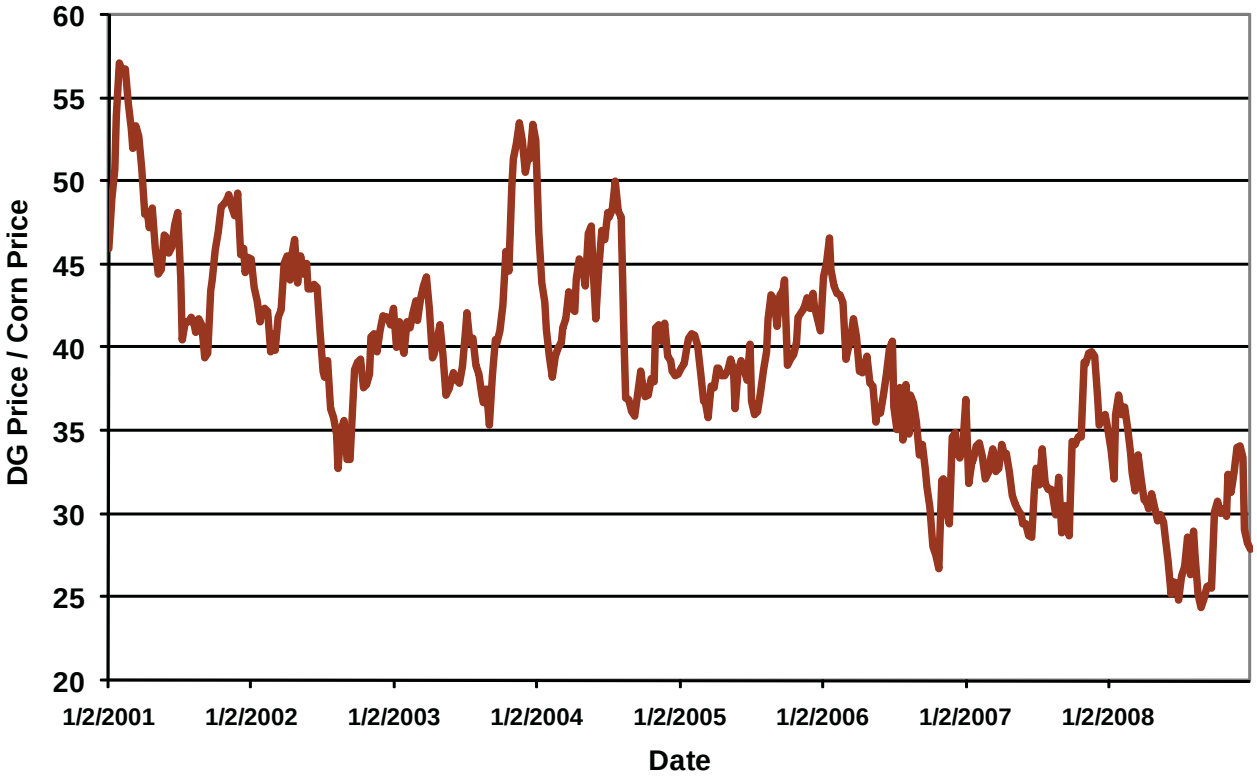
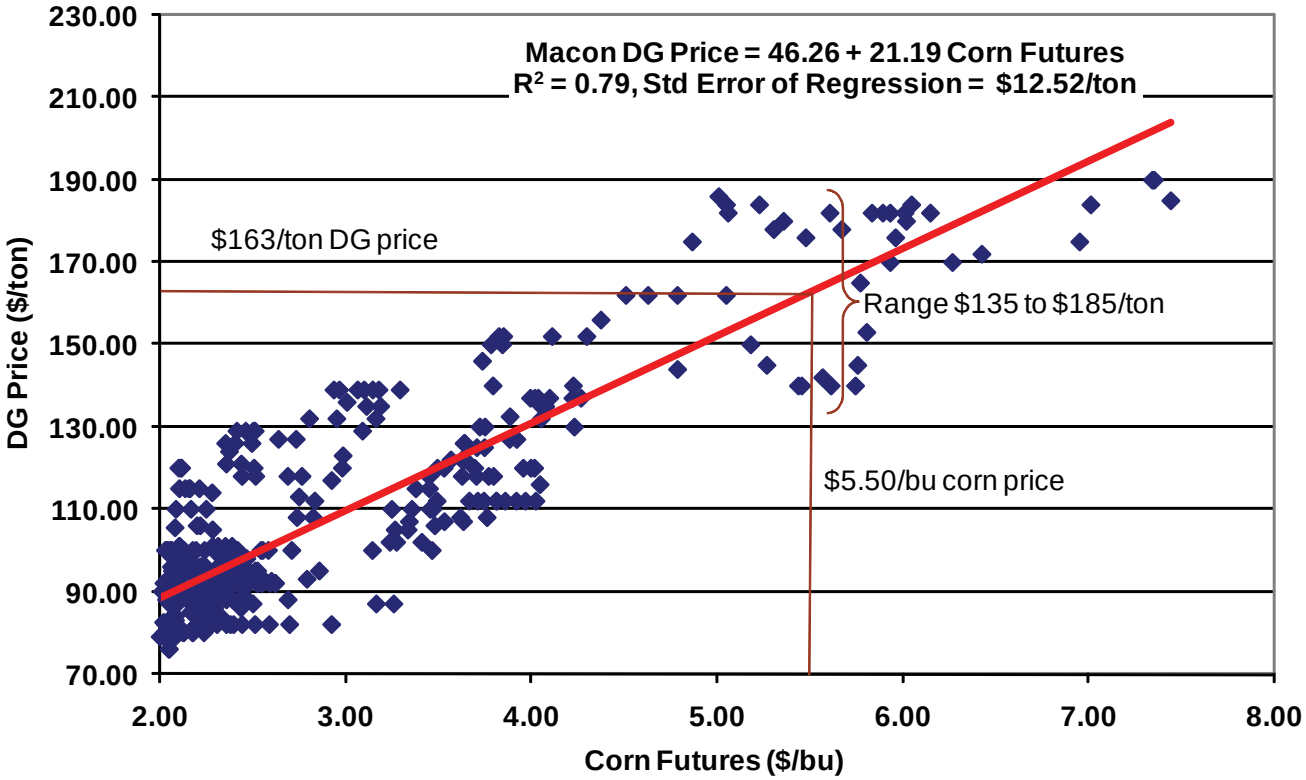


