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Local and Regional Economic Impacts of Biofuel Development

Larry Leistritz and Nancy Hodur¹

Abstract: Expanded processing of agricultural products in rural areas has been widely pursued as a strategy for rural economic development. By adding value to farm products before they leave the area, new processing plants can create new employment opportunities and generate economic spinoffs in rural areas that have experienced economic stagnation or decline as a result of long term trends of farm consolidation. In addition, farmer owned processing facilities provide a way for producers to integrate forward and capture potential profits from processing and marketing their products. Consequently, the expansion of agricultural processing in rural areas usually receives broad-based support from commodity groups, rural development interests, and state political leaders. In recent years, the most prevalent type of new agricultural processing ventures in the Midwest and Great Plains states has been corn ethanol plants. Like other types of agricultural processing, these biofuel ventures have generally received widespread support, and numerous studies have addressed their contributions to local or regional economies. However, while the methods employed have seemingly been quite similar, the findings have varied widely with the impacts attributed to ethanol development differing as much as ten-fold. The purpose of this paper is to (1) examine reasons why estimates of local or regional economic impacts of biofuel development may vary and (2) compare the economic impacts of corn-based ethanol production with those expected to be associated with cellulosic ethanol production.

Expanded processing of agricultural products in rural areas has been widely pursued as a strategy for rural economic development. By adding value to farm products before they leave the area, new processing plants can create new employment opportunities and generate economic spinoffs in rural areas that have experienced economic stagnation or decline as a result of long term trends of farm consolidation. In addition, farmer-owned processing facilities provide a way for producers to integrate forward and capture potential profits from processing and marketing their products. Consequently, the expansion of agricultural processing in rural areas usually receives broad-based support from commodity groups, rural development interests, and state political leaders.

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impacts of biofuel development may vary and (2) compare the economic impacts of corn-based ethanol production with those expected to be associated with cellulosic ethanol production.

2. Economic Impact Assessment for Agricultural Processing Projects

The rationale and methods for estimating the economic impact of a corn-based ethanol plant are similar to those for assessing impacts of other agricultural processing initiatives. Processing a commodity like corn contributes to the local or regional economy to the extent that local inputs are used. Payments for these inputs, such as wages and salaries for plant employees, payments for locally purchased supplies, materials, and utilities, and possibly payments to local financial institutions, represent an addition or contribution to the local economy. These initial local expenditures (direct impacts) then set in motion rounds of spending and responding that result in secondary impacts (indirect and induced effects). These effects are most often estimated using input-output models, and the IMPLAN and RIMS models appear to be the most widely used (Leistritz, 2003).

Review of recent analyses of corn-based ethanol plants suggests that there may be a number of reasons for the wide variance in estimates. These fall into five categories: (1) misuse of impact models, (2) differences in unit of analysis (county vs. state), (3) nature of ownership (local vs. corporate), (4) specific model/analysis assumptions, which in turn may result from differences among projects, and (5) differences in study areas.

Misuse of Models

When analyzing the economic impact of an agricultural processing project, the usual assumption is that the processed commodity is already being produced and, in the absence of the project, would be sold to an alternative market. Thus, the direct impacts of the processing operation include payments for locally produced inputs like labor and utilities but do not include commodity purchases. Some ethanol impact analyses have produced impact estimates that seem inflated when compared to those for other types of agricultural processing. When these are examined more closely, it appears that corn purchases generally were included as part of the direct impacts. For instance, Swenson (2006) cites a national study that indicated 114,844 jobs were indirectly supported by the ethanol industry. This would represent a very substantial employment multiplier, as the direct employment of the U.S. ethanol industry at the time was at most 4,000. Closer examination of the study revealed that 85,311 of the jobs were associated with the production of corn. If those jobs were subtracted, the secondary employment impact would be 29,533 and the employment multiplier 8.4 – seemingly more plausible estimates.

When estimating the impacts of a corn ethanol plant, the purchases of corn **should not** be included as part of the direct impacts as doing so implies that corn production in the impact area is increased by the amount of the plant's purchases. This is almost never the case; the corn is simply being diverted from other markets. Even in cases where corn production does increase, it will generally be at the expense of other crops, as the total land in crop production has been relatively stable. (However, this may be changing somewhat as high commodity prices are

encouraging some producers to take land out of the Conservation Reserve Program.) Development of an ethanol plant generally means that local corn producers receive a somewhat better price because transportation costs are reduced, that is, the local basis (difference between local and futures price) declines. Some analyses include this price premium as part of the direct impact, but research indicates the premium is relatively small (e.g., \$0.05/bu.) (Swenson 2006). Finally, some studies have assumed that the advent of an ethanol plant will lead local farmers to shift acres from other crops (e.g., soybeans) to corn. As corn is more input-intensive than most alternative crops, the shift can add to local impacts through increased input purchases (e.g., fertilizer) (for example, see Low and Isserman, 2008).

