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**Impact of Biofuel Industry Expansion on Grain Utilization and Distribution:
Preliminary Results of Iowa Grain and Biofuel Survey**

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Introduction

The rapidly expanding biofuel industry has changed the fundamentals of U.S. agricultural commodity markets. Increasing ethanol and biodiesel production has generated a fast-growing demand for corn and soybean products, which competes with the well-established domestic livestock industry and foreign buyers. Meanwhile, the co-products of biofuel production are replacing or displacing coarse grains and oilseed meal in feed rations for livestock. These developments in the agricultural and energy markets change the distribution of domestic grains and feeds and the utilization of shipping modes, which is likely affect the prices and basis of grains and other feedstocks in spatial markets.

The growing biofuel industry has drawn significant attention in the recent literatures. Several researchers employed simulation models to examine the impact of biofuel policies in various countries on world and local agricultural markets, including production, consumption, trade and price of feedstocks (Banse et al; De La Torre Ugarte, English and Jensen.; Koizumi and Ohga; Elobeid and Togkoz; Tokgoz et al.). Some studies are particularly interested in the surging price of feedstocks and food in the biofuel boom era (Schnepf; Trostle; Westhoff). The analysis of changes in grain flows caused by biofuel expansion is usually ignored in the literature, with an exception of Wilson et al. Wilson et al. employed a spatial optimization model to project the changes in cropping patterns and flows caused by increasing biofuel production. Most of those studies focus on the biofuel impact at the national or regional level and obtain the results through a simulation approach. In this paper, we study the changes in grain utilization and distribution at the state and cropping district level as most of grain producers and handlers are

directly influenced by local changes in prices, supplies, and demands. We focus on ethanol and corn markets as ethanol is the dominant biofuel in the U.S. while corn is currently the major feedstock for U.S. ethanol production.

Located in the Heartland of the U.S., Iowa has been a leading state in corn production for decades. Historically, Iowa corn production is generally export-oriented (here we define exports as any out-of-state shipments); on average, more than 40% of annual production was shipped to out-of-state or international markets during the 1990-2003 periods. However, the rapid growth of the ethanol production has posted direct implications for Iowa corn disappearance. The ethanol industry increases its corn use possibly at the expense of other sectors' corn consumption. In 1999/2000, corn used for ethanol accounted for only 6% of total corn utilization; however, it has quickly risen to 21% by 2005/06. Meanwhile, the leading exports sector has dropped its share from 44% to 35%, while livestock and food industries have also lost share over the past five years. Beyond the demand for feedstocks as inputs in biofuel production, the co-products of ethanol, e.g. the distillers grains (DG), have also made impacts on feed and livestock markets. With continuous growth in biofuel production, additional co-products will be produced, which consequently increases further competition for shipping facilities and the transportation system.

Since Iowa grain and feed markets are in the midst of a dramatic transition today and the state represents a large production share in U.S. domestic agriculture and ethanol, it could be a good example to demonstrate the impacts of biofuel production on grain utilization and flows at state level. The objectives of this study are to gain a better understanding of the feedstock sources of ethanol plants and the destinations of their fuel products and co-products, and to evaluate the impact of expanding ethanol production on the state's crop utilization of specific end-uses and the distribution patterns of grains and products.

Survey Tools

In order to achieve the study objectives, a survey on grain, biofuel and its co-product flows in Iowa during the 2006/2007 marketing year has been taken. The questionnaires build on previous surveys that examined Iowa grain flows (Baumel et al., 1996, 2001). The questionnaires focus on feedstock sources, grain used in ethanol and biodiesel plants, and production of ethanol, biodiesel and DGS. Quantities of movement, modes of transportation, and shipping routes are covered in the survey. To ensure an adequate response, the 2007 survey process took several months. First, the survey was mailed to selected individuals/entities. Two follow-up mailings were sent to non-respondents several weeks later. Telephone follow-ups were conducted to fill out incomplete responses and clarify some extraordinary survey responses. Nearly 5,000 surveys were sent out to randomly selected farmers and grain handlers. A comprehensive census was conducted for grain processors and biofuel facilities because of the small number in the population. Within each of the five survey sections, the response rate exceeded 30 percent. The survey instruments are available from the authors upon request.

Survey Results

In this section, survey results of corn producers, handlers and processors will be presented. In order to illustrate the spatial characteristics of the survey data, we present the state-level and cropping report district (CRD) level for corn producers and handlers. For corn processor/ethanol plants, only state-level output will be discussed due to a small sample size.

