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Spatial Marketing Patterns for Corn Under the Condition of Increasing Ethanol Production in the U.S.

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Abstract

Events external to agriculture have set in motion the conditions for structural change in the marketing of corn in the U.S. These included a rapid increase in the price of crude oil from $40 per barrel to over $100 caused by hurricanes, geopolitical events, an increased global demand for energy from countries like China and India, and in December 2007, the U.S. raising the renewable fuel standards. The results of this research show that there could be significant changes in the historical utilization and marketing of corn in the U.S. The change in movement patterns provides one source of visible evidence that a structural change is underway.

Keywords: ethanol, corn, spatial marketing, structural change, crude oil

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Introduction

The economics of energy versus food is leading to major structural changes in the marketing of corn in the U.S. A recent historical perspective shows that when crude oil was priced in the range of $35 to $50 per barrel and corn was $1.80 to $2.20 per bushel, the financial feasibility for ethanol plants was viable, but required risk capital from sources that believed the investment would be worthwhile. New construction of ethanol plants was happening at a modest pace. In 1999, less than a decade ago, there were 50 ethanol plants producing a little over 1 billion gallons per year. The production of corn in the U.S. was sufficient to meet the needs of the livestock sector, sustain exports at traditional levels, and supply the growing demand coming from ethanol production. See appendix A.

A series of events external to agriculture set in motion the conditions for structural change. As shown in Figure 1 for 2004, the West Texas Intermediate price of crude oil started to increase to price levels over $50 per barrel brought about by increases in world demand that exceeded comparable increases in world supply. Added to the price situation was Hurricane Katrina in August of 2005 that knocked out refining and distribution capacity in the U.S. Gulf region. This led to temporary shortages of refined fuels and a spiraling up of prices that eventually contributed to crude oil prices over $70 per barrel during 2006. By January 2007, global demand had slowed in response to higher prices and oil prices declined to under $60. Supply and demand economics seemed to be working to the relief of the world's economies.

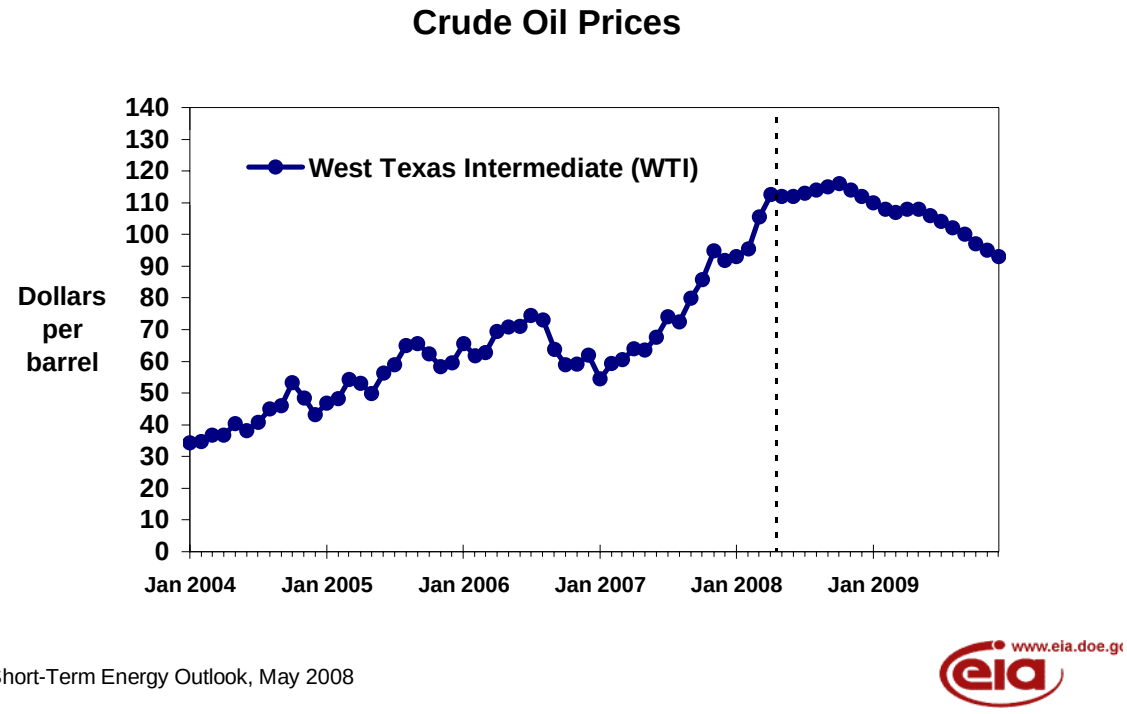

Figure 1. Crude Oil Prices

The relief was short-lived. Geopolitical events during the spring and summer of 2007, such as unrest in Nigeria, contentious relations with Venezuela and Iran, combined with the peak summer season gasoline demand, sustained gasoline prices at record high levels. Longer-term effects were also becoming factored into oil prices. The prolonged Iraq war, growing energy demand in China and India, the declining value of the dollar, and increasing purchasing power in Europe, former Soviet Union countries and the developing world all contributed to a demand for oil that seems to be exceeding the current availability of supply. By September 2007 crude oil was back up over $70 per barrel and by early May 2008 broke through $100. As recently as June 2008, the price has exceeded $135 and the outlook for the remainder of 2008 and into 2009 is uncertain.

