Biodiesel:
Potential Economic Benefits
to Iowa and Iowa Soybean Producers

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Executive Summary

- Biodiesel is a renewable energy source made with edible oil and either methanol or ethanol. Iowa is a low-cost producer of both ethanol and edible oil (soybean oil) and is a net importer of energy. The state would therefore have much to gain from the commercialization of biodiesel.
- Biodiesel reduces emissions problems from existing diesel engines, and a 20 percent biodiesel blend is the least expensive way to satisfy clean air regulations with these engines.
- Biodiesel qualifies as an alternative fuel under the federal alternative fuels program, and a 20 percent biodiesel blend may qualify as an alternative fuel at some point in the future.
- Biodiesel is relatively expensive to produce. High production costs are attributable to high raw material costs (at least $2 per gallon) and the fact that the industry does not yet operate on a commercial scale. The absence of a commercial infrastructure means that the delivered cost of neat biodiesel in Iowa is slightly more than $4 per gallon in Iowa as of September 1995. If biodiesel were to become a large-scale competitive industry, this delivered cost would fall to around $3 per gallon.
- Driven by generous support from U.S. soybean producers, the biodiesel industry has made impressive technical advances in the past three years. This momentum will be lost unless a major new user is found.
- It is not feasible to use biodiesel in all of the state’s diesel vehicles because much of the fleet is fueled from above-ground tanks and from retail outlets that are not Department of Transportation supplied.

- If the state of Iowa were to mandate the use of a 20 percent biodiesel blend in its state vehicle fleet where feasible, the total additional cost of this policy would range from $400,000 to $500,000. In this eventuality, the DOT would use a biodiesel blend in about one-sixth of its fleet.
- If it could be shown that this policy would result in a new five million gallon biodiesel plant in the state, then the policy would create more new tax revenues than it would cost and would clearly be in the best interests of the state.
- In the absence of any causal evidence of this type, the policy becomes a "long-shot" gamble, the success of which depends on whether the industry will evolve to the point where an Iowa-Based plant is needed.
- Iowa soybean producers would benefit from the presence of a biodiesel plant in the state, but these benefits would be relatively small unless enough biodiesel plants are built nationwide to have an impact on national prices. For example, a five million gallon biodiesel plant would be less beneficial than a hog operation of the size of Premium Standard Farms.
- Thus, the key variable for both the state of Iowa and for Iowa soybean producers is the ultimate size of the biodiesel market. Under current regulations and prices, this market will be extremely small.
- The ultimate size of the biodiesel market is small for the following reasons.
  a. New diesel engines will meet clean air requirements without biodiesel.
  b. The alternative fuels program is of relevance only to government-owned pickup-size engines, and only a fraction of these can be expected to use biodiesel.

c. A 20 percent biodiesel blend causes between 6 percent and 15 percent less fuel efficiency (under Iowa conditions), and very few diesel fleet operators will be prepared to pay $3 to $4 per gallon for an additive that doubles the cost of the fuel while reducing its efficiency and increasing its freezing point.

- There are obvious similarities between the biodiesel industry today and the ethanol industry 15 years ago. Ethanol has paid off for Iowa and Iowa corn producers, and biodiesel might do the same.
- One can make a convincing argument that if Iowa and Iowa's soybean producers help build a biodiesel industry, the industry will eventually develop a momentum of its own and that, once the industry exists, it will create political support for the required changes in the regulatory environment.
- This "if you build it they will come" argument has much intuitive appeal. Soybean producers and state representatives need to evaluate this intuitive appeal alongside the negative information about ultimate market size contained in this report.
- In the regulated markets within which biodiesel will compete, political support will be extremely important. In this regard, it probably makes more sense to use ethanol as the alcohol source - a move that would align corn and ethanol interests behind biodiesel. The National Biodiesel Board appears to have put its energy behind methanol. This choice puts the interest of corn and soybean producers in direct conflict because both will be in the business of supplying motor fuel to regulated markets.

Biodiesel: Potential Economic Benefits to Iowa and Iowa Soybean Producers

Biodiesel is produced from the reaction of renewable oils with methanol or ethanol. The sources of these oils are plants such as soybeans, peanuts, and corn; animals; and restaurants and industries that need to dispose of used edible oils. The source of methanol is the petrochemical industry, and the source of ethanol is generally corn.