Unit of Analysis

Another reason why impact analysis results may differ is differences in the definition of the study area. Some studies estimate impacts for a site county (Peters, 2007; Low and Isserman, 2008) or for a small multi-county site area (Swenson and Eathington, 2006) while others estimate the impact for the state economy (Flanders et al., 2007; Hodur et al., 2006). None of these approaches is more or less appropriate than another, and the definition of the study area often depends on who constitutes the primary audience for the study (i.e., local leaders or state decision makers). However, other things equal, the impacts measured at the state level will always be greater than those for a single county or multi-county area within the state.

Local vs. Corporate Ownership

Another factor that can give rise to substantial differences in impact estimates is the degree of local ownership. That is, if a plant is largely or wholly owned by farmers or other local investors, the profits will be redistributed to these local owners, and a substantial portion may be spent locally. If the facility is owned by a corporation headquartered elsewhere, the profits leave the local area. In addition, some suggest that some other local expenditures are likely to be greater for a locally owned facility; accounting, administrative, and marketing functions are more likely to be performed locally for a locally owned plant whereas much of this activity might be centralized off site for a corporately owned facility. (There may be some question about the marketing aspect, as many locally owned plants are believed to have marketing agreements with ethanol construction /management firms [Dunn et al., 2005].) Finally, financing for locally owned firms is more likely to involve local banks (Urbanchuk, 2007).

The extent of local ownership can have a substantial influence on impact estimates. Swenson and Eathington (2006) present estimates for a 50 million gallon per year (MGY) plant employing 35 workers. With no local ownership, the project supports 172 secondary jobs for a total of 207 jobs and an employment multiplier of 5.9. When local ownership was increased to 25 percent, the employment multiplier increased to 6.8. At 50 percent local ownership, the multiplier was 7.6, and at 75 percent it was 8.4.

Model/Analysis Assumptions

Some differences in impact estimates can result from differences in assumptions incorporated in the impact model and analysis procedure. For example, as noted previously, some analyses

incorporate a small premium for locally supplied corn whereas others do not. Sometimes the attributes of the project influence the specific assumptions used. For example, Hodur et al. (2006) chose not to include a corn price premium as very little of the corn that would supply the study plant came from the local area; most of the corn would be shipped in by unit train.

Other project attributes can substantially affect impact estimates. For example, Hodur et al. (2006) estimated impacts of a North Dakota plant, with a resulting employment multiplier of 13.4. This estimate might appear inflated at first glance even for a state level analysis, but closer examination reveals that the plant would be fueled by North Dakota lignite coal and that the coal purchases would represent a net increase in coal production for the state. Coal purchases represent 49 percent of the plant's direct impacts. In this context, the resulting estimates appear more reasonable.

Sometimes seemingly simple assumptions can affect the reporting of results and their apparent reasonableness. For example, in analyzing impacts of a cellulosic ethanol plant, Leistriz et al. (2007) assumed that persons involved in harvesting the feedstock and transporting it to the plant would be contract workers rather than plant employees. Thus, they were not included in the project's direct employment but rather were shown as part of the indirect employment. The resulting multiplier (31) would ordinarily seem excessive, but if transportation workers were assumed to be plant employees, the project's direct employment would likely be doubled and the multiplier reduced by more than half. To summarize, it is important to review study findings in light of the assumptions incorporated in the analysis.

Differences in Study Areas

A final factor affecting impact estimates is the nature of the study area. A site area that incorporates a substantial trade center and has a somewhat diversified, self-sufficient economy will have larger secondary impacts, other things equal, than a sparsely populated rural site. Low and Isserman (2008) analyze the impact of 100 MGY ethanol plants at two locations in Illinois. One site county has a population of 109,000 and is described as mixed rural while the other has a population of less than 9,000 and is described as rural. Secondary employment in the more urbanized county was estimated to be 211, compared to 114 in the more rural county.

