Dude, Where’s My Corn?  
Constraints on the Location of Ethanol  
Production in the Corn Belt

Liesl Eathington  
and  
Dave Swenson  
Department of Economics  
Iowa State University

Abstract
As the Midwest gears up to rapidly add new ethanol manufacturing plants, the existing regional economy must accommodate these changes. There are issues for decision makers regarding existing agricultural activities, transportation and storage, regional economic impacts, and the likelihood of growth in particular areas. Many of these issues need to be considered in a simultaneous fashion.

This paper describes our ongoing model development for determining the optimal placement of new ethanol plants based on the availability of feedstocks within a defined geographic territory. One of the model’s intended applications is to explore the limits of statewide or regional ethanol production and its potential economic value to the regional economy. Toward that end, we first address the issue of determining reliable and credible biofuels-related job impacts. Next, in the second phase of our research, current or future levels of local demand for biofuels inputs (corn, currently) and processing plants are factored into the model to account for competing uses in space. The GIS-dependent application iteratively places new plants until the supply of available feedstocks in the study region no longer meets the threshold level required to sustain additional plants. This model allows manipulation of the various assumptions so that many different policy and economic scenarios can be assessed. Last, we will combine the results to determine where and by how much we might expect the ethanol industry to grow in our region.

This is an applied research and planning exercise designed to figure out the pace, pattern, and outcomes of rapid growth in the number of corn-supplied ethanol plants in Iowa and in particular sub-regions of the state. This process also has application to future biomass development scenarios as credible technical information emerges about agricultural production and about the future ethanol industry.

Introduction

Iowa is in the midst of a radical change in the use to which its most prevalent agricultural commodity, corn, is being put. An ethanol production boom has led to rapid-fire ethanol plant development across the state, further yielding multiple regional economic research, planning, and policy development challenges. The state’s ethanol production capacity nearly doubled between 2003 and 2004, doubled again between 2004 and 2005, and increased another 60 percent between 2005 and 2006. Construction of new plants continues.

As production capacity grew, so grew the public awareness of the biofuels industry. Judging from the number of ethanol-related newspaper stories indicated in Figure 1, public interest in ethanol spiked sharply in 2006. Announcements of new ethanol plant proposals, on-going ethanol plant construction updates, and other ethanol-related stories were frequently found in Iowa’s daily newspapers during 2006.

Figure 1

Iowa Newspaper Stories Containing the Phrase "Ethanol Plant"

![Figure 1: Iowa Newspaper Stories Containing the Phrase "Ethanol Plant"](image)

A combination of economic, global, and political factors also helped feed the state’s interest in ethanol. A federal mandate re-authorizing tax credits of $.51 per gallon for 7.5 billion gallons of ethanol production certainly helped fuel growth. Higher gas prices especially after Hurricanes Katrina and Rita, and again during the summer of 2006, piqued the public interest in and the perceived need for alternative fuels. The phased-in use of ethanol to replace MTBE as a fuel additive in several regions of the U.S. led to sharp spikes in the price of ethanol during the summer of 2006, and Mideast and other international issues involving producers like Venezuela and Nigeria kept crude oil prices very high for much of last year. Profits in the industry were

¹Ethanol is a viable substitute for gasoline, and its price will track closely to gasoline prices, so if gasoline prices are high, the price for ethanol will generally follow, provided of course that demand and supply are in concordance. The energy value of
reported to be very high. The industry does best when gasoline prices are high and corn prices are low.

In Figure 2 we see that by November, 2006, a huge run-up in expected demand for corn from this booming industry led to much higher corn prices. The jump in corn prices coincided with a major spike in ethanol-related news stories. Notably, gasoline prices declined sharply at that time – an offset to the ostensible profitability of ethanol plants. Currently the pace of new plant growth appears to have ebbed.

![Figure 2](image)

In the earlier stages of this boom in both public support and plant construction, politicians, local policy makers, and economic developers hailed the emerging industry as the right and proper evolution of modern agricultural production capacities coupled inexorably with for-sure-just-around-the-corner technological breakthroughs and long overdue changes in the nation’s energy policies.

Amidst all of this enthusiasm, biofuels trade associations reported in various venues that thousands and thousands of jobs had been created across the Corn Belt, politicians and government agency representatives parroted those claims uncritically, state governments began to specifically apply agency services in support of the boom and offer lucrative tax credits and incentives to promote even faster growth, land-grant universities promoted their vital scientific contributions in this coming energy revolution, cities and counties scrambled to be the site of a modern ethanol factory – to be on the winning

ethanol is roughly two-thirds of gasoline, so price without subsidy would be expected to be two-thirds the price of gasoline.
side for a change, and rural leaders in Iowa started talking about a rural renaissance. All from ethanol.