Biodiesel has some very attractive properties. First, it can be used in today's diesel engines without modification and in various blends. For example, a truck's fuel tank filled with a 20 percent biodiesel blend can be refilled with petro-diesel and then refilled with the 20 percent biodiesel blend. At various times the tank mix will vary from 0 percent to 20 percent biodiesel with no negative impact on engine performance.

Second, a 20 percent biodiesel blend reduces emissions of carbon monoxide, particulate matter, and unburned hydrocarbons, and with some engine timing modifications biodiesel can help reduce the oxides of nitrogen. These clean air properties may help owners of today's diesel fleets meet forthcoming federal restrictions originating in the Clean Air Act and the Urban Bus Retrofit Program.

Third, it seems possible that biodiesel blends will be accepted as alternative fuels by the U.S. Department of Energy. If this acceptance occurs, government-owned fleets of small diesel engines will be able to meet alternative fuel guidelines with biodiesel under the 1992 Energy Policy Act.

Fourth, biodiesel has a positive energy balance. In manufacturing biodiesel, it takes less than one unit of nonrenewable energy to produce one unit of renewable energy.

Biodiesel also has some problems. It is very expensive to produce, in large part because its primary ingredient (soybean oil) is much more expensive than its petrochemical equivalent. For example, a gallon of biodiesel requires 7.35 pounds of soybean oil and other inputs valued between 50 cents and 70 cents. If soybean oil costs 25 cents per pound, biodiesel must cost at least $2.33 per gallon excluding taxes, or at least four times the cost of tax-free petro-diesel. This cost problem means that biodiesel will only be used where it is mandated (i.e., in urban transit fleets and government-owned diesel vehicles), which limits the ultimate market size and ensures that whenever biodiesel is used the vehicle owner will have an incentive to look for less expensive alternatives.

Another problem is that biodiesel freezes at temperatures 2 to 3 degrees higher than the freezing temperature of petro-diesel. Thus, underground storage tanks are required if biodiesel is used in cold weather states and extra care must occasionally be taken with vehicles parked overnight.

The success of corn-based ethanol against somewhat similar financial obstacles has created interest in biodiesel among oilseed producers and led to the creation of the National Soydiesel Development Board in 1992. One purpose of this organization is to encourage legislative bodies to consider using biodiesel in state vehicle fleets.

One of the primary purposes of this report is to determine whether it makes sense for Iowa's taxpayers to finance biodiesel purchases for the state's vehicle fleet. A second, related objective is to evaluate the advantages and disadvantages to Iowa soybean producers of participating in this process. The following section of this report presents the short- and medium- term outlook for soybean oil production and prices. Next, the current status of biodiesel is discussed, with emphasis on the current need for a major new user. Then, the case for the state's participation in biodiesel is presented. As with any forward-looking analysis of this type, the financial projections presented in this report depend heavily on certain assumptions; consequently, this section discusses a range of scenarios, each of which considers different prices or plant sizes. The subsequent section evaluates the benefits and costs to Iowa soybean producers of becoming involved in the legislative changes required to create a state-funded biodiesel market in Iowa. The final section presents a summary and conclusions.

The Outlook for the U.S. Soybean Oil Market

The cost and success of biodiesel depend heavily on soybean oil prices, which in turn are related to soybean production and soybean/soybean meal demand. As of September 1995, soybean oil prices are averaging 26 cents per pound. This average price is quite high by historical standards and can be explained by poor palm oil harvests and increased demand for food oil, particularly in China. Soybean and soybean meal prices are currently about $6 per bushel and 9 cents per pound, respectively. Both prices are also relatively high, a development that can be explained by the poor condition of some late-planted crops and strong domestic demand for soybean meal.

For the past decade, the U.S. government has provided support to the soybean market by withdrawing land from production through the Acreage Reduction Program (ARP) and the Conservation Reserve Program (CRP). Also, because the farm program has been more favorable to corn than to soybeans, planted area has been distorted in favor of corn, thereby reducing soybean production and increasing soybean prices.

Almost all of the options under consideration for the 1995 Farm Bill eliminate the ARP and cut the CRP, and most would remove the current bias in favor of corn. These changes mean that soybean production is likely to increase over the next few years. Fortunately, world demand for meat and soybean meal is also growing, and projected prices for soybean meal continue to be reasonably strong. However, soybean oil prices are expected to remain above 25 cents per pound for only one to two years and then to return to their traditional trade range of 20 cents to 23 cents per pound.