Figure 7. Scatter Plot of Weekly DG Prices, Macon, MO and Nearby Corn Futures, 2001-2008



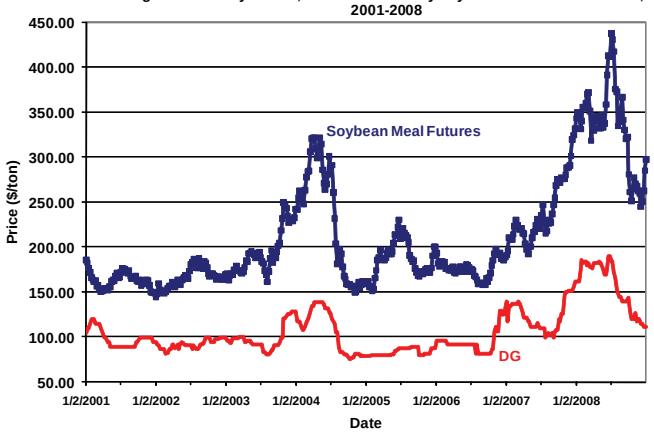
2008, the ratio ranged from less than 25 to more than 35.

Another way to observe cross hedging potential of DG in corn futures is to observe an x-y scatter plot of the two price series. Figure 7 shows the scatter plot between weekly Macon, MO DG and nearby corn futures prices over the 2001-2008 period. In addition, a regression model fit of regressing DG as a function of corn futures is summarized in the graph. The strong positive correlation between DG and corn prices is evident with an R-squared of 0.79. However, also apparent is the risk associated with cross hedging DG in corn futures. The diamonds scattered around the regression trend line in figure 7 are actual weekly DG and corn price pairings over time. As can be seen, if for example one used the regression equation to cross hedge DG using a hedge ratio of 21.19 with a $5.50 corn price, the expected DG price being hedged would be 46.26 + 21.19($5.50/bu) = $163/ton. However, the historical range of DG prices with an approximate $5.50/bu corn price are from around $135/ton to $185/ton indicating the cross hedging relationship has considerable uncertainty in realized DG price.

