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Update on Local Processing in Iowa: Ethanol and Soybean Processing

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Introduction
Local processing of corn and soybeans in Iowa continues to expand production of food, feed, and fuel products. Opportunities for farmers to sell crops locally to processing plants as well as grain handling facilities are expanding. Iowa farmers are expected to produce in 2007 2,511,000 bu of corn and 443,000 bu of soybeans. With the rapid expansion of biofuels production, Iowa has become the national leader in both ethanol and biodiesel production. These two products alone offer markets for 43% of Iowa's corn production and the oil from 42% of Iowa's soybeans. Biodiesel differs from ethanol in that biodiesel uses one of two primary soybean crush products rather than raw grain.

Ethanol production
A report entitled “Sourcing Corn for Ethanol: Impact of Local Processing” was released in November 2006 by the Iowa Grain Quality Initiative (www.iowagrain.org) summarizing the results of interviews with managers representing 20 of Iowa's ethanol plants. Since then, new plants have begun production and several others have entered the planning or construction phase. Following is an update of Iowa ethanol production and corn usage data for 2007.

Nationally, there are 131 ethanol refineries operating in 26 states and capable of producing 13.4 billion gallons of ethanol per year. In 2007, Iowa has a production capability of nearly 2 billion gallons per year from 24 dry-grind plants and 4 of Iowa's wet-milling plants. If all plants were running at full capacity, this level of Iowa ethanol production would require 714 million bushels of corn. In addition, 21 facilities are in the construction or expansion phase which will add another 1.7 billion gallons of Iowa ethanol production by early 2009. Nationally, 73 new facilities and 10 expansions are under way. At this time, twenty-seven dry-grind plants are in the planning phase in Iowa.
Table 1. Ethanol production capability and corn usage - 2007

<table>
<thead>
<tr>
<th>Summary Statistics</th>
<th>n</th>
<th>Ethanol Produced mil gal/yr</th>
<th>Corn Used mil bu/yr</th>
<th>DGS 000 tons/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current dry-grind Plants</td>
<td>24</td>
<td>1,640</td>
<td>591</td>
<td>5,021</td>
</tr>
<tr>
<td>Planned plants, expansions</td>
<td>48</td>
<td>4,083</td>
<td>1,019</td>
<td>12,060</td>
</tr>
<tr>
<td>Wet mills</td>
<td>7</td>
<td>990</td>
<td>355</td>
<td>3,020</td>
</tr>
<tr>
<td>Nearby, Iowa draw*</td>
<td>6</td>
<td>402</td>
<td>143</td>
<td>1,220</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>7,115</td>
<td>2,108</td>
<td>21,321</td>
</tr>
</tbody>
</table>

Corn quality

Iowa's dry-grind plants purchase more than half the corn they use directly from farmers, and the plants can store, on average, about 5% of their annual corn inventory. Most plants choose to buy US Grade #2 Yellow Corn at moisture levels at or below 15%. Plants will accept moisture levels up to 17%, but will discount above 15%. Another factor that is critical to ethanol production is low damage levels, particularly mold damage. Plants will discount corn above 5% damage and will begin to reject loads at 7% damage, although some accept up to 10% damage.

Both moisture and damage levels affect how well the corn will perform in the fermentation process. Dry corn stores well with a minimal amount of mold and bacterial damage, even over several months, and it proves to be most efficient for the ethanol process, yielding the most ethanol and higher quality distillers grains. Also, dry corn is easier to grind for those mills that use a hammermill to break the corn. The introduction of molds and bacteria into the fermentation process (which depends on selected yeast strains) can be disruptive to the yeast cultures, sometimes requiring the addition of an antibiotic to the fermentation tank. This step is not only expensive, but it has become a point of concern that antibiotic residues might carry over into the distillers grains. Virginiamycin is one broad-spectrum antibiotic used (when needed) in ethanol fermentation broth. Virginiamycin has been targeted as a potential hazard if the distillers grains are fed to dairy cattle and meat animals that might accumulate residues in the milk and meat.