Because soybean prices depend on the sum of soybean oil and soybean meal value, any weakness in soybean oil prices will become apparent to soybean producers, even if (as is expected) meal demand continues to be strong. A major new use for soybean oil would nicely complement additional meal demand and allow the industry to painlessly absorb additional production.

The Current Status of Biodiesel

Aided by $10 million in producer funds over the past three years, biodiesel research and development has advanced almost to the point of commercialization. The industry has accrued eight million test miles in 1,500 vehicles and has numerous ongoing test sites. Despite these successes, there is no commercial infrastructure in place to provide biodiesel, and early users have been hampered by irregular deliveries and high and volatile prices. Soybean producers can help create the product, but they cannot create the market. It is not in the interest of any one producer to use biodiesel, nor is it the interest of anyone to force soybean producers as a group to use the product.

With products developed for competitive markets, the early adapters are those with the most to gain from the technology; therefore, these individuals are willing to put up with high prices and inconvenient delivery schedules. For example, new computer and electronic equipment almost always is marketed at a high price in the first year than in subsequent years. The early users essentially finance the infrastructure required to bring the cost down for everybody else. For products developed for regulated markets, this mechanism breaks down. The officials who run city bus fleets or state-owned diesel engine fleets will use biodiesel only if it is convenient and cost effective. Only the most enlightened officials can be expected to run fleets on a product with an uncertain price and availability.

The importance of these infrastructure problems can not be overestimated. For example, U.S. meat exports have grown since 1985, in large part because the opening of the Japanese market created enough profit opportunities to cause development of an export infrastructure and to create interest within U.S. meat companies about the export market. At first, difficulties in maintaining shelf life and finding ways to physically transport meat to Japan severely limited export growth. Now that the industry has learned by doing and benefitted from economies of scale, new non-Japanese markets are growing rapidly. In addition, a large number of people now depend on meat exports and any changes, political or economic, that reduce the size of this market will be vigorously opposed. In fact, the growth of the market has created its own momentum, and as more individuals become involved the likelihood that political and economic changes will work to the benefit of exports increases. This is a good example of how initial customers in the form of Japanese consumers paid high prices to create an infrastructure that then gave other, less wealthy customers access to a product.

In contrast, the biodiesel industry now appears to have stalled. Those individuals who agreed to try the product have faced large price increases recently as soybean oil prices have risen. And because overall use has been small and dispersed, the necessary efficient delivery infrastructure has not developed. In terms of the meat export example used earlier, the current biodiesel situation is equivalent to the situation that prevailed for meat exports in 1984, when U.S. meat was air freighted to Japan at great expense. Government officials in importing countries could (and did) point to the high delivered cost (or poor quality) as the reason for rejecting the product. In addition, because so few companies in the United States were involved in exporting meat, nobody was in a position to lobby for policy changes or to fix the problems. Fortunately for U.S. meat exporters, in 1984 some Japanese companies saw the potential and were patiently prepared to iron out the difficulties and pay for the infrastructure. A major difference between the meat and biodiesel situations, however, is that the individuals in Japan were driven by a profit motive that is missing from regulated markets.

Faced with this hurdle and the immediate need to maintain momentum, the biodiesel industry has begun to look for creative ways to develop a market. To date, this effort has involved working with soybean producers and state representatives to encourage one or more states to switch their diesel fleets over to biodiesel use. Iowa's expected number one ranking for soybean production in 1995 and the relative importance of the soybean industry to Iowa make this state an obvious choice for such a large-scale demonstration project. To see the importance of this development, consider that by switching just one-third of the Iowa Department of Transportation's petro-diesel purchases to biodiesel (about 500,000 gallons of biodiesel blend), the change would account for between 2 million and 3 million miles driven with biodiesel, an achievement that would equal almost 50 percent of the total number of miles driven to date using biodiesel.

In summary, the biodiesel industry has achieved some important technological successes but the product has not yet become commercially available. The next crucial step is to find a major new user who is prepared to accept the problems associated with the creation of a commercial infrastructure. Because biodiesel is being prepared for regulated markets, this new user must inevitably be a state or federal government, Without this new market, the biodiesel industry will lose momentum and, coupled with high raw material prices, this momentum loss could bring the experiment to an end. The state of Iowa and Iowa's soybean producers have much to gain from a biodiesel industry. The purpose of the rest of this report, therefore, is to lay out the case for and against state and producer funding of this proposal.