Events internal to the agricultural sector also set in motion conditions for change. In 2005 the U.S. Congress passed legislation called the Renewable Fuels Standard that mandated 7.5 billion gallons of ethanol production by the year 2012. The legislation was strongly supported by state and national organizations interested in the welfare of corn producers. This was in addition to the federal excise tax credit of 51 cents per gallon that provides an incentive for the production of ethanol. In December 2007, the U.S. Congress passed, and the President signed, an energy bill that doubled the Renewable Fuels Standard for ethanol from corn to 15 billion gallons by 2015.

The following figure from the National Renewable Energy Laboratory shows actual and projected production of ethanol in the U.S. As of March 2008, existing ethanol production is at 8.6 billion gallons per year (Renewable Fuels Association), an eight-fold increase since 1999.

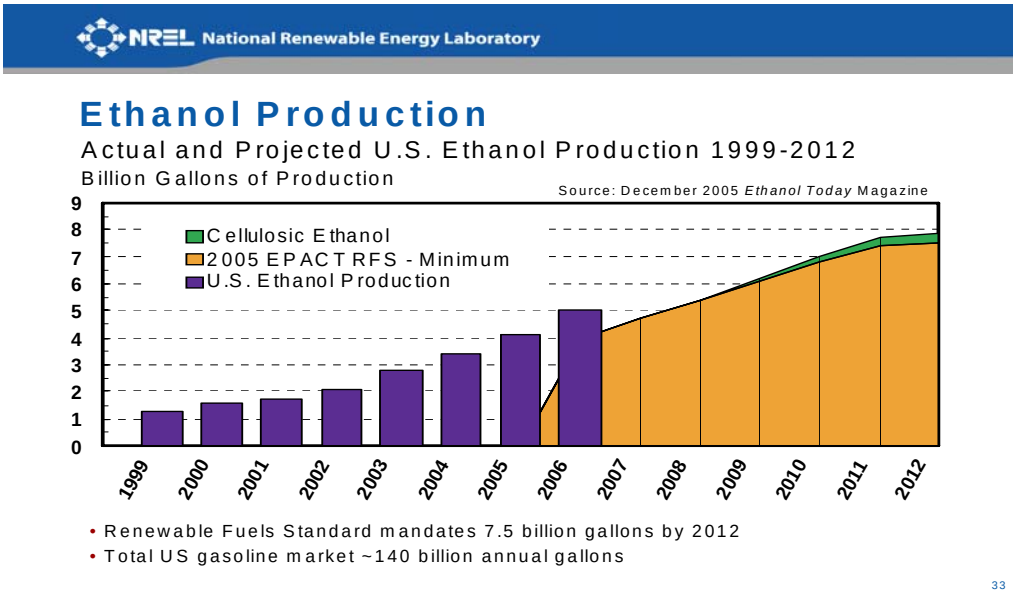

Figure 2. Ethanol Production

Problem Statement

The economic stimulus for more ethanol production caused a "gold rush" mentality for investors of capital (comment by Todd Sneller, Administrator, Nebraska Ethanol Board, 2006). When crude oil prices ranged from $50 to $70 per barrel, corresponding retail gasoline prices were $2.30 to $3.00 per gallon (in the U.S.), and corn prices were at $2.00 or even $2.50 per bushel, the ethanol crush spread ranged from $1 to $9.50 per gallon (Chicago Board of Trade). General estimates on the investment cost for a 100 million gallon per year plant was around $100 to $120 million or $1 to $1.20 per gallon. The "gold rush" of investor capital to build plants was caused by a 12 to 18 month payback period for the initial investment (comment by Tom Hauser, loan officer, Omaha Bank for Cooperatives, 2006).

As more ethanol plants continue to be built, the more will be the demand for corn to supply the plants. As shown on the following map (DTN Ethanol Resource Center), most existing and proposed plants are in the Corn Belt area of the U.S. where currently there is a surplus of corn available. However, the problem is that as more plants are built, projections are beginning to show that the surplus states becoming deficit. Robert Wisner, a long-time economist at Iowa State University, has projected that under normal assumptions for corn production, the state of Iowa could be in a significant deficit position by the year 2008 (Iowa State University). Iowa has not been deficit in corn for decades, if ever. Not only could this happen to Iowa but also to other Corn Belt states.