The strong positive correlation between DG and corn prices is evident with an R-squared of 0.79. However, also apparent is the risk associated with cross hedging DG in corn futures.

An alternative for cross hedging DG in corn futures is to use soybean meal futures instead. Because distillers grains tend to have higher protein levels than corn, DG may be considered a better substitute for soybean meal than corn in certain uses. The weekly prices of Macon, MO DG and nearby contract soybean futures over the 2001-2008 time period are provided in figure 8. The general price patterns between DG and soybean meal futures are similar over time. However, more detailed comparisons and analysis are needed to evaluate potential for cross hedging.

Figure 8. Weekly Macon, MO DG and Nearby Soybean Meal Futures Prices, 2001-2008



The ratio of Macon, MO weekly DG ($/ton) to nearby soybean meal futures ($/ton) over 2001-2008 is presented in figure 9. The ratio of the DG to soybean meal futures shows wide variation ranging from under 0.40 to more than 0.75. Much of the time the ratio is in the 0.40 to 0.55 range. However, in 2001 and again in 2007, the ratio exceeded 0.70 during some weeks. There is not the same pronounced downward trend in DG relative to soybean meal futures as was apparent with the DG relative to corn futures price though, a gradual downward trend is present.

As with the DG and corn cross hedging analysis, we can also assess cross hedging risk with soybean meal futures using an x-y scatter plot of the DG and soybean meal prices. The weekly Macon, MO dry DG and nearby contract soybean meal futures prices over the 2001-2008 period are plotted in a scatter diagram in figure 10. The strong correlation between DG and soybean meal futures prices is evident with an R-squared of 0.77 regressing DG price on Soybean meal futures. The regression line indicates that DG price = 26.82 + 0.38 Soybean meal futures is the predicted price associated with hedging DG using the 0.38 hedge ratio. However, as shown in the scatter plot, with a $350/ton soybean futures price, the historical price range on DG has been from about $140/ton to $185/ton indicating there remains quite a bit of price risk (basis and hedge ratio variation) if DG were cross hedged using soybean meal futures.

Figure 9. Ratio of Weekly Macon, MO DG and Nearby Soybean Meal Futures Prices, 2001-2008