Within this cycle of what a non-Corn Belt observer might see as irrational, if not more accurately parochial, exuberance, several questions and concerns emerged:

- The rhetoric of job growth claims by politicians and trade groups clearly did not square with reality. Despite claims of thousands and thousands of job impacts, rural areas simply were not realizing the promised gains made by trade groups and political leaders. Dozens of jobs, maybe, but not the hundreds that folks were told to expect.

- The number of announced new projects, were they to be constructed, would literally wipe out the region’s corn exports and more – there was an ostensible future demand for corn that simply could not be met by current and even reasonable projections of future corn production.

- Planned expansions in corn production would have spatial ripple effects on soybean, wheat, and other small grain production that could disrupt the grain markets and processors across several states.

- Environmental concerns emerged as higher corn prices induced removing land from Conservation Reserve Program participation, the conversion of pasture and hay land to crop land, and more continuous cropping of corn, which is both energy and chemically intensive and leads to higher rates of soil erosion and other degradations of the environment.

- In much of the Midwest swine and poultry producers, primarily, rely on corn for feed and tend to be concentrated in the most desirable locations for ethanol plants. The animals that are most compatible with ethanol plant byproducts, feeder cattle, are concentrated in the western and southern Plains.

- The vast grain handling infrastructure that had evolved over decades to store, broker, and move corn out of the Midwest to the coasts and down the Mississippi river would rapidly become inefficient as more and more corn was converted to ethanol.

- As the rhetoric heightened, and as community after community sought to be part of the ethanol expansion, public subsidies in the form of property tax breaks started to increase to the point where the newer ethanol plants in Iowa are receiving 100 percent tax abatements for 20 years. State subsidies also escalated, even in states that had relatively meager corn supplies. And oddly, states with the highest corn supplies, the places where the plants had to locate, ramped up their subsidy packages in an effort to grab as many plants and jobs as might be grabbed.
• And last but not least, the future of biofuels is supposedly in the area of cellulosic not corn-based systems. If there is, as promised, a technology shift, how might that affect the state’s agricultural sector, its regions, and this nascent industry?

Faced with a growing list of concerns about rural development, economic impact, environmental factors, and shifts in the character and nature of agricultural production in the state of Iowa, we have the task, as policy analysts and regional scientists, of helping sort out many of the critical elements of the biofuels phenomenon. First, our basic review of published economic impact claims of biofuels trade groups, many state agency studies, and even a handful of academic papers told us that the job growth potential was severely overstated and ill-described. State and local policy makers were, we concluded, frequently making decisions based on unrealistic economic outcomes.

Second, while there are very easily calculable answers as to the number of ethanol plants that any large region can accommodate, those findings do not tell us where in particular those plants are likely to locate. There is a strong and distinct spatial impact of this whole phenomenon within Iowa, as there is strong spatial variation in corn production capacity and in the uses to which that corn had been put historically.

Third, ethanol proponents, both political and at the industry level, have adopted an “everything will work itself out” response to any claims that this rapid expansion will have disruptive effects on other dimensions of agricultural production in the state or on the environment. This tut-tutting of those raising issues has likely had a chilling effect on scientific, community, and political policy development and debates that might address the emerging consequences of this industry.

Fourth, if most of these transformations happen, there will be very real and knowable pressures placed on local, regional, and state planning activities. Roads and bridges will wear out faster, air and waste-water discharges will increase dramatically and have to be monitored, ground water usage and depletion will have to be gauged, community planning and land-use standards may need to be modified and addressed, and nuisance issues in rural areas will have to be re-visited.

We began to address these issues and concerns in earnest with a set of research products beginning in mid 2006. The first concerned wrestling with the issue of compiling reliable economic impact summaries of the emerging ethanol industry. That research produced two reports designed to stimulate debate and discussion on economic impact issues as well as broad corrections to the manner in which we approach and measure this industry. As these studies neared completion, and we arrived at sound conclusions about the net regional economic gains that an ethanol plant can be expected to produce, another set of questions emerged:
a. where would the plants locate ideally (and, importantly, where would they not be expected to locate),
b. how do existing uses of corn potentially influence plant placement,
c. what is the amount of alignment between where the plants would ideally locate versus where they are actually locating, and
d. what is the upper limit both numerically and spatially to the number of plants the study region can accommodate?