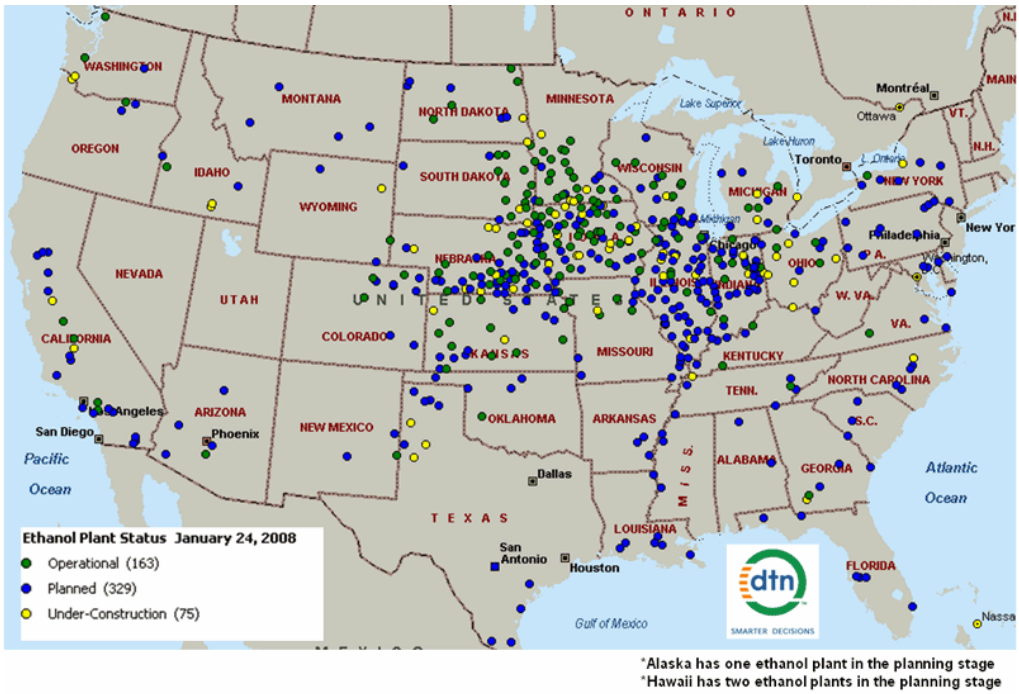

Figure 3. Ethanol Plants, March 2008

Objectives

The objectives of this research are to:

1. Estimate the historical supply and disappearance of corn for each state in the U.S. National level estimates are periodically available but not at the state level, so these figures need to be developed. Once the historical figures are developed, then use projected national figures to estimate future supply and disappearance at the state level.

2. Determine the gallons of ethanol that are currently being produced and the expected gallons in the future based on plants under construction. Factor the current and projected ethanol production into the disappearance for corn at the state level.

3. Show what the geographic pattern of corn movements would be in the U.S. under the changing conditions of traditionally surplus states becoming deficit.

Basically, the questions to be answered are what states will likely go deficit with the surge in ethanol production, and how those deficits will be met.

Procedure

A global corn transshipment model was built and solved using computer software called Solver Premium 7.0 as an add-on to MS Excel. More details on transportation models including model structure, applications and computational methods for solution can be found in *Computational Economics* (Thompson and Thore 1992, 9-22, 113-119) and *Linear Programming* (Naylor and Byrne 1963, 83-99, 147-151).

The advantages of using a transshipment model are discussed in Thompson and Thore (1992, 177) where they state,

> "It is rather curious to note that the spatial dimension seldom appears in textbook presentations of economic theory. Economic relationships are conveniently formulated with no reference to the geographical location of the participating economic subjects." They go on to state, "And yet, how can one understand the spectacular development of modern economies without pointing to the development of new markets in developing countries and the search for raw materials and energy sources in remote locations? As transportation and distribution costs come down, the logistics networks that connect resources with final consumer demand become even longer and more complex."

In contrast, general and nonlinear equilibrium models provide prices and quantities at the equilibrium of supply and demand, but have little or nothing to say about the spatial movements of a commodity. The choice for this research was to use the transshipment model because it explicitly describes spatial movement patterns along with quantities under various conditions.

As shown in Figure 4 there were 13 corn surplus states, 30 deficit states, 10 U.S. ports of export, 10 foreign surplus countries and 52 deficit countries. The combination of all the surplus origins and deficit destinations results in a model with 16,000 possible routes. The transshipment model was solved for the pattern and quantity of corn shipped by minimizing the cost of transportation from the surplus to the deficit states, and from the surplus states to the ports of exports. Exports available from the U.S. were in competition with exports that originated from foreign surplus countries in serving deficit countries.

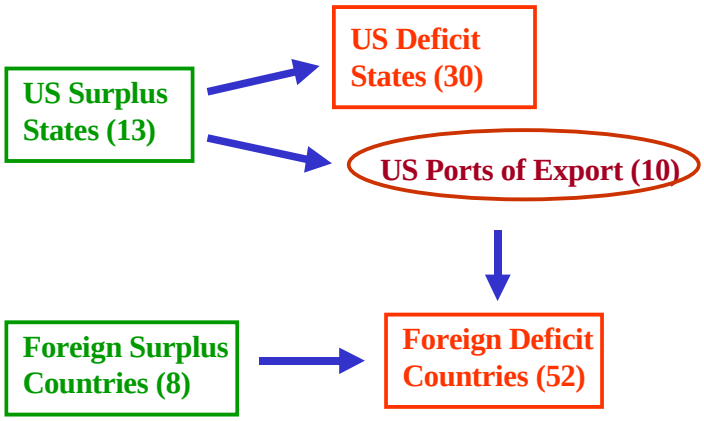

Figure 4. Global Corn Transshipment Model

U.S. figures on production, beginning and ending stocks, feed, food, industrial and seed uses, and exports are shown by the graphs in Appendix A (U.S. Department of Agriculture, Food and Agricultural Policy Research Institute). Actual data ranges from 1990 to 2007 and projections are from 2008 through 2015. The surge in ethanol demand for corn can be seen in the section on food and industrial use.

State level projections are given in Appendix B. Figures 5 and 6 graphically show the estimated net surplus and deficit states during the 2007-08 marketing year. The methodology for estimating surplus and deficits can be found on the Web site at the University of Nebraska-Lincoln Extension.