Corn Producers

During the 2006/07 marketing year, Iowa corn producers planted 12.6 million acres, producing 2.05 billion bushels of corn. The survey results indicate that 82 percent of that corn was sold during the marketing year, 11 percent was utilized on the farm, and 7 percent had not been sold

yet but was expected to be marketed in the near future. Figure 1 shows the market of Iowa corn production. The largest percentage of Iowa corn, 48 percent, was sold to cooperative elevators, followed by Iowa ethanol plants at 16 percent. About 14 percent went to private elevators and another 10 percent was marketed to processors. Nearly 7 percent went directly to river terminals and only 1 percent went to other farm/feeding operations. In general, 62 percent of Iowa's marketed corn went to elevators and 27 percent to ethanol plants and other corn processors.

In comparison, the 2001 survey (for the 1999/2000 marketing year) showed that 77 percent of Iowa corn was sold by farms during the marketing year, 15 percent was used on farm, and 8 percent remained to be sold. In that year, over 66 percent of Iowa corn went to elevators, while 13 percent was sent to corn processors, including ethanol plants. About 14 percent entered river terminals and 5 percent went to other farm/feeding operations. This shows that ethanol plants and other corn processors have gained market share of corn sold by Iowa producers while all other categories have lost ground. The shares of river terminals and other farm/feeding operations had the most reductions.

Table 1 outlines the corn planted area and production by crop reporting district (CRD) as published by USDA-NASS. The table also shows the disposition of the crops. The lowest percentage of corn sold off the farm is in Northeast Iowa, where roughly 75 percent was sold and over 20 percent was used on the farm, the highest percentage in the state. The Northeast Iowa on-farm use is likely to be tied to the concentration of dairy production there. In Northwest, East Central, and Southwest Iowa, over 10 percent of the corn produced was used on farm. Just over 4 percent of the corn crop was still available at the end of the marketing year in Northeast and South Central Iowa, while producers in North Central, Central, East Central, and Southwest Iowa had more than 8 percent of their corn crop still available at the end of the 2006 marketing year.

Table 2 displays the share of corn producers' markets by each district. Country elevators were the top destination market for corn sales in all CRDs. However, country elevators in the Northwest, North Central, West Central, and Southwest were the particularly dominant markets, accounting for more than 64 percent of corn sales in those regions. The extensive network of train-loading facilities was identified as the foremost advantage of those country elevators. For the East Central district, Mississippi River terminals were the top destination. Iowa ethanol plants absorbed at least 10 percent of all corn sold in every district, with the exception of East Central Iowa. The ethanol industry in the Central district absorbed more than one-quarter of corn sales in the district. A great number of corn processors and barge terminals are located in eastern Iowa; hence, corn processors and river terminals purchased at least 10 and 15 percent of all corn sold in those regions, respectively.

Grain Handlers

During the 2006/07 marketing year, about 1.1 billion bushels of corn were received by grain handlers and 99 percent of those bushels were sent to the market. Figure 2 presents the destination of the corn processed by the country elevators. The largest percentage, 26 percent, went to Iowa's dedicated ethanol plants, followed by Iowa feeders (23 percent) and processors (18 percent). Out-of-state feeders purchased 11 percent of the corn. River elevators (Mississippi, Illinois, and Missouri) together received less than 5 percent of handlers' corn. More than 11 percent went directly to export markets (Gulf Coast, West Coast, Mexico, and others). In total, nearly 34 percent of Iowa handlers' corn went to feeders, 26 percent to ethanol plants, 20 percent to corn processors, 11 percent directly to export markets, and 4 percent to river terminals.

In comparison, the 2001 survey (for the 1999/2000 marketing year) showed that 44 percent of Iowa handlers' corn went to corn processors, including ethanol plants, which is similar to the share that went to corn processors in 2006/07. The livestock industry utilized almost 27

percent of country elevators' corn six years ago and absorbed one-third of the corn in the current survey. The dramatic change in the utilization of handlers' corn between 1999/2000 and 2006/07 is the share of corn entering the river terminal; it declined from 15 to 4 percent over the past six years. This shift from the export-destined market to domestic customers is likely driven by the strong demand for corn from the local livestock and ethanol industries. Although the share of corn utilization in some markets may decline, the corn volume to those markets is expected to increase, as total corn marketed posted significant growth between the two survey periods.