Questions a through c led to the development of a GIS-based system designed to allocate ethanol plants in Iowa based on the production of corn, the existing competition for that corn, and the existence of rail transport systems that helped to determine the best choices for plant placements. That system then, given the constraints in the model, helps us to get at question d. the upper limit of plant development.

Last, and with the aid of this research, we can begin to incrementally or on a projection basis identify not only the amount of plant level impacts that might accrue, but specifically where and in what sequence they might occur. Armed with that knowledge, we can begin to assist policy development and planning activity regionally in our state.

**Phase 1. Determining the Economic Impact Contribution of Ethanol Plants**

There is limited economic impact research of the emerging ethanol industry in Iowa and in the nation that does not raise analytic eyebrows. Indeed, much of the earlier research relied on by decision makers and biofuels advocates was based on poorly specified industrial accounts in modeling systems that were not designed to accommodate the modern and rapidly expanding ethanol industry, or they resulted from simply applying sets of final demand RIMS II – type multipliers to input elements of the industry; in both instances leading to a crude, blunt-instrument approach to estimating the consequences of this emerging industry.

As examples:

- Analysts often “created” new jobs in the corn producing sector of the economy, along with all existing, multiplied-through impacts, even though those jobs were already in the economy.

- Analysts boosted economic activity in the transportation sectors even though the haulage differences between surplus grain (or fed grain products) and ethanol were not articulated well, or at the outset evident.

- Researchers translated price premiums into farmer incomes without determining the net regional effects of higher prices on farm income,
production costs (as in land rents), or the uses to which that income might be put, opting in the main to simply convert the values directly into household income gains and consumption.

- The cost impacts of higher corn prices locally on other corn users or on other industries that handle and distribute grain were ignored or the economic consequences minimized.

- The full value of the short-term economic consequences of new plant construction were commonly allocated to the rural economy at the location of the plant unmindful that the vast majority of the components that capitalize an ethanol plant as well as the higher valued engineering, architectural, and specialized construction talent inevitably come from outside of the region of production. Further, naïve analysts were prone to add construction impacts to ongoing, operational impacts, when reporting totals.

- Most importantly, the cost and revenue structure of modern ethanol producing facilities had not been systematically reconciled with the kinds of industrial impact modeling systems that are necessary for this kind of study.

Our research addressed many of these issues. It sifted through the analytic limits of previous research and created an ethanol impact modeling prototype for studying the regional effects of the placement of an ethanol plant. The procedures were quite basic. Early research at the university level had been done compiling enterprise budget information on ethanol plants (Tiffany and Eidman, 2003; Tiffany 2005; Jolly, 2006; Shunmugavelu, 2003). Translating that information into input output accounts had not been done, however. Some earlier analysis addressed some of these issues (Petersan, 2002; Stuefen, 2005; Swenson, 2005), but none to that point had actually reconfigured existing input-output systems to align with the enterprise budgets for ethanol plants.

Our research, using 2005 cost of production information, translated the Tiffany (2005) structure, as modified and applied by Jolly (2006) and Shunmugavelu (2003) into IMPLAN to replace the wet milling sector in a study region (we could also have replaced the organic chemicals sector, the sector where ethanol is properly located, but neither was in use in the region of study, so it really didn’t matter). That research produced a set of reports (Swenson, 2006; Swenson and Eathington, 2006) designed to clarify the issues associated with determining the economic impacts of biofuels expansion.

The Findings

Our research directly confronted the generally limited economic analysis that had been conducted by advocates, academics, and government agencies on
the regional economic impacts of ethanol in the U.S. In those reports we employed an economic impact definition limited to the net new economic product generated in an area beginning with and as a result of ethanol industrial direct activity. We begin with the plant and move forward – we ignored backward linkages to a corn production sector that was already in existence. In the main we were most interested in isolating labor incomes and jobs attributable to the plant, as these are the elements of most interest to local policy makers and affected citizens. And while construction activity can stand out in rural areas, we focus on plant operations and do not consider construction effects.

An ethanol plant has important commodity supply requirements. It needs new-to-the-region inputs to convert the existing corn supply into ethanol.* These include natural gas or other fuels, electricity, water, enzymes and chemical inputs, perhaps a reconfigured rail distribution system locally, along with a host of financial, technical, mechanical, waste discharge, and service inputs that keep a modern plant running. All of these examples constitute net new input demands in the region that are directly attributable to the placement of the plant in the area. Hence, the plant creates an indirect impact on supplying industries and bolters their sales and their employment.