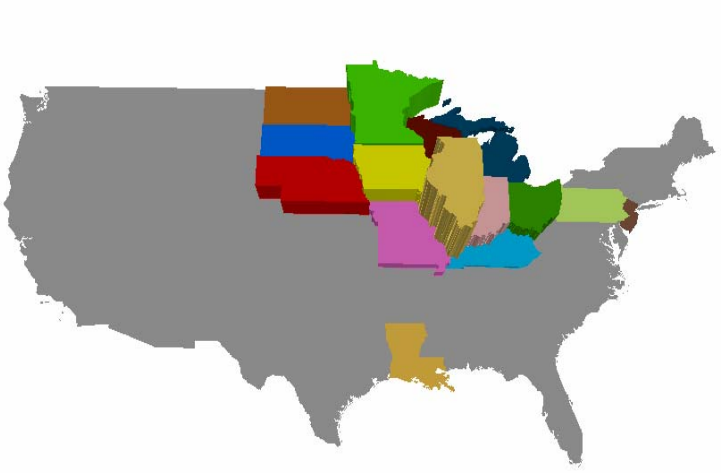

Figure 5. Net Surplus States, 2007-08 Marketing Year

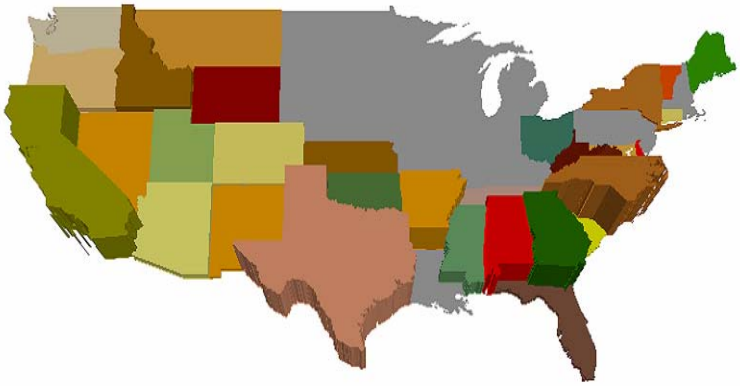

Figure 6. Net Deficit States, 2007-08 Marketing Year

The global model was solved for corn movements using 2007-08 estimates for the amount of ethanol expected to be produced, along with current estimates on state level corn production, beginning and ending stocks, feed, food, industrial and seed uses, and exports. The model solves for the least cost distribution of corn from the surplus states to the deficit states, through the ports of export, and from foreign surplus countries to deficit countries.

Identifying and quantifying trade barriers, trade facilitation, country specific grain policies, etc. for sixty foreign countries plus the United States in empirical modeling is extremely difficult. The approach applied in this research was to use the actual data on corn imports and exports from foreign deficit and surplus countries, respectively. The imports and exports were fixed at the three-year average for 2004-07. The actual data would reflect and be conditioned by the existing trade and

policy environment that existed in the foreign sector. U.S. exports for the baseline year of 2007-08 were comparable to past years, as shown by the first graph in Appendix A, and would also reflect the existing trade and policy environment. While the trade and policy environment can unexpectedly change in the future, the model input and results are based on those conditions that existed in the 2007-08 period. It was not the purpose of this research to explore the impacts of possible trade and policy changes. Prior research using the same transshipment model did evaluate the impacts of disaster events like Hurricane Katrina on the marketing of corn (Conley and Kerr 2006).

Projections were made for the supply and disappearance data for the 2008-09 marketing year (Food and Agricultural Policy Research Institute, Ethanol Producer Magazine) and the model was solved to compare with the baseline model of 2007-08.

Baseline Year Results

Figures 7 and 8 show the results for the baseline model year 2007-08. Corn from surplus states is shipped to deficit states in the first figure, and to the ports of export in the second. The movements of corn shown in the maps for 2007-08 are similar to past years because of the fixity of assets used in the production and marketing of corn. The primary land base for producing corn is in the surplus states along with the specialized investments in production assets, such as planters, combines and tractors. The marketing infrastructure includes storage and drying facilities, and transportation vehicles, both on-farm and off, that are designed to handle corn. In addition, the marketing institutions that involve the spot and forward pricing of corn, and the sale up through the distribution channel are well developed. The production and marketing of corn that has existed for decades has imbedded in it this fixity of assets and institutions.

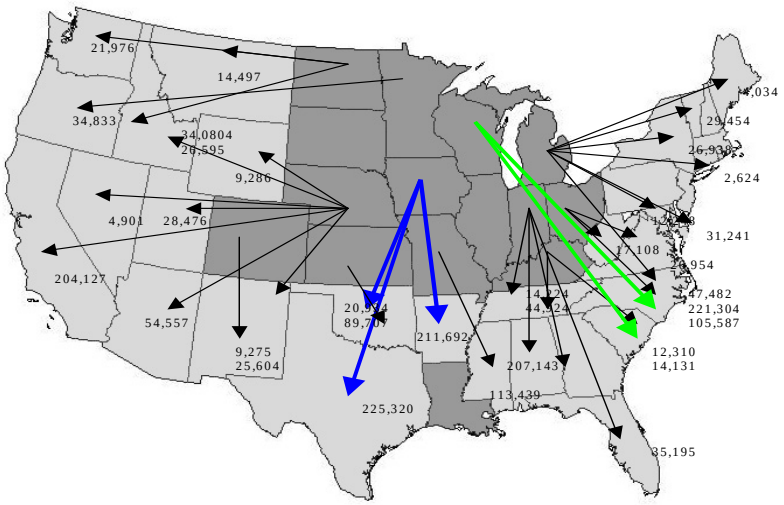

Figure 7: State-to-State Corn Movements for 2007-08
U.S. Production at 13.1 bil bu and Exports at 2.25 bil bu