Costs and Benefits to the State of Iowa

Cost to the State of Iowa of Mandating a 20 Percent Biodiesel Blend in the State's Vehicle Fleet

In 1994, the Iowa DOT used almost three million gallons of petro-diesel, but only one-third of this amount (934,518 gallons) was distributed by the agency. The remainder was purchased at retail outlets. Because biodiesel has a slightly higher freezing point than does petro-diesel, its use will, for practical purposes, be confined to underground tanks controlled by the Iowa DOT. The data in Table 1 show that about one-half of centralized DOT purchases could potentially contain biodiesel.

Table 1. Fiscal year 1995 diesel fuel issue, by Iowa Department of Transportation locations with underground tanks

Location	Center	Tank Size	FY95 Gallons
Boone	551201	10,000	16,521
Cedar Rapids	556106	10,000	44,454
Davenport	556204	10,000	52,138
Elkader	552403	10,000	20,580
Fort Dodge	551208	10,000	22,647
Latimer	552109	10,000	21,578
Leon	555302	10,000	27,284
Missouri Valley	553202	10,000	31,555
Muscatine	555405	10,000	19,636
Newton	551304	10,000	20,236
Oakdale	556407	10,000	48,088
Onawa	553205	10,000	10,173
Pacific Junction	554108	10,000	24,686
Sac City	553308	10,000	16,387
Sidney	554107	10,000	21,066
Sigourney	555103	10,000	16,482
Tipton	556401	10,000	14,847
Urbana	556102	10,000	31,103
Williamsburg	556405	10,000	21,703
Total			481,164

Source: Iowa Department of Transportation.

The Iowa DOT has been running a biodiesel demonstration at its Boone facility and has calculated the change in fuel efficiency when engines were switched from petro-diesel to biodiesel. These test results show about a 15 percent reduction in fuel efficiency under Iowa's winter conditions and a 6 percent reduction under summer conditions using a 20 percent blend of biodiesel compared to using petro-diesel under the same conditions. The DOT has calculated that 555,957 gallons of biodiesel blend would be required to supply the vehicles fueled by the DOT's underground tanks. For a 20 percent biodiesel blend, this total implies a total state purchase of 111,191 gallons of pure biodiesel.

The total additional cost of using biodiesel in the Iowa DOT fleet can be calculated as follows. First, estimate the annual cost of the petro-diesel option: 481,464 gallons x $0.595 per gallon, or $286,292. Next, calculate the cost of the petro-diesel used in the biodiesel blend: 80 percent of $555,957 x $0.595, or $264,636. Then, add the cost of the pure biodiesel at $3 per gallon ($3 x 111,191 = $333,573) or at $4.00 per gallon ($444,764). Finally, compare the cost of the petro-diesel - $286,292 - with the cost of the 20 percent biodiesel blend - $598,209 at $3.00 per gallon and $709,400 at $4.00 per gallon. If we include an additional $70,000 to pay a salary and other expenses for operating the program, the total extra cost equals about $400,000 using biodiesel at $3.00 per gallon and about $500,000 using biodiesel at $4.00 per gallon.

Benefits to the State of Iowa of a
Mandatory 20 Percent Biodiesel Blend in the State's Vehicle Fleet

Iowa is located at some distance from export ports, and soybean prices in this state are therefore usually among the lowest in major producing states. Also, Iowa is usually ranked the number one or number two soybean producing state. Low soybean prices (and by extension low soybean oil and meal prices), coupled with a large, concentrated local supply, mean that Iowa is an ideal location for a biodiesel industry should such an industry emerge.

Three possible benefits would accrue to the state from a biodiesel industry. First, by expanding demand for soybean oil, biodiesel would allow soybean processors to pay more for soybeans. Second, soybean farmers located near a biodiesel plant would receive slightly higher soybean prices. Third, the presence of a facility that creates energy from soybeans would add to the Iowa's industrial base and income. The first two benefits can be assessed accurately because similar demand-strengthening events have occurred in the past. The industrial impact is more difficult to estimate because we are attempting to measure all the thousands of transactions and interactions of an industry that does not yet exist. For example, a large-scale biodiesel plant would presumably require a truck washing facility, and the person who supplies detergents to that facility would be better off as a result of the biodiesel plant. To attempt to predict how much extra will be earned by this individual, however, or whether the additional income is earned in Iowa or in surrounding states, is practically impossible.