Last, of course, when workers at the plant and workers in the supplying industries receive their pay, they convert it into household spending. This induces a third round of economic activity.

Figure 3 demonstrates the basic job economic impacts of a 50 Million Gallon Per Year (MGY) dry-milling ethanol plant in a three county region of Iowa assuming that there was no local ownership in the plant. The plant required 36 jobs, it linked to as many as 75 indirect jobs, and the induced bump from household spending increases yielded 23 jobs for a total of 134 jobs.

We next scaled our plant sizes up. While 50 MGY plants were considered large just two years ago, nearly all newer plants are closer to 100 MGY in size. Using the same procedures, we then modeled the expected job impacts of the larger plants. Those findings are also displayed in Figure 3 also. The plant required just 10 more direct jobs to double its output. We assumed that a preponderance of the scale economies evident in the plant similarly apply to a large fraction of the increases in input supplies (natural gas, water, and transportation especially), and that yielded just 20 more indirect jobs. Including the six more induced jobs, the 100 MGY plant had a 170 total regional job impact. In doubling the output, the job impacts from plant operations only increased by 27 percent. As this industry evolves and

* As the corn already exists and the plant is not altering the overall production of agricultural goods in the region (in a situation where the corn is produced in surplus), we did not count the corn production as net new regional economic content as many of the flawed analyses frequently do.
matures in Iowa, there is the expectation that significant scale economies will be sought and realized.

**Figure 3**

Regional Job Impacts in a 50 MGY and a 100 MGY Ethanol Plant

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<th>50 MGY</th>
<th>100 MGY</th>
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<tbody>
<tr>
<td>Direct (ethanol plant)</td>
<td>36</td>
<td>46</td>
</tr>
<tr>
<td>Indirect (suppliers)</td>
<td>75</td>
<td>95</td>
</tr>
<tr>
<td>Induced (household spending)</td>
<td>23</td>
<td>29</td>
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To illustrate this, using the 2006 corn crop as our base and assuming that all of the corn that was not fed to animals was processed into ethanol by 50 MGY capacity ethanol plants, only 70 plants would have been required to do the task. The total job impacts under that hypothetical situation would yield from 9,000 to 9,500 jobs, assuming minor variations in regional multipliers. These results are not the purported tens of thousands claimed by advocates, but still a large number of jobs. If all of the plants were 100 MGY in size, had scale economies been achieved broadly, the direction that this industry is rapidly taking, it would take only 35 plants and have a total job impact of from 5,700 to 6,200 jobs. The upper limit in Iowa given current corn supplies is somewhere between the two ranges, but of late weighing toward the latter. These estimates are future values, we do not yet process 1.5 billion bushels of corn into ethanol in the state; but we are rapidly

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*For those not up on ethanol production factors, the following assumptions were used: Plants produce at 115 percent of their nameplate capacity (or more); hence a 100 MGY ethanol plant produces 115 MGY of ethanol. Plants also average about 2.7 gallons of ethanol per bushel of corn. For these calculations I assumed that there was 1.5 billion bushels of corn available for the ethanol industry in Iowa.*
approaching the capacity to do so. That means that we have not achieved the job impacts listed above."

So there are two simultaneous transformations in Iowa. First, there is the move to larger plants. It is expected that over time, some of the larger plants will overwhelm earlier, smaller, more labor intensive operations. As this industry matures, it will average fewer jobs per million gallons of ethanol produced than in the past. Second, the supply of corn, in the short run at least, will increase in the state and nation primarily because of planting decisions but also, slowly, through yield improvements. That means that the upper limit on ethanol plants in the state of Iowa is yet to be determined. In order to accommodate those two moving functions, we need to get a better handle on the probability of ethanol industry growth in Iowa spatially and to build an estimate process that could consider industry changes, production changes, and different regional competition-for-corn scenarios.

**Phase 2. How Many and Where?**

A primary goal of this research was to identify a realistic estimate of the potential economic value of the ethanol industry to the state of Iowa. In Part 1, we tackled some of the issues involved in determining the average impacts of a typical ethanol production facility. The next step was to identify a reasonable upper limit for total statewide production and where that production is likely to occur.