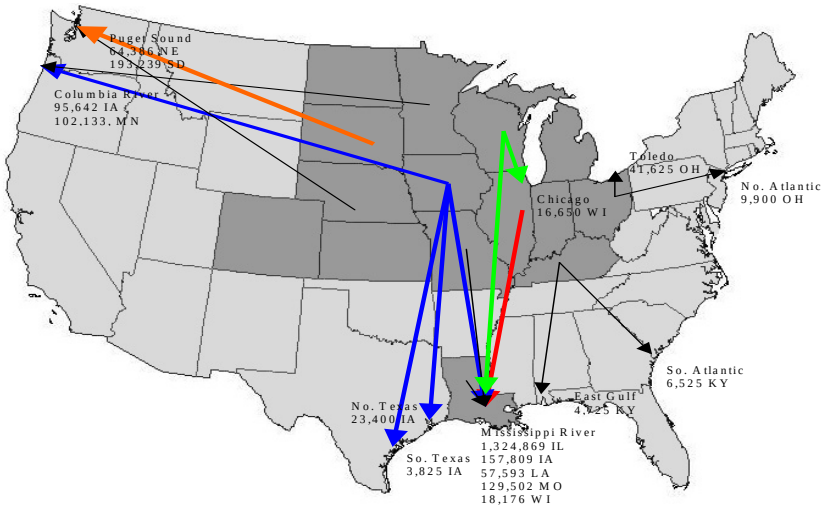

Figure 8. State-to-Port Projected Corn Movement for 2007-08.
U.S. Production at 13.1 bil bu and Exports at 2.25 bil bu

Projected Results for 2008-09

The results of the model for the 2008-09 marketing year are based on projected supply and disappearance data that includes production declining by 2.0 billion bushels from the record 13.1 billion in 2007-08. The reason for the projected decline is because planted acres of corn are expected to drop from 93 million to around 87 million, but other expectations are to a level of 83 to 84 million. While corn prices are at record high figures of around $5 per bushel so are soybean prices at $10 to $12. It is expected that the soybean acres are "bidding away" acres from historical corn production. In addition, the cost of nitrogen fertilizer is at $700 to $800 per ton and significantly increases the cost of corn production. The scenario of 2.0 billion bushels less of corn production seems reasonable and for this analysis.

A second projection for the 2008-09 marketing year is the higher amount of ethanol production over the previous year. The amount is based on the known plants under construction and when they are expected to be operational. Ethanol production is expected to go from 8.6 billion gallons in 2007-08 to 10.8 billion by the 2008-09 marketing year for an increase of 2.2 billion gallons. The total corn required would be 4.0 billion bushels or about 36 percent of the projected corn production.

The net surplus and deficit states for 2008-09 are shown in Figures 9 and 10. The states of Illinois, Iowa and South Dakota that were significantly surplus in 2007-08, and had been for decades, now turn into deficit states in 2008-09 under the above assumptions. Wisconsin turns nominally deficit in 2008-09.

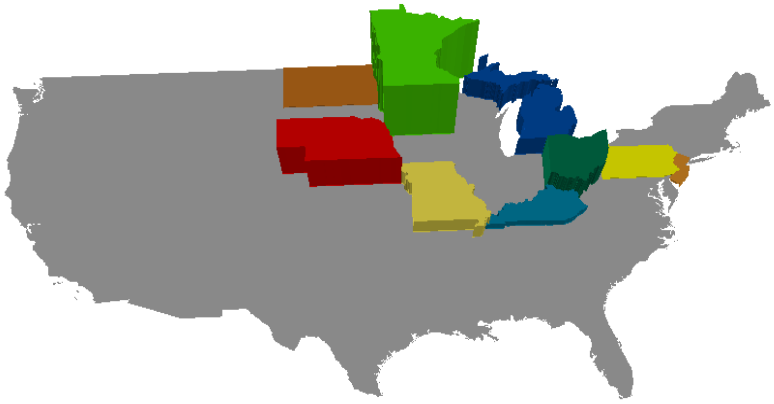

Figure 9. Net Surplus States, 2008-09 Marketing Year

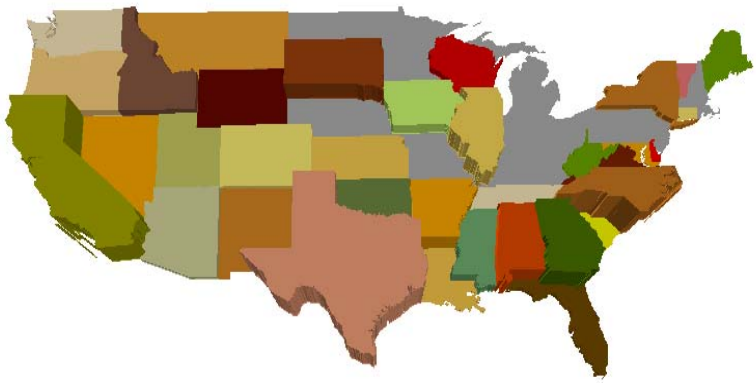

Figure 10. Net Deficit States, 2008-09 Marketing Year

Figure 11 shows the distribution of corn from surplus states to deficit states during the 2008-09 marketing year under the above assumptions. The dashed lines show the historical movement of corn from the formerly surplus states of Iowa and South Dakota to other deficit states, and those movements would disappear.