The Value-Added Method

Fortunately, a very intuitive and simple solution exists to solve this problem. This approach is called the value-added method. The method works because for present purposes we do not need to know who will receive the additional income; rather, we need some measure of the total economic activity that will be generated. For example, suppose a company buys soybean oil at 25 cents per pound and turns it into biodiesel worth 40 cents per pound (oil equivalent). About 15 cents in income is generated per pound from a product that would otherwise have left the state. Some of this additional income will go to workers, some will be used to pay off capital investments, and some will accrue as profit to the plant owners. What matters from the state's perspective is that all the income is generated in Iowa and thus becomes taxable in Iowa.

With the value-added method, we do not have to concern ourselves with where the capital equipment came from because once the equipment is located in Iowa it begins generating taxable revenue for the Iowa economy. The same is true of any corporate profits and of wages and salaries.

The value-added method underlies U.S. national income accounts and allows the government to measure “income” from the value of domestic production. This method also underlies Professor Daniel Otto’s model of the Iowa economy. Dr. Otto’s model attributes Iowa’s total income to all the various value-added subsectors and allows us to predict the impact of an increase in the state’s manufacturing base on the service sector. The model also allows us to calculate the total increase in taxes such a change would provide.

A Criterion for Evaluating the Benefits of Biodiesel

The above discussion suggests a reasonable criterion for evaluating the benefit of biodiesel - namely, that any public monies used to advance the biodiesel process create at least as much additional tax revenue as the costs. Any industry that meets this criterion will by definition benefit all taxpayers. Note that many people will do much better than this tax measure would suggest, either because they find better jobs or start new business or because they receive a better price for soybeans. Because we are discussing taxpayer dollars, however, it is difficult to justify changes based on the benefits of those individuals who are most closely affected by the process. The most reasonable criterion, as mentioned above, is that the policy should benefit all taxpayers (i.e., the additional taxes generated by the industry should exceed the cost of the policy so that overall tax rates would decline).

Dr. Otto has calculated that for each $1.00 generated in the state's soybean processing industry an additional $1.50 is generated in the service sector. Of the $2.50 generated, the state receives 7 percent (or 17.5 cents) in income, sales, and corporate taxes. To satisfy the criterion outlined above, the procedure is to take the estimated income increase multiplied by 0.07 to get the projected tax revenues, and then to compare these revenues with the cost of the policy to the state.

To implement the value-added measure, we need to know the prices of inputs and outputs. Because we can not know these prices in advance, it is better to base the analysis on a realistically wide range of values. Table 2 shows how value added per gallon of biodiesel depends on both soybean oil and biodiesel prices. These values assume that 7.35 pounds of soybean oil are required to produce one gallon of biodiesel and 0.50 pound of unrefined glycerin. It is also assumed that the glycerin has no value.

Table 2. Value added per gallon of biodiesel produced

Biodiesel Price (per gallon)	Soybean Oil Price (per pound in cents)			
	22	24	26	28
	(dollars)			
2.50	0.88	0.73	0.59	0.44
3.00	1.38	1.24	1.09	0.94
3.50	1.88	1.73	1.59	1.44
3.75	2.13	1.98	1.84	1.69
4.00	2.38	2.27	2.09	1.94

As of September 1995, the price of soybean oil is 26 cents per pound and the delivered price of biodiesel is $4.14 per gallon, for a current value added of

$2.23 per gallon, The European biodiesel industry is more developed than the U.S. industry and because many of the logistical and technological problems have been ironed out, processing costs average between $0.40 and $0.50 per gallon. If we add another $0.20 for delivery, the total cost of producing and delivering biodiesel under large-scale commercial conditions should be less than $1.00 per gallon. That the current markup (or value added) is so much greater in the United States reflects the logistical problems discussed earlier. However, were a large-scale competitive biodiesel industry to emerge in the state, it seems likely that the value added would be between $0.70 and $1.30 per gallon. This means that with a soybean oil price of 26 cents per pound, the competitive delivered price of biodiesel should be about $3.00 per gallon.

Interestingly, the actual size of the markup is not crucial to the results of the current study. This statement is true because if we mistakenly inflate the price of biodiesel, we also inflate the value-added measure. To see how this works, consider the following example. Suppose that we mistakenly assume that, given soybean oil prices of 26 cents per pound, biodiesel would have a delivered cost of $4.00 per gallon, when in truth the actual delivered cost was $3.00 per gallon. We would overestimate the cost to the state of using biodiesel by $1.00 per gallon and underestimate the impact on the state's manufacturing value added by $1.00 per gallon.