Table 3 summarizes the share of the corn market for elevators in each CRD. Feedlots were the major destination markets for country elevators in the western CRDs and obviously dominated corn sales in the South Central district, absorbing almost 80 percent of corn sold in this district. At least 10 percent of corn was sold to the ethanol industry in all CRDs, except for the South Central district. Ethanol plants are particularly strong buyers in Northwest, North Central, Central, and East Central districts, accounting for at least one-quarter of corn sales in each district. At least 37 percent of corn sold by country elevators in the three East districts went to wet milling processors. Mississippi River terminals, as expected, purchased a significant share of corn sales in those eastern districts. A sizeable amount of corn (8-12 percent) was sold to Mexico by country elevators in Northwest, North Central, Central, and South Central districts, facilitated by the convenient rail network located in these regions.

Corn Processors/Ethanol Plants

During the 2006/07 marketing year, the majority of Iowa corn processors (85 percent) utilized dry-mill processes and produced ethanol and its co-products. Estimated total nameplate ethanol production capacity based on the survey was 2.2 billion gallons per year. About 38 percent of survey respondents indicated that their facilities plan to expand their operations by 2012, 23 percent did not plan to expand, and 38 percent were undecided. The survey results implied that

for the 2006 marketing year (September 1, 2006 to August 31, 2007), Iowa corn processors produced roughly 2 billion gallons of ethanol, 5.1 million tons of dried distillers grains (DDG), and 2.6 million tons of wet distillers grains (WDG). For those processors that produced ethanol, ethanol sales accounted for 85 percent of their total dollar sales, while sales of WDG and DDG each contributed almost 8 percent of total sales.

Iowa corn processors purchased 92 percent of their corn needs from Iowa sources and moved all by truck. Survey results indicate that most of ethanol and DDG sales were delivered to out-of-state destinations whereas WDG was primarily utilized in Iowa. Figure 3 presents where ethanol, DDG, and WDG were sold. For ethanol sales, other states were the dominant markets for Iowa ethanol production while 7 percent of ethanol was used in state. The international market for Iowa ethanol was still pretty thin (<2 percent). Similarly, a significant portion of Iowa-produced DDG was sold to other states while the local livestock industry absorbed almost 30 percent of DDG production. International markets took more than 10 percent of Iowa DDG production. In contrast, WDG was basically utilized in local feed lots, as the moisture content of WDG makes it hard to store and transport.

The survey then further examined the destinations for ethanol and DDG sales. Figure 4 presents the share of ethanol sales in those regions identified in the survey. Based on valid responses, about 23 percent of ethanol was sold to California, Arizona, Nevada, and Utah, while about 10 percent of ethanol was shipped to the Northeast region. More than 7 percent of ethanol was destined to Southern Plains states, such as Texas, Oklahoma and New Mexico. A major share of ethanol production was shipped to states not listed in the survey, which likely suggests that Iowa ethanol is primarily used in the surrounding states. This question will be further examined in an extension of this study; the survey instruments have been updated to request

information on more detailed destination regions for the 2007 crop year (Sept. 1, 2007 to August 31, 2008).

Similarly, detailed information about DDG sales destinations is summarized in Figure 5. For those states specified in the survey, California group states received a quarter of Iowa DDG production while Texas group states purchased about 13 percent of Iowa DDG. Since DDG is particularly suitable for ruminants, it is not a surprise to see that California and Texas group states absorbed nearly 40 percent of Iowa DDG sales, as California is a major dairy production state, while the Texas panhandle is a dominant beef cattle production region. The Northeast region received almost 10 percent of Iowa DDG sales. More than 25 percent of Iowa DDG sales that went to other states were not explicitly determined.

In the survey, corn processors were asked questions regarding fractionation processes. The majority of processors (85 percent) did not use a fractionation process prior to fermentation in 2006/07. However, nearly 23 percent of processors expected to adopt this process by 2012, while about 46 percent of processors did not expect to adopt a fractionation process over the next five years. Regarding the question of corn oil extraction, only 8 percent of processors extracted corn oil in 2006/07; however, half of the processors said they would implement it by 2012 to earn the extra revenue derived from the corn oil. The fractionation and oil extraction questions indicate that the corn processors and ethanol plants continue to examine production and product streams in order to increase revenues, reduce costs, and/or modify product streams to take advantage of market opportunities. The survey also included a look toward the possible shift to cellulosic biofuels, as outlined within the Renewable Fuels Standard of the 2007 Energy Act. About 38 percent of processors were not considering adding cellulosic capabilities by 2012, while 62 percent of processors were undecided.