Once the surplus states become deficit in 2008-09 they would no longer supply their traditional deficit state customers, and instead would need to be supplied from nearby surplus states. The state of Illinois would be supplied by Indiana, Iowa by Minnesota, and South Dakota by Nebraska and Minnesota. Those traditional

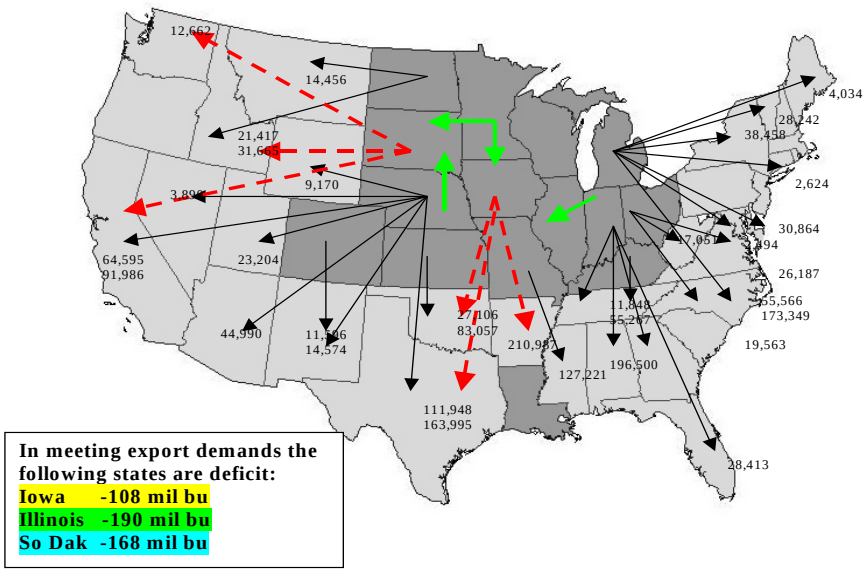

Figure 11. State-to-State Movement of Corn, 2008-09
U.S. Production at 11.1 bil bu and Exports at 2.25 bil bu

deficit state customers no longer served would need to receive greater shipments from other surplus states. This would be a major structural change in the marketing of corn for these large corn-producing states. The reason they become deficit is because of the geographic concentration of ethanol plants in those states. Even though Nebraska is the second largest producer of ethanol, it remains a surplus state because of its lesser role in serving the export market.

Figure 12 shows the movement of corn from the surplus states to the ports of export for 2008-09 under the above assumptions. While the states of Illinois, Iowa and South Dakota became corn deficit because of the increased ethanol demand for corn, they still would be a major source of corn for the export market. Illinois would ship to the New Orleans port of export, Iowa to south Texas and Portland, and South Dakota to Puget Sound. This would not be different than their historical shipments (Fruin et al. 1990, 22-23, Hill et al. 1981, 16).

Estimates of corn surpluses and deficits were also made for 2009-10 that included ethanol production capacity reflecting the completion of additional plants currently being built. The same states as in 2008-09 remained surplus and deficit, and the corn movements given by the transshipment model were similar.

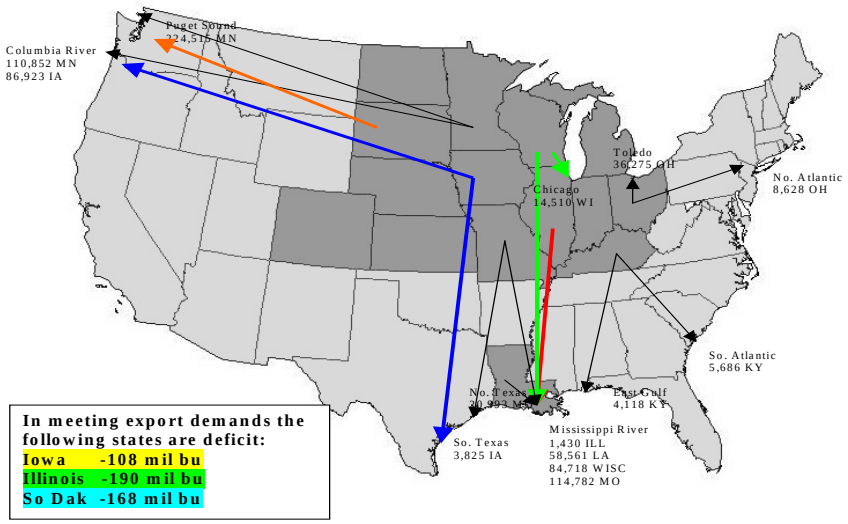

Figure 12. State-to-State Projected Corn Movement, 2008-09
U.S. Production at 11.1 bil bu and Exports at 2.25 bil bu

Conclusions

The results show that there could be significant changes in the historical utilization and marketing of corn in the U.S. The change in movement patterns provides one source of visible evidence that a structural change is underway being caused by the surging development of ethanol production. The structural change is not only affecting the production and marketing of corn, but also of soybeans, wheat and even cotton because of the related nature of crop rotation and producers decisions about what crop to plant given market signals. The increased demand for corn is creating a derived demand for increased acres planted to corn that would mostly come at the expense of soybean, wheat and cotton acres. In response, the prices of soybeans, wheat and cotton have substantially increased, by double or more over historical levels, during 2008. Those commodities are in price competition with corn to sustain their respective acres planted to assure adequate commercial supplies of the commodity.