The number of viable ethanol plants in Iowa will likely depend on several factors, including their spatial distribution across the Iowa landscape and how intensively they must compete for inputs. Variations in soil quality and average yields, infrastructure and transport costs, and the level of competition for inputs from existing uses for corn are all factors that will influence decisions about where ethanol plants will be built and how large they will be.

The physical factors influencing the location of new ethanol plants are relatively easy to assess. Other factors, especially those related to human behaviors, are not. As an example, consider the geographic clustering of proposed ethanol plants in Figure 1. The map shows the locations of existing and proposed ethanol production facilities at the time our model was built. The locations of the 21 proposed plants suggest that competition from existing plants was a major consideration. For example, there were very few plants proposed in the eastern part of the state, where several very large, wet milling facilities are already in operation. In contrast, it appears the locations of competing proposals for ethanol plants did not serve as a major

"While these are indeed future ethanol plant impact job values, the Renewable Fuels Association released a study in March, 2007, claiming that the ethanol industry supports the creation of 53,000 jobs throughout the Iowa economy."
deterring factor. In some parts of the state, competing groups were racing each other to raise capital and navigate the approval process for building a plant.

Figure 4

One of the goals of this project was to compare the locations of proposed plants with an objectively determined distribution of plants that was based solely on physical factors. A second goal was to identify regions in the state that might be headed for a deficit corn supply, assuming that all of the proposed plants were actually built.

To obtain the objectively determined geographic distribution of plants, we built an application using geographic information systems (GIS) software. The GIS application iteratively places new ethanol plants in our region of interest until the available corn supply had been exhausted. Details of the model’s construction are described in Appendix B to this report. Here, we limit ourselves to a discussion of our considerations in building the model and our modeling results.

Study Region

Our study region included Iowa and neighboring counties within 60 miles of Iowa’s borders. Including the bordering counties allowed us to more realistically portray the potential supply regions for ethanol plants in every corner of the state. The set of potential plant locations initially included all communities in Iowa.

Model Constraints
The first constraint we introduced into our model was the state’s existing transportation infrastructure. Remote communities that were not situated along paved highways or existing rail lines were ruled as ineligible sites for a new ethanol facility.

The next constraint was the ability of the land to produce corn. Figure 5 shows which regions of the state have the highest average corn yields over the last three years. In general, the northern and central regions of the state have the best yields. Southern and eastern regions have soil types that are less profitable for corn production.

For the third constraint, we considered competing uses for the corn. These competing uses included wet corn milling operations producing corn sweeteners and other products, existing ethanol facilities, and the livestock production sector. The levels of demand for corn from the livestock and other sectors vary within the state. Some of the state’s best corn producing regions also have the highest levels of livestock production, especially hogs and poultry. Figure 6 illustrates, for example, the relative density of hog production in the study region.

Our goal was not to develop a model that reached new equilibrium levels of production between ethanol, corn sweetener, and livestock production. Rather, we were interested in how much ethanol production could occur in the state before existing industries and supplies were substantially disrupted. Therefore, the total corn requirements from existing users were simply subtracted a priori from regional corn supplies in our model. We are leaving existing users whole in this first round of modeling with the option, down the road, of reconfiguring their demand as new production information emerged.

**Model Procedures**

After accounting for regional production capacities and existing demands for corn, the application of the GIS model involves a simple, iterative process.

1. Start looping through all potential plant locations.
2. For each location, identify a fixed market territory from which a plant might obtain corn inputs.
3. Calculate the total corn supply available to a new plant by multiplying the total area in its circular market territory by the regional average density of corn supply.

4. Identify the location with the largest available corn supply in its market territory.

5. Place a plant in that location. The model allows for two plant sizes to be built. Large, state-of-the-art 100-million gallon plants are placed first. Smaller, 50-million gallon plants are squeezed into regions that can sustain them.

6. Begin another loop through the potential plant locations.

The model stops looping through potential plant locations when there are no remaining locations with large enough regional corn supplies to sustain a plant.

**Model Results**

The map in Figure 7 shows locations where the model suggested new ethanol plants in Iowa. Recall that there were 21 plants in proposal status at the time of this project. Among those 21, there were proposals for three ethanol plants at 50-million gallons, one at 80-million gallons, 16 at 100-million gallons, and one at 150-million gallons. Our model placed the same total number of plants in the state; however, the combined capacity of these 21 plants was only 83 percent of the actual proposals. Just 12 of the model-placed plants were 100-million gallon plants and 9 were 50-million gallon plants. The location of the proposed plants also differs from the locations chosen by the model. Figure 7 shows the model-proposed and actual proposed ethanol plant locations. Notably, the GIS model identified a greater number of potential plant locations outside of Iowa than within the state.