Conclusions

This paper presents updated information about grain flows from Iowa farms and country elevators to destination markets between September 1, 2006, and August 31, 2007. Attention is also given to feedstock resources and product markets for the Iowa biofuel industry.

Country elevators are still the primary market for Iowa grain producers, accounting for 62 percent of corn sold by farms statewide. However, the share of grain sales direct from farms to corn processors increased continuously over the last decade, as compared to the 1996 and 2001 survey shares reported. Driven by the expanding biofuel industry, the market share of processors (including ethanol plants) for farms' corn sales almost doubled between the 1999 and 2006 marketing years. In contrast, the share of Iowa feeders and river terminals for corn sales by farms shrunk. This transformation is particularly significant in eastern Iowa and the North Central and Central Iowa CRDs.

Although the market share of feeders in producers' corn sales declined significantly over the past six years, the combination of corn used for on farm feeding, deliveries to other feeding operations by farms, and corn sales to livestock industry by country elevators show that Iowa livestock feeders still remained the single largest end user of corn in the 2006 marketing year. As expected, the competition for local corn between Iowa feeders and the ethanol industry is likely to continue, as additional ethanol plants have been under construction or have been planned in all CRDs.

Regarding the destination markets selected by country elevators, a sizeable amount of corn went to ethanol plants during the 2006 marketing year. The share of corn sold to river terminals by country elevators dropped significantly over the past six years because of strong competition from local feeders and ethanol plants.

The expanding ethanol industry is likely to have two-sided impact on country elevators: country elevators' share in local corn markets declined, as direct deliveries off farms to processors/ethanol plants increased; however, country elevators also benefited from the ethanol industry because of the emerging sales of ethanol co-products, for example, DDG or WDG.

The rapidly expanding ethanol industry in Iowa has a significant impact on corn utilization in the state. Ethanol plants drew a considerable amount of corn away from traditional destination markets, such as feeders or export markets. A major portion of corn supplies came from in-state sources, while the sales of Iowa ethanol and DDG were dominated by out-of-state buyers. A sizeable share of ethanol and DDG sales went to the western United States, while the Southern Plains states absorbed a sizable shares of ethanol and distillers grains sold by Iowa. Results also suggest that a significant share of Iowa ethanol was sold to Midwestern states, such as Minnesota and Nebraska.

Most of ethanol plants did not extract corn oil in the 2006 marketing year. However, given the strong performance of vegetable oil market, it is expected to see more ethanol plants adopt this process. The increase of corn oil production would generate more revenue for ethanol plants, and also provide an additional feedstock source to biodiesel refineries.

Iowa's grain, livestock, and biofuel industries continue to adjust to each other and to everchange market conditions. This survey outlines the changes in grain flows and transportation methods over the past few years and provides a snapshot of the emerging biofuel industry in Iowa. An ongoing survey effort will extend these results to examine the additional shifts in Iowa's agricultural and biofuel sectors over the 2007 crop year, a year in which crop and energy prices continued to rally to record high levels.

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Table 1. CRD corn data

	Corn planted acres	Corn production	Corn sold	Corn used on farm	Corn not sold or used
	(million acres)	(million bushels)			
Northwest	1.955	298.2	79.0%	14.1%	6.9%
North Central	1.822	314.8	85.3%	6.3%	8.5%
Northeast	1.499	253.3	74.6%	21.2%	4.2%
West Central	1.867	271.3	85.6%	8.4%	6.0%
Central	1.839	324.5	86.7%	4.7%	8.5%
East Central	1.283	218.2	75.7%	15.9%	8.3%
Southwest	0.996	157.8	81.2%	10.6%	8.2%
South Central	0.497	74.2	89.1%	6.7%	4.2%
Southeast	0.842	137.8	87.4%	6.4%	6.3%