In summary, for each gallon of biodiesel produced in the state, total value added (a measure of income) within the state's manufacturing sector will increase by about $1.00 if a competitive commercial infrastructure is in place, and by as much as $2.00 in the absence of such an infrastructure. Although the

$1.00 figure is more defensible in the long run, the initial higher value will probably last for several years. Given that we are interested in the impact of the first biodiesel plant on the state, a reasonable compromise is to use a $1.50 measure.

The above discussion implicitly assumes that a biodiesel plant would be attached to an existing crushing facility. It may be the case, however, that a new crushing facility is constructed to produce the additional oil. This would occur if, for example, the new biodiesel producer was not the owner of one of the existing crushing facilities in the state, or if one of the existing crushers decided for tax or capacity reasons to increase in size.

In the event that biodiesel created a need for a new crushing facility, the value-added measure discussed earlier would need to incorporate the value added by the crushing process itself. This value can be measured with accuracy. For example, on a day when the Chicago price of soybeans hit $6.23 per bushel, the meal price equaled $186.90 per ton and the oil price equaled 26.05 cents per pound. At these prices, each $6.23 bushel created 47 pounds of meal valued at 9.34 cents per pound and 12 pounds of oil valued at 26.05 cents per pound, for a total value of 7.52 cents per pound. This total implies a crushing value added of $1.28 per bushel, or $1.92 per gallon of soybean oil. Note that these values will not depend in any major way on the prices of soybean oil or meal because crushers will not operate their plants at a loss.

Tax Revenue Estimates

Table 3 projects some likely tax revenue gains from small, medium, and large biodiesel plants. The national price impacts are based on the Food and

Agricultural Policy Research Institute (FAPRI) model and are quite small. These small impacts are true in part because we are assuming that no biodiesel production occurs in other states (i.e., that the Iowa-based facility is one of a kind).

Table 3. Projected impact of a biodiesel plant on Iowa tax revenues

	Plant Size					
	5 Million Gallons		10 Million Gallons		20 Million Gallons	
	Biodiesel Plus Crush	Biodiesel Only	Biodiesel Plus Crush	Biodiesel Only	Biodiesel Plus Crush	Biodiesel Only
	(million dollars)					
Value added @ $1.50 per gallon	17.1	7.5	34.2	15.0	68.4	30.0
National Price Impact x Iowa Production (0.047¢ x 447)	0.5	0.2	1.0	0.4	2.0	0.8
Local Price Impact	0.5	0.0	2.0	0.0	6.0	0.0
Total direct	18.1	7.7	37.2	15.4	76.4	30.8
Add Indirect	45.25	19.25	93.00	38.50	191.0	77.0
State Taxes @ 7 percent	3.17	1.35	6.51	2.69	13.37	5.39

The local price impacts are based on experience from existing crushers and from the livestock industry. The logic behind these numbers is that a new crushing facility (should it be needed) would cause prices near the plant to be slightly higher because processors will bid up the price of soybeans near that plant. Note that the local price impacts are not linearly related to plant size because bigger plants cause greater price increases over wider areas.

The values at the bottom of Table 3 shows that a $500,000 annual investment would be worthwhile if it attracted a biodiesel plant. This is true even if the plant in question had only a 5 million gallon capacity and if this plant were added to an existing crushing facility. Even if we use the smaller $1.00 per gallon value-added figure, the analysis favors the biodiesel plant.

The key phrase in the above paragraph is the one linking state expenditures to the decision to build the plant. It can be argued that a company searching among alternative sites would find a state with low soybean prices and a ready market for about 100,000 gallons for biodiesel to be an excellent location. However, it is very difficult to show that by creating this market we could attract a plant that would otherwise not have located here.

There are two possible solutions to the uncertainty about cause and effect. First, one could let the state's decision hinge on the industry itself providing proof that the plant would be built. Industry sources suggest that a plant with a capacity between 5 million and 10 million gallons is at the advanced planning stage for west central Iowa. Negotiation with these individuals could quite easily provide information on whether the likelihood of a 100,000 gallon annual state purchase could influence the planning process. Second, one could put subjective probabilities on the series of events that must fall in place for the state to benefit and then see if the odds are sufficient to justify the investment to a rational gambler.