Last, Figure 8 demonstrates that after the process has run its course there are small areas with corn left over and small areas where demand will exceed modeled supplies. Merely dividing all of the corn in Iowa by the number of ethanol plants to process that corn oversimplifies the process and likely overestimates the number of plants the state might support. On the other hand, considering the border counties and plant locations in those surrounding areas helps us to better predict the likely amount of plant growth in Iowa.

The modeling exercise demonstrated that the number of state-of-the-art, 100-million gallon ethanol plants that can be sustained with a local corn supply is lower than the number obtained when spatial competition is ignored. The regional pockets of projected surplus and deficit remaining after the modeling exercise suggest that a greater percentage of corn inputs for future ethanol plants will likely come from non-local sources. Increased transportation costs and related issues will have implications for the cost structures and profitability of the plants.
Figure 7

Model-Chosen and Actual Locations of Future Ethanol Plants in Iowa and Neighboring Counties

Legend
- Proposed plants
- Model-chosen plants
  - 100 million gallons
  - 50 million gallons

Figure 8

Model Results: Net Surplus or Deficit of Corn

Legend
- Net surplus or deficit
- Bushels per acre
- 75 to 100 surplus
- 25 to 50 surplus
- 0 to 25 surplus
- Study-region counties
Model Manipulation

Certain assumptions and variables within the GIS model’s program can be altered. For example, we can change the average corn yields to account for corn breeding technology gains or adverse environmental conditions such as drought. We can also change the buying radius used for determining a plant’s market territory. Finally, we can change the amount of corn demanded by the region’s livestock production sector. Some of the by-products of ethanol production are already used for livestock feed, and the extent to which these by-products will offset feed grain requirements is still an open question.

Other factors that may be introduced to the model at a later date include constraints on plant location based on the available local water supply and constraints due to transport costs.

Phase 3. Implementing the Findings

We are currently in the process of applying our findings. First, new information needs to be entered into our corn supply and demand model. Better information on all livestock numbers will be entered to more accurately simulate regional grain competition. Second, since this model was initially built and first run there have been several new plant additions along with changes in the number of proposed plants. The model needs to be updated to the latest available data. And last, there are expected sharp increases in the amount of corn acres in Iowa. We would want those numbers included to accommodate and shift in corn supplies. That done we will begin to piece together a regionally-specific biofuels economic impact job and income forecast for the state.

Concluding Comments

All pertinent state agencies and Iowa State University, our home, are actively engaged in the development of the state’s biofuels potential. There have been several large conferences, and the University has developed several outreach components, to include web-casts of technical, economic, and other research pertinent to this industry.

There are several challenges for research and policy development still remaining in Iowa, among which are:

- Notwithstanding, the rhetoric of sustainable systems, most of the economic development activity and community focus is on corn-based systems.
- The university, while working very hard to position its scientific community around the next generation of biofuels research and technology transfer, still expends tremendous personal and research
resources in supporting and maintaining the existing corn-based production system.

- Iowa governments, both state and local, are dedicating increasingly lucrative, multi-million dollar incentive packages to entice plant locations, notwithstanding the paucity of returns to fiscal accounts.
- Though economic research is beginning to accumulate that is broadening and deepening the discussion of the economic and agri-system consequences of biofuels promotion, that research is yet to gain the amount of public attention and acceptance that has accumulated from ad campaigns from biofuels proponents.
- Community meeting opportunities abound where biofuels issues can be delivered and discussed, but attendees often have an inflated sense of the localized benefits potential of hosting an ethanol plant.

This research demonstrates that there are clear and knowable limits to the size and distribution of the ethanol industry as it is currently technologically configured in Iowa. This research has also introduced a modicum of nimbleness into the policy assessment and economic development process that allows us, as information and conditions warrant, to revisit and reconfigure our estimation systems to address both regional and statewide issues.
Works Cited or Otherwise Used to Prepare this Paper
(including citations for Appendix A)


Appendix A: A summary of ethanol economic impact issues  

Great Expectations or Multiplier Madness: Biofuels Economic Impacts

Those promoting aggressive private and public investment in more biofuels processing capacities range from farm commodity groups, farm state politicians, many environmental organizations, automobile manufacturers, to both right and left wing political orientations. There are, however, incredible ranges of economic activity attributed to biofuels production. Very little appears to be based on rigorous research even though the authors of the research often allude to the use of standard national multipliers (produced by the U.S. BEA) or input-output models (like Implan). What follows is just a brief sampling of the dimensions of economic expectations from ethanol or biofuels production.