Table 2. Percentage of market for CRD corn producers

	Northwest	North Central	Northeast	West Central	Central	East Central	Southwest	South Central	Southeast
Cooperative elevators	66.4%	66.9%	33.0%	60.1%	53.1%	21.3%	27.4%	37.2%	7.7%
Private elevators	11.7%	12.6%	18.4%	6.4%	5.8%	10.8%	36.8%	10.8%	27.5%
Iowa ethanol plants	16.9%	14.1%	12.8%	16.9%	27.1%	5.6%	10.0%	10.9%	11.8%
Out-of-state ethanol plants	1.5%	0.5%	0.0%	3.8%	0.0%	0.0%	0.0%	0.0%	0.0%
Iowa processors	0.1%	2.3%	10.3%	0.2%	9.0%	27.6%	1.8%	31.4%	27.2%
Out-of-state processors	0.0%	0.0%	0.0%	9.0%	0.0%	0.0%	2.9%	0.0%	1.8%
Illinois River terminals	0.0%	0.1%	0.7%	0.0%	0.0%	0.0%	0.0%	0.3%	0.4%
Mississippi River terminals	0.0%	0.8%	15.5%	0.0%	0.8%	29.5%	0.0%	0.9%	20.1%
Missouri River terminals	0.3%	0.0%	0.0%	1.0%	0.0%	0.0%	14.7%	0.0%	0.0%
Iowa farm operation	2.9%	1.3%	0.9%	0.6%	3.5%	0.1%	2.1%	1.9%	1.4%
Out-of-state farm operation	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	6.7%	0.0%
Destination unknown	0.1%	1.4%	8.3%	1.8%	0.8%	5.1%	4.3%	0.0%	2.2%

Table 3. Percentage of corn market for CRD elevators

	Northwest	North Central	Northeast	West Central	Central	East Central	Southwest	South Central	Southeast
Iowa feeders	45.5%	16.4%	11.8%	27.6%	27.6%	10.7%	6.1%	21.9%	15.5%
Out-of-state feeders	8.2%	6.9%	0.0%	32.0%	11.4%	1.7%	40.4%	55.4%	0.2%
Iowa ethanol plants	32.0%	34.5%	14.0%	12.4%	30.3%	26.6%	17.5%	1.6%	11.8%
Out-of-state ethanol plants	0.0%	0.0%	0.0%	1.3%	0.0%	0.0%	2.2%	2.5%	0.1%
Iowa processors	3.2%	13.8%	50.4%	4.9%	11.5%	37.3%	4.1%	3.9%	39.0%
Out-of-state processors	0.0%	7.8%	0.0%	5.1%	1.4%	0.0%	1.0%	1.4%	0.0%
Illinois River terminals	0.0%	0.0%	1.0%	0.0%	0.0%	0.0%	1.9%	0.0%	0.0%
Mississippi River terminals	0.0%	1.3%	12.1%	0.0%	0.5%	8.3%	0.0%	1.0%	24.7%
Missouri River terminals	0.0%	0.4%	0.0%	0.1%	0.0%	0.0%	2.8%	0.0%	0.0%
Gulf Coast	1.3%	7.4%	10.4%	0.7%	1.8%	15.4%	0.0%	0.0%	7.3%
West Coast	0.5%	0.3%	0.0%	0.9%	0.0%	0.0%	0.0%	0.0%	0.0%
Mexico	8.6%	7.7%	0.0%	3.8%	8.7%	0.0%	0.6%	12.3%	0.0%
Other exports	0.0%	3.6%	0.3%	1.6%	1.7%	0.0%	0.0%	0.0%	0.0%
Other	0.7%	0.0%	0.0%	9.4%	5.1%	0.0%	23.5%	0.0%	1.3%