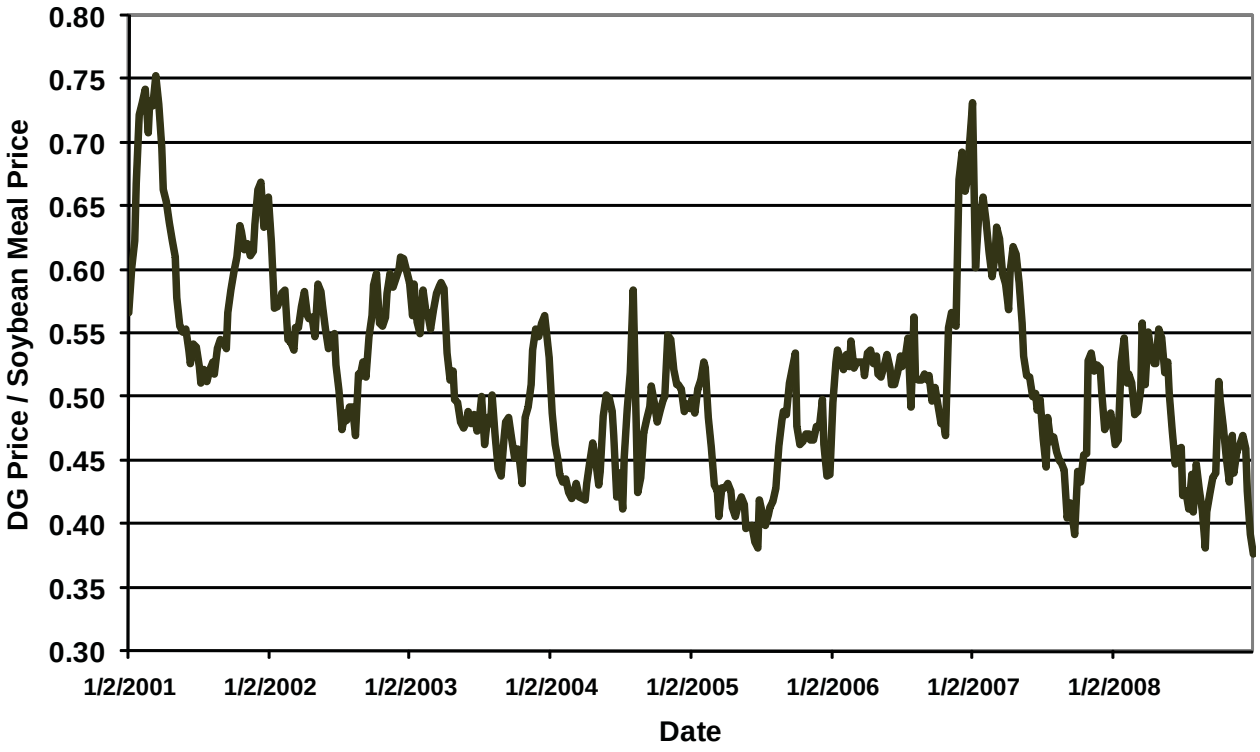
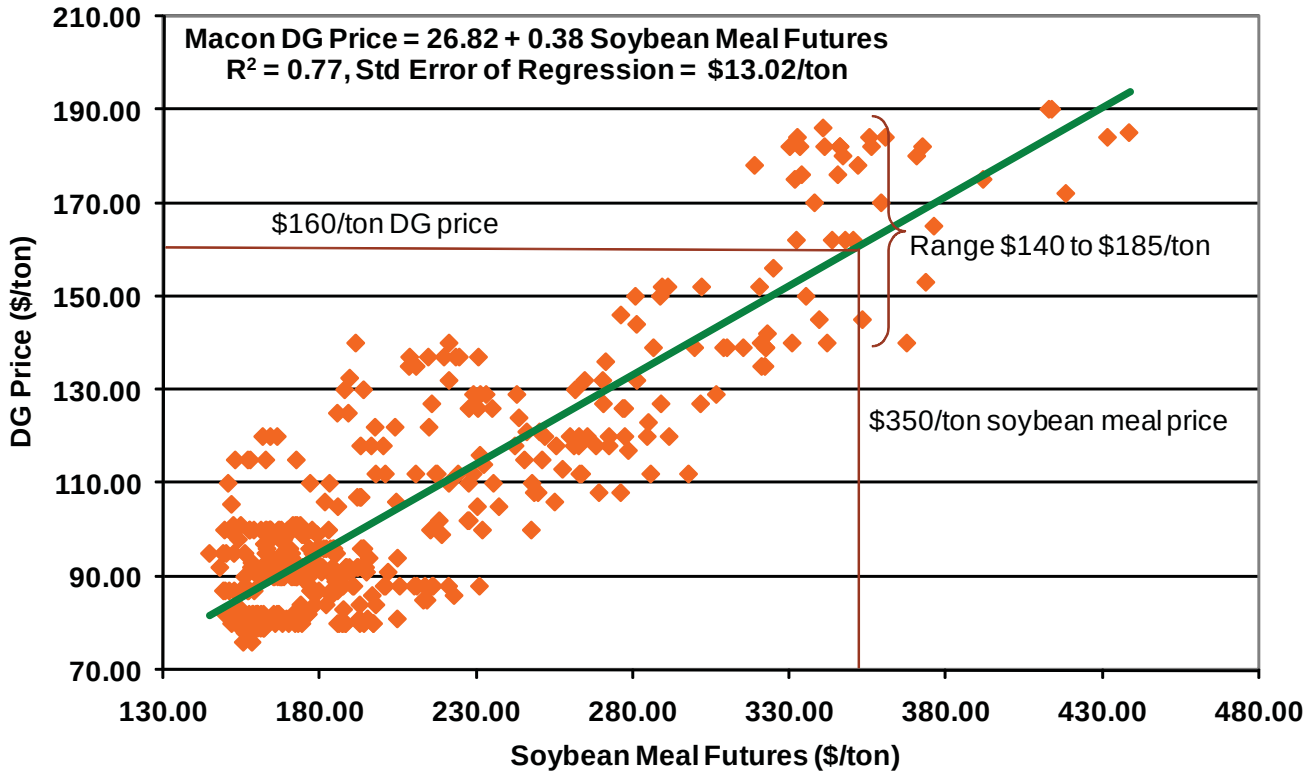



Figure 10. Scatter Plot of Weekly Macon, MO DG Prices and Nearby Soybean Meal Futures, 2001-2008