3. Comparing Economic Impacts of Corn-based and Cellulosic Ethanol Production

While the rapid growth of the corn-based ethanol industry shows the potential for biofuels and numerous studies have estimated the related economic impacts, a broader resource base is clearly needed in order to make a substantial contribution to the U.S. energy supply. As a result, federal resources for R&D efforts to improve and commercialize biomass conversion processes have been increased substantially in recent years, and several studies have examined potential biomass feedstock supplies. However, one aspect of biomass-based industry that has received very little attention is its potential as an economic development stimulus for rural areas with high biomass production potential. This section addresses the rural economic development potential of biofuels development.

Local Economic Impact of Lignocellulosic Ethanol Production

As previously discussed, recent studies have shown that the local impacts of corn-based facilities are moderate, as the corn they utilize would otherwise be sold to other markets and local effects arise primarily from worker payrolls and other local expenditures for supplies and utilities. Biomass-based plants will have substantially greater impacts as the feedstocks will typically be from sources that do not presently have a market (e.g., agricultural residues, wood wastes) or from biofuel crops grown on lands with limited alternative use (e.g., Conservation Reserve Program [CRP] land). Studies recently completed in North Dakota allow a comparison of the economic impacts of the two types of facilities. Hodur et al. (2006) examined a recently developed corn ethanol plant; the plant had a production capacity of 50 MGY, employed 40 workers, and made annual expenditures (direct impacts) of about \$16.8 million to North Dakota entities (Table 1). Purchases of corn were not included in this total, as the corn would otherwise have been sold to markets outside the state. On the other hand, the plant was fueled with North Dakota coal, so the plant's fuel costs (\$8.25 million annually) were included as part of the direct impacts.

As part of an analysis of the economic feasibility of a biorefinery using wheat straw feedstock, Leistritz et al. (2007) estimated the economic impact of a 50 MGY facility. The base case facility was analyzed using an update of an economic-engineering model originally developed by the National Renewable Energy Laboratory (NREL). Plant construction cost was estimated to be \$176.5 million; during plant operation, \$53 million of the plant's \$74.6 million annual operating expenditures were estimated to be made to North Dakota entities. By far the largest expenditure item was feedstock purchases (\$36 million). The feedstock purchases represent income for local farmers, custom baling operators, and persons involved in transporting the feedstock to the plant. The plant would directly employ 77 workers with an estimated payroll of \$2.7 million (Table 1). Input-output analysis indicated that the \$53 million of direct expenditures would result in secondary impacts totaling \$130 million for a total contribution to the state economy of \$183 million annually. The economic activity generated by the plant would support more than 2,400 jobs in various sectors of the state economy, including persons involved in baling and transporting feedstock.

Table 1 allows for direct comparison of the economic impacts of corn-based and cellulosic ethanol production. The cellulosic plant has direct economic impacts (i.e., expenditures to in-state entities) that are more than three times those of the corn-based plant, as well as nearly twice as many direct employees.

Given the relatively undeveloped state of technology for lignocellulosic biomass conversion, these findings should be considered as somewhat tentative. Further, the results are obviously somewhat sensitive to the assumptions incorporated in the analysis. For example, increased fuel costs could lead to some increases in the cost of feedstock harvest and transportation, while increases in conversion efficiency could reduce feedstock requirements and costs. Also, some plant inputs may be available locally in some areas but not others, changing the proportion of plant operating expenditures that represent payments to local or in-state

entities. The fact that feedstock costs make up a high percentage of total operating costs for cellulosic biorefineries, however, supports the premise that their economic development effects will be substantial.

Table 1. Direct economic impacts of corn-based cellulosic ethanol production, North Dakota

Sector	Corn-based Ethanol ^a	Cellulosic Ethanol ^b
	\$ million	
Agriculture, crops	--	11.07
Construction	0.62	--
Communications and utilities	1.53	--
Transportation	1.00	8.82
Manufacturing	--	9.94
Retail trade	1.10	1.84
Finance, insurance, and real estate	0.48	2.16
Business and personal services	0.28	0.36
Professional and social services	--	0.36
Households	3.59	18.45
Coal mining	8.25	--
Total	16.84	53.01
Direct employment (FTE) ^c	40	77

Source: Hodur et al. (2006)

^bSource: Leistriz et al. (2007)

^cDoes not include persons involved in harvesting and transporting feedstock

Rural Economic Development Implications of Meeting EISA Mandates

The recently enacted Energy Independence and Security Act (EISA) of 2007 established a Renewable Fuel Standard (RFS) of 36 billion gallons by 2022, of which 21 billion gallons must be advanced biofuels with a minimum of 16 billion gallons of cellulosic biofuels. If the 16 billion gallon cellulosic mandate is to be met exclusively from domestic production, a substantial number of new biorefineries will need to be developed. If these facilities are assumed to have an annual production capacity of 50 MGY, 320 new plants would be needed. While many

questions remain about the conversion technologies and feedstock sources that will find the greatest success, one aspect of the industry's development seems virtually assured—the conversion facilities will be located as close as possible to reliable feedstock sources.