Distillers grains

Iowa dry grind plants will produce over 5 million tons of distillers grains at their present capacity, approximately one-third of the total US production. Approximately 75% of these will be sold as distillers dried grains with solubles (DDGS) which includes the spent corn solids and solids from the fermentation broth. These make a desirable feed ingredient with approximately 27-30% protein, 10-14% fat, and 6-8% fiber. When dried to 10% moisture content, DDGS can be stored and transported by truck or rail to livestock and dairy markets. Most dry-grind ethanol plants can store approximately 2.5% of their annual DDGS production (3-6 days of production.)

Plants also sell, on average, about 25% of their distillers grains as wet distillers grains with solubles (WDGS) at an average 55% moisture to markets within 50 miles of the plant. Sales of
WDGS is desirable for ethanol plants because they save the cost of drying, which can be 35-40% of the total energy costs to run the plant. Markets for WDGS are limited because they need to be used within a matter of days.

Approximately 90% of the DDGS is sold in the USA, while several export markets are beginning to open. Reports at the recent Distillers Grains Conference in Schaumburg, IL suggest that markets for 10% of US DDGS are in Costa Rica, Japan, Taiwan, China, Mexico, and Morocco and that these markets will grow as quality improves. One industry projection suggested that there is a potential worldwide demand of 39.2 million metric tons of DDGS, which is more than twice the present production in the USA.

Quality characteristics of distillers grains depend primarily on corn quality. Nutrient variability in corn will significantly affect nutrient levels in the distillers grains. Protein and oil levels in the distillers grains will be approximately three times that of the original corn. Similarly, field mold toxins ( aflatoxin, fumonisin, vomitoxin) will concentrate by a factor of three in the distillers grains. Process variations will affect nutrient levels, and additives (such as antibiotics or sulfur dioxide) may leave residues. In addition, the drying process for DDGS will affect the darkness or lightness of DDGS color. Many buyers question the quality of darker brown DDGS compared with lighter golden DDGS. Browning reactions tend to make amino acids less digestible for poultry and swine.

Testing procedures are becoming more sophisticated for both buyers and sellers of DDGS, and buyers are demanding more uniformity and consistency of DDGS quality. At the same time, ethanol producers hope that buyers will understand that their process is a biological process that depends, to a great extent, on the quality of the corn they use, thus resulting in some variability in their process and in the product. Standardization of DDGS quality attributes is probably not feasible, but the industry is moving toward more uniformity in tests that will accurately describe important parameters, such as nutrient levels and digestibility. Process modifications (i.e., fractionation) will also change the nutrient levels in distillers grains because the corn germ is removed prior to the fermentation process.

**Soy processing**

A survey conducted for the Iowa Grain Quality Initiative in Fall 2007 identified 30 plant locations that process raw soybeans into food and feed products. Currently over 95% of US soybeans, probably a similar percentage in Iowa, are solvent-extracted in large plants (capacity over 40,000 bu/day ranging up to 100,000+ bu/day). These plants are generally operated by grain marketing firms, and the products, meal and oil, are traded as commodities in a similar manner as commodity soybeans. Processors selling oil into the food market usually have refining capabilities at or near their plants to refined bleached and deodorized “RBD” oil for food markets. For the solvent extraction soybean plants, oil has become a more profitable product than soymeal. Nonetheless, some of these plants have buying programs that credit the producers for soybeans with higher protein and oil levels, thus enhancing the plants’ ability to make high protein soymeal.

Rapid growth in biofuels production in Iowa has resulted in 13 new biodiesel plants and 3 under construction. Iowa’s current capacity for biodiesel production is 257 mgy (million gallons per year), and plants under construction will add 95 mgy. About half of these plants are owned by
farmers through a cooperative or limited liability corporation. The others are owned by investor groups. These plants are designed to use soybean oil as a feedstock, but many are capable of using other plant oils and animal fat as feedstocks, too. The growing market for oils in biodiesel production has significantly affected the price of vegetable oils by competing with oils that might otherwise go into the food market. Biodiesel manufacturers use refined oils (not usually bleached and deodorized) so that gums (lecithin) is removed before the process. The methylation process in biodiesel production leaves a co-product, glycerin, for which more markets are needed.