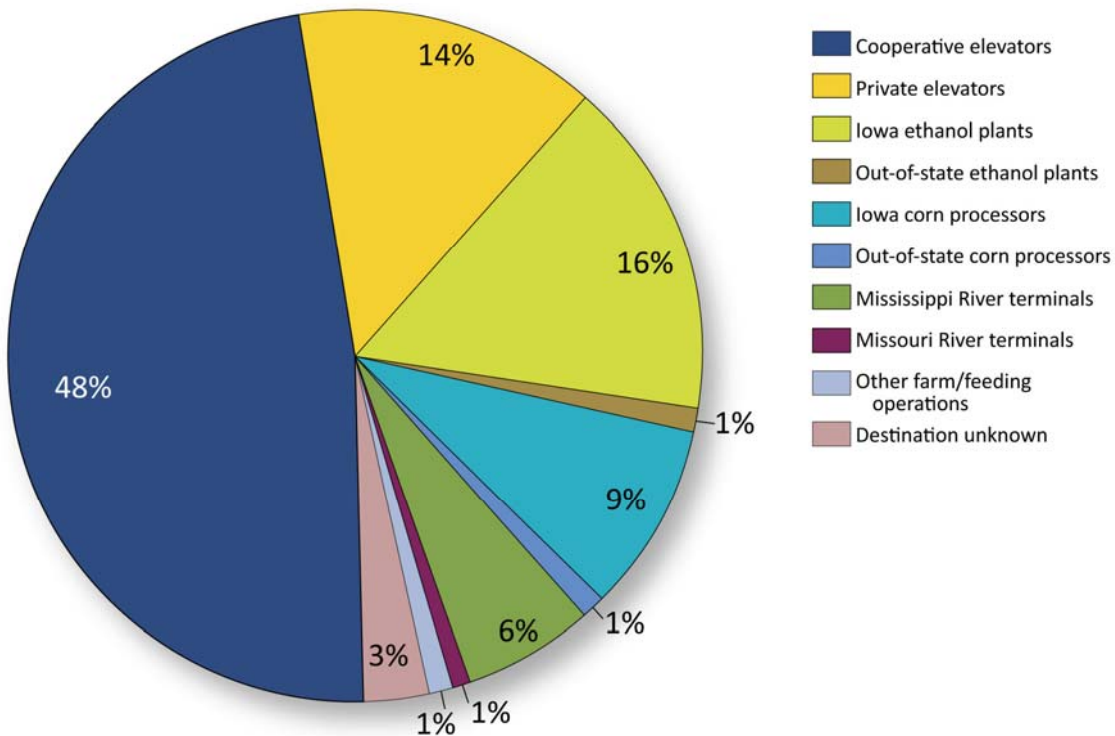


Figure 1. Markets for Iowa corn producers

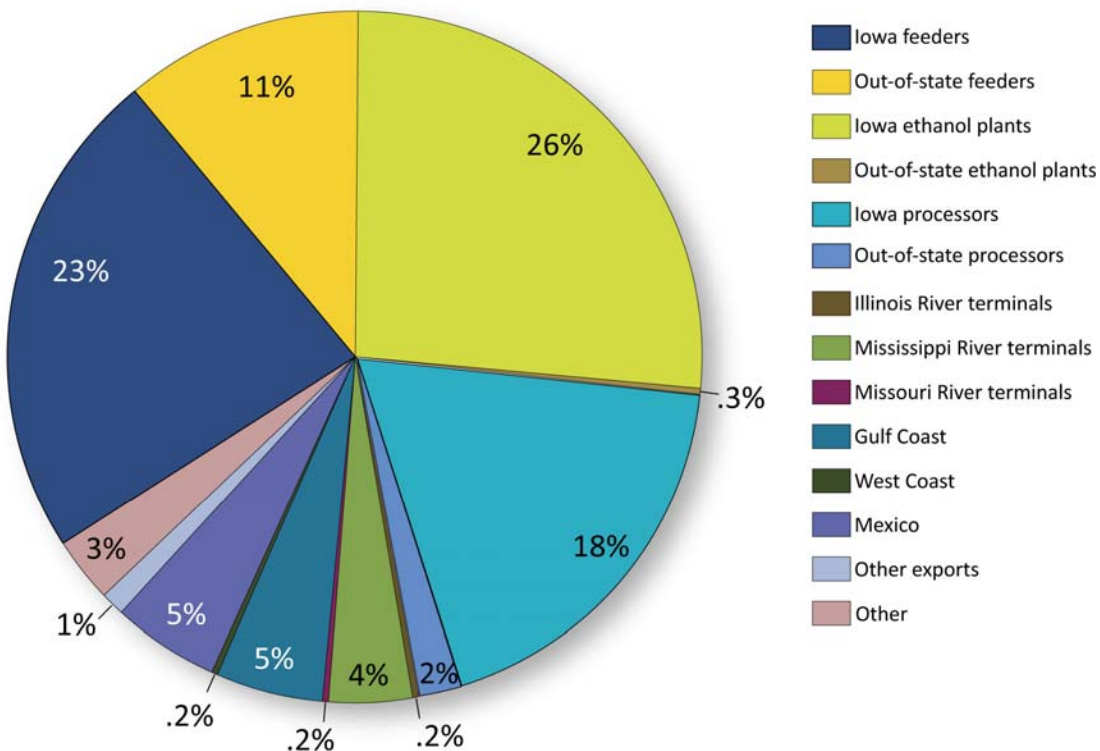


Figure 2. Markets for Iowa corn from country elevators