One of the mainstay mechanisms for the marketing of corn by producers is the forward contract. These contracts are offered by agribusinesses that originate and merchandise grain. The contract offers the producer a fixed price for their corn that is to be delivered at some future agreed upon time period. The agribusiness hedges the forward purchase by selling a futures contract and assuming the obligation of meeting margin calls if the price increases. The producer favors the forward contract because the price is fixed and they do not need to meet any margin calls. With the increased U.S. and global demand for corn and the affect on prices, not

only for corn but also for soybeans and wheat, the availability of forward contracts is becoming scarce.

Implications for Agribusiness Managers

As the ethanol industry grows and the related demand for corn shows a substantial increase, there are a number of implications for the managers of agribusiness firms that are in the business of marketing grain.

First, as the demand for corn by ethanol plants increases, agribusinesses in the marketing chain have to provide the logistical functions of origination, transport and storage. The ethanol plant is primarily focused on the processing of corn into ethanol and co-products and usually has storage capacity for only a short time period. The existing local grain elevator that has traditionally been in the storage business can provide storage so the ethanol plant has assured supplies during the post-harvest season. Producers can also provide storage on-farm. The origination and transport of corn can be done by the ethanol plant depending on their ability as new competitors with area agribusiness firms that have been marketing grain usually for years before the arrival of an ethanol plant. Given an agribusiness's historical relationship with their customer base – a relationship in rural communities that is typically a personal one - the ethanol plant can use the existing agribusiness to provide the needed origination and transport of the corn.

Second, and directly related to the results of this research, the interstate transportation of corn will need to be developed between agribusinesses at origins and destinations in the respective surplus and deficit states. This involves a seller or a buyer making arrangements with carriers, such as trucking companies or railroads, for shipments that have not been a routine part of the their business. Not only will arrangements with carriers be needed, but also a basic business relationship between those agribusinesses that can supply the corn and those that need it. This involves establishing a relationship of trust across state lines including provisions for pricing, quality, delivery, receipt and payment. The research from this study shows where potential new markets will likely exist for those agribusiness in surplus states.

A third implication for agribusiness managers has to do with the increased demand for corn and the affect this is having on prices for corn and other commodities. As discussed in the results section the availability of forward contracts is becoming scarce, which also has significant implications for producers wishing to use these contracts to manage price risk. The reason the forward contracts are becoming less available is because commodity prices have substantially increased from historically normal levels by double or more. The agribusiness offering the forward contracts finds itself having to meet exceedingly large margin calls. Agribusinesses borrow money to finance the margin calls, but lending covenants on other forms of debt can

become restrictive. In addition, the cost of borrowing the money can reduce the expected earnings from offering forward contracts. With the doubling or more of commodity prices, those earnings are in some cases becoming negative. The agribusiness can no longer afford to offer a risk management contract to the producer, and the producer is left to go directly into the futures market or accept the spot price.

How long the commodity prices will remain at these high levels and continue to show increased volatility is unknown, but the return to the historically normal pricing and marketing of corn seems unlikely for the next few years. Agribusiness managers are facing a number of new challenges.

Additional Research

The research done in this study estimated the surpluses and deficits for corn with the projected increased in ethanol production. One of the co-products of ethanol production is distiller's grain or DDGs. DDGs can be substituted, up to a limit, for corn in the feed rations for cattle, hogs, dairy and poultry. This would lessen the feed demand for corn and make it available for the traditional customers in the market. For example, the state of Nebraska exports approximately half of its net surplus to California for feeding dairy cows. If that corn goes into Nebraska ethanol production, then the California market would need to find other sources. But Nebraska is also a major cattle feeding state and the substitution of DDGs into the feed rations may still allow the California market to receive the needed corn. Data and information is only now being developed on the inclusion levels of DDGs for feeding livestock and the adoption rate into feed rations by producers. With more complete information and data, the substitution of DDGs for corn can be factored into the estimates of surpluses and deficits for corn, and the movement patterns projected using the transshipment model. Again, the substitution of DDGs for corn will be a significant component in the structural change taking place in the feed grain-livestock economy being caused by the growth in ethanol production.

At a more global level, reflecting on the demand for energy and especially crude oil and refined fuels in areas of the world like China and India, it is evident that in recent years the demand for energy is showing healthy growth relative to current supplies. Increasing, the supply of energy takes time, including adjustments to public policies that restrict the development of known energy sources. There are chain-like connections between the global supply and demand for energy, the surge in ethanol production, and the production of corn in the U.S. and rest of the world. The focus of additional research would be to estimate, as best as possible, the future demand and supply of energy in the various regions of the world and connect that back to the expected production and demand for ethanol, and hence corn. Imbedded in this global view is the issue of food versus fuel.