Nationally, an Urbanchuck (2005) report using US BEA RIMS II multipliers, claimed 114,844 jobs in the national economy depended indirectly on the operation of all ethanol plants and the purchases that are made by workers (and this does not include ethanol plant employment of perhaps 3,500 to 4,000, which were not specified in the report). Corn, a commodity that the country overproduced historically (and currently) and is subsidized heavily accounts for 85,311 of those jobs. These results intimate that increased ethanol production is expanding the number of farmers and farm related jobs in the United States (USDA statistics notwithstanding to the contrary), as that is where the vast majority of job impacts are located.

Novack (2002) of the Federal Reserve Bank of Kansas City is much more expansive, but does not cite her sources. She reported that “… the [ethanol] industry added nearly 200,000 jobs to the U.S. economy.” This is truly an optimistic statement because the U.S. Census Bureau reported that in 2002 the ethyl-alcohol industry itself in the U.S. had just 2,200 jobs. She goes on to predict that “an additional 214,000 jobs will be created through the economy over the next decade.” Former South Dakota U.S. Senator and biofuels advocate Tom Daschle likes Novack’s numbers. He noted in an essay this year (2006) that the current U.S. production of 3.1 billion gallons of ethanol created 200,000 jobs.

At the state level, a 2003 Minnesota Department of Agriculture study concluded that state’s 356 direct ethanol production jobs created a total of 2,562 jobs using in this case, Implan, as the basis for its estimation. More robust job multipliers using Implan are found in a recent University of Missouri Extension report (2006). It concluded just 4 plants employing 154 persons in the state accounted for 2,784 total jobs – a hefty jobs multiplier of 18. In Evans’s, 1997, work for the Midwest Governors’ Conference, the author figured that 800 total jobs in ethanol production in Iowa alone sparked an increase of 5,800 jobs in machinery manufacturing in the state.
and 33,900 additional jobs related to the enhancement of farm income for a 
jobs multiplier of 51.

A Des Moines Register story in April of 2006 quoted an industry advocate 
from an organization called BIOWA claiming that 10 new bio-refinery plants 
in Iowa would create 22,000 jobs. That advocate cites a University of 
Northern Iowa study in support of those figures, but he could not produce a 
copy of that research when asked. Iowa’s Soybean Association announced 
in March of 2006 that it had done a study in which they predict soy biodiesel 
will add $1.3 billion in income to the state and 15,000 jobs, although one 
cannot obtain their study via their press linkages.

In very stark contrast to this numerical enthusiasm, there are other reports 
that provide markedly lower estimates of job impacts for Iowa. A 2006 
(Imerman and Otto) report on energy supply and usage in Iowa contained a 
table on the economic impacts of 800 million gallons of ethanol in Iowa 
produced for export. That table is more modest compared to previous 
estimates and concluded that 2,400 total jobs were impacted by the industry 
(outside of corn production) in the production of those export sales. That 
analysis and conclusion were reached by a university researcher and 
professor in a different university in Iowa who has a good sense of input 
output analysis, especially in value added agricultural situations.

There are reports by researchers linked to agribusiness that are much more 
modest in their expectations. In the Stueffen (2005) report produced for the 
South Dakota Corn Growers Association, the author removes the corn inputs 
from his impact calculations – a step in the right direction as the corn was 
already produced in his study area. Just on the ethanol side, this author 
concluded that 473 direct jobs were tied to 2,972 jobs in the state economy. 
Another more modest finding was produced by Petersan (2002) of the 
Nebraska Public Power District. Noting that “the existence of this facility will 
not result in the production of additional agricultural products within the 
study area...” Petersan found that an 80 MGY plant in an rural Nebraska area 
would require 48 direct workers and would link to just 163 total jobs in the 
rural regional economy, and my earlier effort (Swenson 2005) in this area 
using a wet mill configuration aligned closely with the Petersan example.