The potential development of the cellulosic-based industry can be illustrated by assuming that conversion facilities are located in proportion to potential supplies of major feedstocks. A recent NREL study analyzed feedstock availability and determined that agricultural and forest sources accounted for 97 percent of total biomass resources (Milbrandt 2005). Agricultural feedstocks (crop residues and energy crops from CRP land) were estimated to total 241 million tonnes nationwide while forest resources totaled 92 million tonnes, if only the unused portion of primary mill wastes are included. The states of the North Central region account for 60 percent of total available biomass (75 percent of agricultural biomass and 20 percent of wood)(Table 2). If 60 percent of the 16 billion gallons of production capacity were located in the North Central region, 9.6 billion gallons of capacity would be built. If capacity were proportional to feedstock by state, Iowa would be the leading state with 1.7 billion gallons of capacity, followed by Illinois (1.3) and Minnesota (1.2).

Development of a cellulosic-based industry on this scale could have major rural economic development implications. A 9.6 billion GPY industry would be equivalent to 192 plants with 50 MGY capacity. Assuming that the values reported by Leistriz et al. (2007) are representative of likely investment costs and operating expenditures, the initial investment in 192, 50 MGY plants would be nearly \$34 billion and their annual direct expenditures to local and regional economies would total nearly \$10 billion. The processing facilities would directly employ nearly 15,000 workers, as well as supporting many thousand additional jobs in feedstock harvest and transportation. Feedstock payments could also represent a substantial income supplement for agricultural producers; nearly half of a plant's annual operating expenditures are estimated to be for feedstock. To put the magnitude of the potential development in perspective, if development were to occur proportionally to potential feedstock supplies, North Dakota could be the home of 16 plants with production capacity of 826 MGY. If development were to occur on this scale, the cellulosic ethanol industry's annual contribution to the state economy would exceed that of the state's substantial coal mining and conversion industry.

4. Implications

The potential economic development contributions of an emerging biofuels industry are particularly significant because many of the areas where such an industry could concentrate have in the not distant past faced adverse economic and demographic trends. The rural, agricultural counties of the western Corn Belt and northern Great Plains have experienced long term trends of farm consolidation, leading to fewer and larger farms. In the absence of major nonfarm employers, many counties have experienced substantial out-migration and population losses (Rathge and Highman, 1998; Rowley, 1998; McGranahan, 1998). Farm households have also become more dependent on off-farm employment. In North Dakota, during the period 1993-2007, off-farm wages and salaries of farm households more than doubled, growing from \$6,847

in 2003 to over \$16,000 in 2007 (ND Farm Management, 2007). An emerging biofuels industry could offer the new jobs and economic stimulus that many agriculturally dependent areas have been seeking and could also substantively change the economic and demographic makeup of some Midwest and Great Plains counties.

Table 2. Biomass resource availability, North Central states and U.S., 2005

State	Crop Residue	Switchgrass from CRP	Wood Wastes ^a	Total	% of U.S.
Iowa	23.6	10.2	0.7	34.5	10.4
Illinois	19.6	5.3	2.1	27.0	8.3
Minnesota	14.2	7.9	2.9	25.0	7.5
Missouri	6.0	8.5	2.7	17.2	5.3
North Dakota	6.6	10.5	0.1	17.2	5.2
Nebraska	10.9	3.3	0.3	14.5	4.4
Kansas	7.6	6.3	0.5	14.4	4.3
Indiana	9.0	1.6	1.7	12.3	3.7
Wisconsin	4.4	3.1	2.7	10.2	3.1
South Dakota	5.1	4.8	0.2	10.1	3.0
Ohio	5.0	1.6	2.2	8.8	2.6
Michigan	3.6	1.5	2.6	7.7	2.3
North Central Region	115.6	64.6	18.6	198.8	59.8
U.S.	157.2	83.6	91.7	332.5	100.0
North Central Region as percent of U.S.	73.5	77.3	20.2	59.8	

^a Includes only the unused portion of primary mill residues. Source: Milbrandt (2005)

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