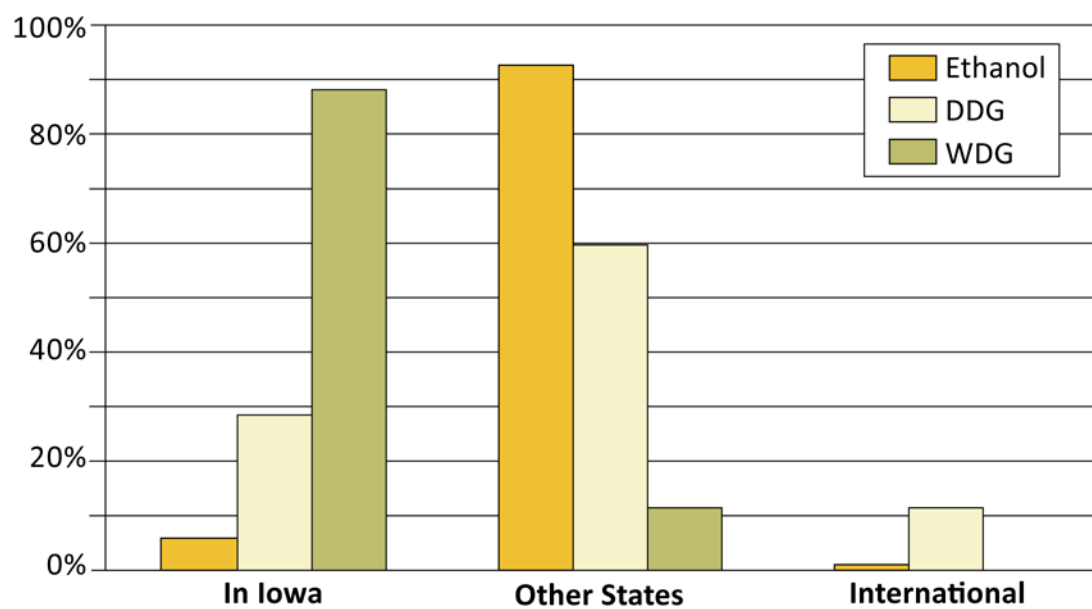
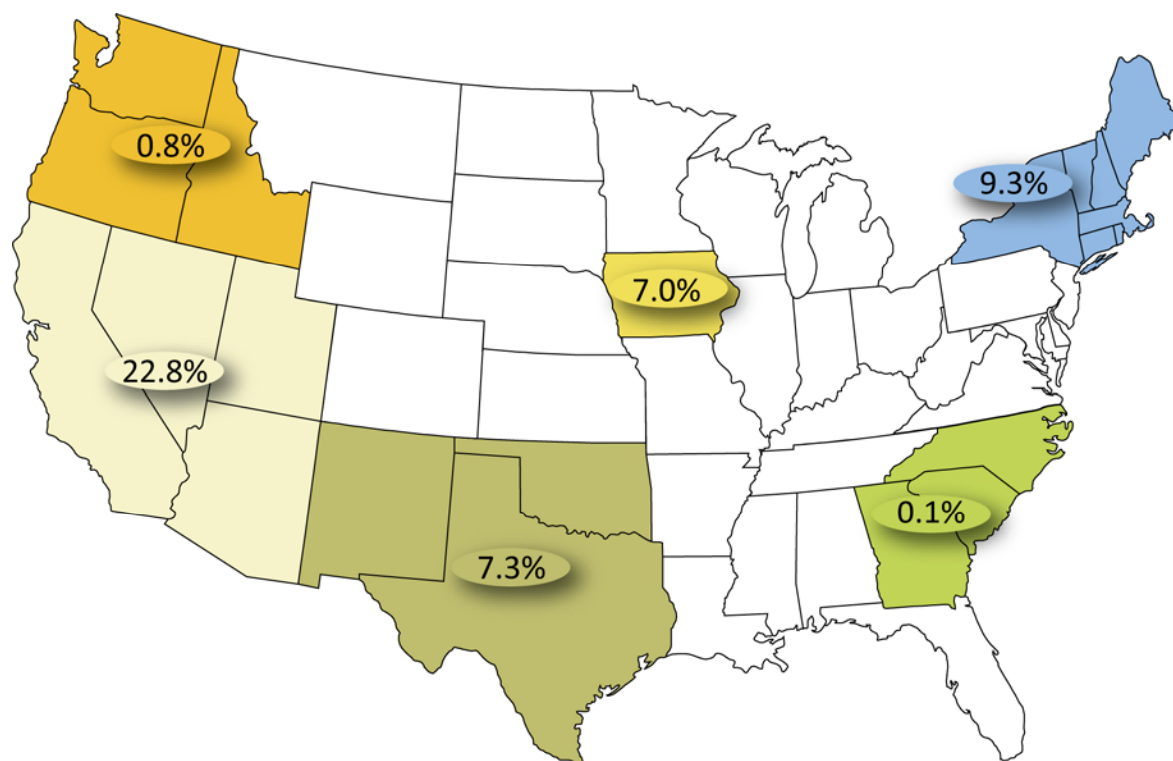
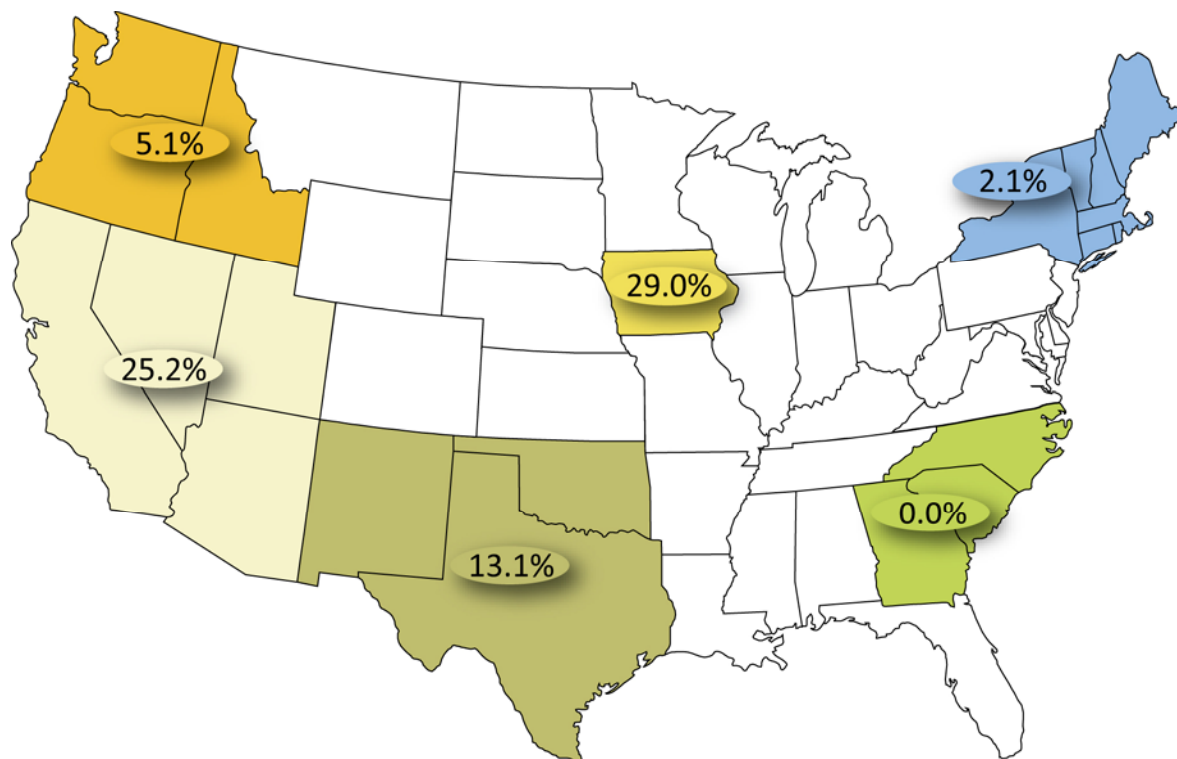


Figure 3. Markets for Iowa ethanol, DDG, and WDG from corn processors



Note: Percentage sold to other states and countries = 52%

Figure 4. Percentage of Iowa ethanol sold



Note: Percentage sold to other states and countries = 25.5%

Figure 5. Percentage of Iowa DDG sold