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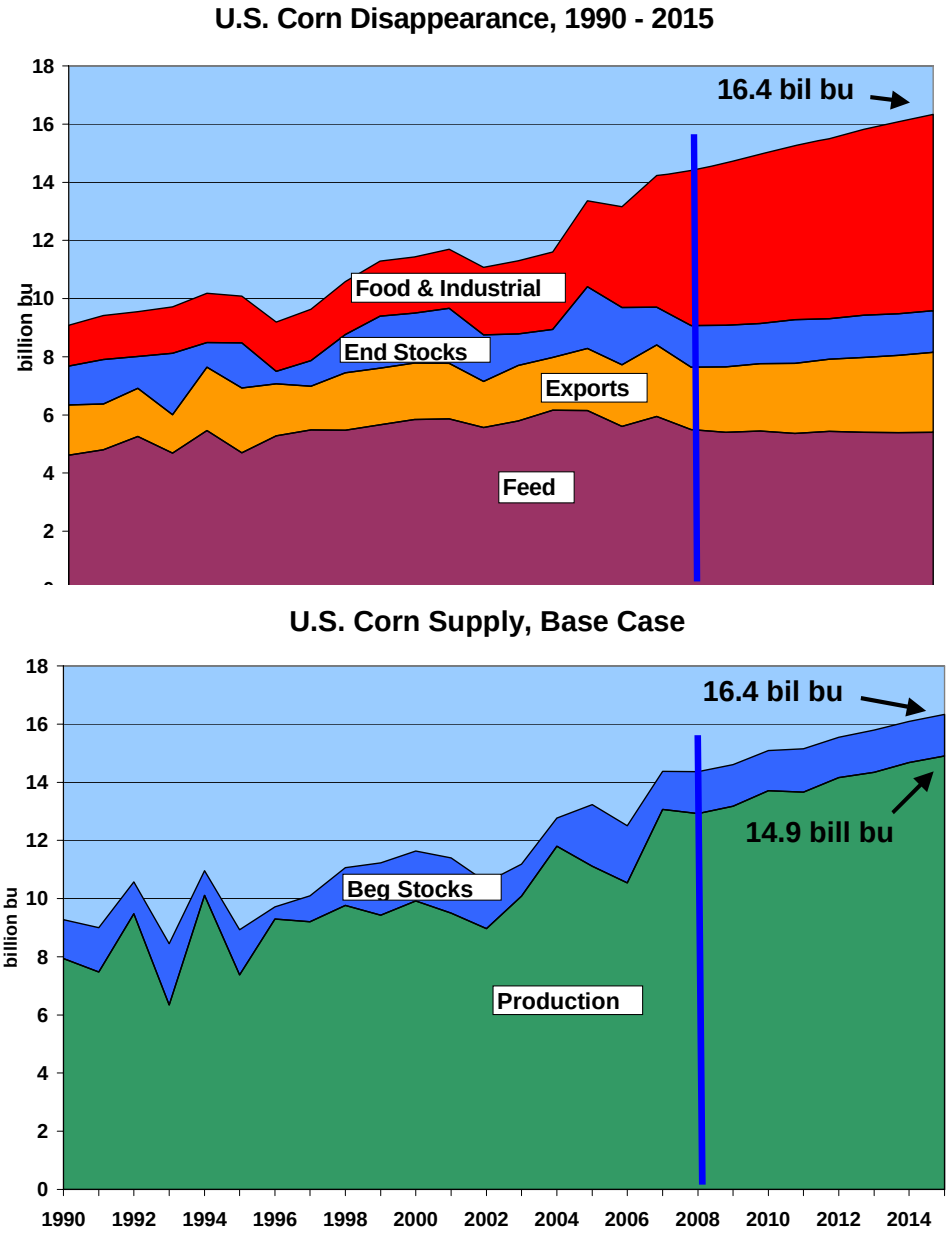
Appendix A.



Appendix B. State Surplus or Deficits, million bushels, 2007-10.

State	2007	2008	2009	2010
Alabama	-238	-221	-216	-218
Arizona	-65	-61	-60	-60
Arkansas	-254	-233	-227	-228
California	-237	-247	-250	-257
Colorado	-67	-57	-51	-48
Connecticut	-9	-8	-8	-8
Delaware	-33	-29	-27	-27
Florida	-32	-29	-28	-29
Georgia	-283	-285	-285	-292
Idaho	-60	-72	-75	-79
Illinois	1,134	-190	-163	-126
Indiana	399	296	293	298
Iowa	315	-108	-90	-83
Kansas	-80	-87	-79	-76
Kentucky	46	40	45	51
Louisiana	21	-25	-23	-21
Maine	-4	-4	-4	-4
Maryland	-13	-9	-7	-4
Michigan	103	109	118	127
Minnesota	563	312	329	338
Mississippi	-151	-137	-133	-133
Missouri	163	86	94	104
Montana	-18	-16	-16	-16
Nebraska	300	182	193	199
Nevada	-6	-5	-5	-5
New Jersey	7	7	7	8
New Mexico	-29	-26	-26	-25
New York	-29	-49	-53	-57
North Carolina	-372	-342	-333	-334
North Dakota	57	6	-3	-11
Ohio	305	130	112	95
Oklahoma	-149	-136	-132	-133
Oregon	-51	-75	-80	-87
Pennsylvania	0	8	14	17
South Carolina	-29	-25	-24	-23
South Dakota	105	-168	-167	-167
Tennessee	-79	-102	-107	-110
Texas	-334	-358	-360	-370

Appendix B. Continued

State	2007	2008	2009	2010
Utah	-29	-27	-26	-26
Vermont	-11	-10	-10	-10
Virginia	-57	-51	-49	-48
Washington	-42	-51	-53	-57
West Virginia	-20	-18	-18	-18
Wisconsin	53	-58	-47	-42
Wyoming	-15	-14	-13	-13
Other States	-52	-41	-37	-47
Total	**2,725**	**-2,197**	**-2,082**	**-2,056**