Soybeans with specialty (IP) traits also need to be separated into oil and meal to capture value of the specialty traits. The products need to be kept separate from other production runs to maintain their identity for specialty markets. Extrusion-expelling plants and smaller solvent extraction plants are more suited for this type of processing than large solvent extraction facilities. Batch processing in these plants allows producers of specialty or identity-preserved soybeans to retain ownership of the products.

Our survey data (to date) shows that Iowa has at least 7 facilities that use a non-solvent extrusion-expelling process which lends itself to processing of specialty (IP) oilseeds (i.e., low-linolenic, low-saturate, organic soybeans) for which there are smaller supplies. Because they do not use solvents, these plants can be approved for organic/natural processing. One extrusion/expelling plant also physically refines oils, a process which is approved for organic/natural products. The oil and meal products from extrusion-expelling (EE) processing differ from solvent-processed oil and meal. Expeller meal may contain 2-5% oil in the meal, whereas solvent-processed meal usually contains less than 1% oil. Protein digestibility and oil quality and flavor may differ between the two processes.

Another group of specialty soybeans that are considered “food-grade” soybeans are not separated into meal and oil, but instead are made into flour, flakes, and snack ingredients. These are usually the large-seeded, clear hilum, high protein varieties, often processed first by seed cleaning companies so that the millers and other processors receive cleaned, sorted beans. These companies use both raw and roasted soybeans, depending on whether they are selling to markets where enzyme active flour is desired or, alternatively, where roasting creates desirable flavors in the meal, flour, or flakes. Nearly all of these products are sold as ingredients to other food manufacturers. Only a few processors create finished retail food products.

Processors of certified organic products and/or certain varieties of specialty, identity-preserved soybeans are paying considerably more for these soybeans than processors of commodity soybeans (i.e., $14-19 per bushel for cleaned, sized, sorted IP soybeans). Some processors have cleaning and sorting capabilities at the plant, but that is less common. Some processors manage their own grower contracts. Otherwise, grower groups manage the supply of specialty soybeans and usually retain ownership of the soybeans and the finished products.

**Soybean quality**

Commodity soybean processors by US Grade #2 Yellow Soybeans, except that foreign material is discounted above 1%. Green soybeans may be accepted, but they cause problems because of chlorophyll that must be bleached out of the oil. Buyers of specialty beans intended for the food market require additional quality characteristics; for instance, Lighter soybean color is important for soymilk and tofu processors. Soybeans with darker hilum color or stained soybeans are usually rejected for this market. Millers who process soybeans into flour discount or reject beans
that have insect damage and mold damage which, in turn, affect protein content, enzyme activity, and flavor. One miller cautions that a small amount of moldy soybeans caught in an auger can spread moldy flavor through an entire load of soybeans. Larger seeded soybeans are preferred for most food soybean users because the ratio of seed to hull is larger; also, soybeans that are oval-shaped do not dehull easily.

Storage time and conditions play a role in soybean product quality. Generally, large solvent processors have more soybean storage capacity on-site than small processors, so they are able to store soybeans in concrete or steel bins for several months with enough aeration to provide cool, dry conditions. Inventory management is important to minimize lot-by-lot variation in the meal and oil products. Smaller processors store soybean inventories for up to one month at their plants, and some processors of food-grade beans prefer to store most of their inventory at the seed cleaning facility. Off-flavors that develop in the soybeans due to long storage times, and warmer, moist conditions translate into lower quality (sometimes unacceptable) food products. Biodiesel manufacturers are also interested in minimizing rancidity in biodiesel fuel to prevent off-odors and filter-clogging polymers that can develop in oxidized vegetable oil.

**Concerns for the industry**

Survey participants stated that “adequate supply” and “price” were general concerns for all soybean processors as some soybean acres were converted to corn in 2007. One processor stated that this problem is exaggerated by speculators who, anticipating shortages, buy soybeans and drive the price higher than would normally occur in the market. Specialty and food-grade soybean processors also cited the erosion of non-genetically-modified germplasm as a problem. One processor stated that more training is needed for producers of specialty and organic soybeans, not only in production methods, but in harvesting, storage, and inventory control. Processors of organic food and feed products recognize that their markets are growing faster than their ability to contract acres for organic soybean production, and they worry that importers of organic products will move in to serve those markets.