The attached graph shows some of the different job multipliers that were 
discerned from these research reports by the analytical foundation for the 
estimates (RIMS II or Implan). They ranged from a low of just 3.4 for one 
plant in Nebraska (Petersan), to over 50 in the case of Evans’s estimate for 
the state of Iowa.
Estimated Jobs Multipliers in Ethanol Studies
(Excluding Construction Effects)

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States: IA (Iowa), MO (Missouri), PA (Pennsylvania), MN (Minnesota), SD (South Dakota), U.S. (United States)
Appendix B: Technical summary of the GIS-based ethanol plant location simulation model


Purpose
With this modeling exercise, we are simulating the construction of new ethanol plants in Iowa to determine the number and placement of plants to would minimize regional competition for corn and transport distances for corn inputs. their demand for corn disrupts the current framework of corn and livestock production decisions.

We use a GIS application that selects optimal locations for new ethanol plants based on the availability of corn within a defined geographic territory surrounding a potential location. Current levels of local demand for corn for livestock feed and existing wet and dry milling plants are factored into the model. The GIS application iteratively places new plants until the supply of available corn in the study region no longer meets threshold level required to sustain additional plants.

Study Region Definition
The study region includes Iowa counties and bordering counties within 60 miles (237 counties in total)
Potential Plant Locations
The locations for potential ethanol plant are restricted to cities along rail lines or paved highways.
Local Corn Supply and Livestock Demand for Corn

The amount of corn available for any potential plant location is based on regionally-specific average densities of corn supply and demand. We estimate these densities using county-level data for:

- Average corn yield in bushels per acre (weighted average for 2003-2005)
- Average crop acres per square mile (2002 Census of Agriculture),
- Percentage of crop acres in corn (2002)
- Average number of hogs and cattle per square mile (2002).

We use a GIS interpolation procedure to spread these county average values over space and create continuous “surfaces” for each variable.
Next, we “capture” these surface values at supply nodes defined at the township level of geography.  

For each supply node, we estimate the total bushels of corn produced and the amount of corn demanded for livestock feed. Corn supply and demand at each node as calculated as follows:

- Total corn supply in bushels = average crop acre density * average corn acre percent * average corn yield * square miles in township
- Hog demand in bushels = average hog density * square miles in township * 30 bushels per year
- Dairy demand in bushels = average dairy density * square miles in township * 71 bushels per year * 80 percent
- Available corn supply = total supply – livestock demand
Demand from Existing Wet and Dry-Milling Plants
Corn requirements for existing or planned plants are subtracted from regional supplies as follows.

- For each existing plant or plant currently under construction, a minimum required geographic supply area is determined. This minimum area is based on the plant’s total corn requirements in bushels, average regional yields, corn acreage, and estimated local corn demand for livestock feed.
- 90 percent of each plant’s requirements are spread evenly throughout the surrounding region, with a buying radius 1.25 percent larger than the minimum required radius.
- For each supply node falling within the purchasing territory, the plant’s requirements are subtracted from the available supply.

Existing or Planned Ethanol Plants

Legend
- Existing plants
- Requirements in bushels
  - 1 to 25 million
  - 25 to 50 million
  - 50 to 203 million
New Plant Locations
After accounting for corn demanded by existing plants and livestock, the model begins searching for new plant locations.

- The model creates a 30-mile buffer zone surrounding each potential new plant location.
- It assesses the available corn supply within each buffered zone until the location with the greatest supply is identified.
- The model places a new ethanol plant in that location. 100-million gallon plants are placed first, then 50-million gallon plants.
- The new plant’s requirements are subtracted from the available supply.
- The program loops until no buffered region contains enough corn to sustain a 50-million gallon plant, assuming 90 percent of the corn will be supplied locally.

Potential Plant Locations With Supply Region Buffers
Model Results
The baseline model begins with the following estimates for available corn supply within the 237-county study region:
- total corn supply of 4,185,501,988 bushels
- hogs and dairy cattle requirements of 766,562,259 bushels (18 percent) of the total supply
- available supply of 3,418,939,730 bushels for ethanol production, other milling, or export

The model next satisfies demand from 36 wet and dry-milling facilities in operation or under construction (reflecting information available as of May 31, 2006).

New plants are placed in 61 locations (21 in Iowa)
- 35 @ 100-million gallons (12 in Iowa)
- 32 @ 50-million gallons (9 in Iowa)

After the modeling exercise, 480,000,000 bushels of corn remain in the study territory. This represents roughly 11 percent of the original available supply. However, the model predicts regional pockets of deficit and surplus within the study territory.

Expected New Plant Locations

Legend
- New plants, 100
- New plants, 50

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