Suppose, for example, that there is a 50 percent chance that Iowa's use of biodiesel would create enough momentum for a new plant and a one-third probability that the plant would be located in Iowa. If such industry expansion occurred, the tax values in Table 3 should be multiplied by one-sixth. With this value as a criterion, all but one of the outcomes would still justify state funds. We could go further and assume a 50 percent chance of a large plant and a 50 percent chance of a small plant, or a 50 percent chance of a new facility and a 50 percent chance of an add-on facility. Again, the odds would favor state funding, with an expected payout of $0.94 million for a $500,000 investments. Under this scenario, the decision is best viewed as a long-shot gamble that would make sense to most gamblers. It should be made clear, however, that the most likely outcome is that the plant will either not be built anywhere or at least not in Iowa.

In summary, the analysis suggests that a $500,000 state investment would result in more than a $500,000 increase in tax revenues if it led directly to a plant opening. If no information is available about such an opening, the investment may still make sense. In this latter case, however, the state would be involved in a long-shot gamble with a high payout if successful and a high probability of failure. The eventual outcome would depend heavily on the ultimate size of the biodiesel market, a factor discussed in the following section.

Costs and Benefits of an Iowa Biodiesel Industry to Iowa Soybean Producers

It is much more difficult to make the case for state producer funding of biodiesel in Iowa than for state funding. As Table 3 shows, the producer benefits (i.e., national and state price impacts) are relatively small. This is true because the state can capture a relatively large proportion of the value added via existing tax regulations. Soybean producers can only capture that portion of the value added that is attributable to local and national price increases, and a single biodiesel plant (even if it means new crushing capacity) will not have a major impact on prices. For example, the presence of a 10 million gallon biodiesel plant in the state is less important to Iowa soybean producers than the presence of a large new hog finishing operation such as Iowa Select Farms or Premium Standard Farms. The technology makes sense for Iowa soybean producers only if the ultimate market size is sufficient to justify construction of several new biodiesel plants, both in Iowa and in surrounding states. Consequently, it is worth looking at the ultimate size of the biodiesel market.

The Potential Market for Biodiesel

Under current regulations, some city diesel fleets will be forced to reduce emissions, and biodiesel is probably the least expensive way to achieve these reductions for existing diesel engines. But the cost of biodiesel will quickly force many fleet operators to replace existing engines with newer ones that can meet clean air requirements. As these new engines are phased in, this market will lose its importance. To see why this is true, consider the following example. A transit bus with a 200-mile, seven-day-a-week schedule that averages 4 miles per gallon will have an annual petro-diesel cost of about $11,000. If the bus is switched over to biodiesel at $3.40 per gallon, this annual cost will increase to about $30,000. Under these conditions, the fleet manager clearly will be able to install new engines, pay off the additional capital costs, and come out well ahead by borrowing to buy new engines rather than choosing the biodiesel option.

A second alternative may be the mandated use of alternative fuels in government-owned fleets. However, this market will evolve only if a 20 percent blend of biodiesel is accepted as an alternative fuel by the Environmental Protection Agency and if fleet owners choose biodiesel from among the wide rage of alternatives. Also, because the regulation is binding only for small pickup-size engines, the ultimate market size is very limited. Given that fleet managers will require alternative fuels for only a small portion of their fleets, it seems highly unlikely that they will be prepared to designate underground storage tanks for biodiesel blends. A less expensive alternative would be to switch these smaller vehicles to compressed natural gas or ethanol, both of which can be purchased at retail outlets.

Another concern from the perspective of the Iowa soybean producer is whether one state should push technologies that will benefit soybean producers in other states. One could argue, for example, that biodiesel is best funded at the national level because the price effects will be seen primarily on national prices and because it is not clear that the biodiesel industry (if it does grow) will grow in Iowa. A second concern is the possibility that oils other than soybean oil will be used. It may be possible, for example, to recycle food oils from fast food restaurants and from the prepared food industry. Here the possibility exists that soybean funding may go to create a market for other food oils and recycled oils. Again, the expense of soybean oil based biodiesel will create a need for less expensive substitutes. Market forces will work against soybean producers as new sources and new technologies are developed to replace soybean oil with a less expensive alternative.

Potential Benefits of Biodiesel to Iowa Soybean Producers

Probably the strongest argument in favor of Iowa soybean producer support of the initial phases of this industry is that, once established, the industry will develop a life and momentum of its own. Once capital and workers have been attracted into an industry, the industry and its political representatives will work to ensure its success. The same ingenuity that will be used in other sectors to avoid having to purchase expensive biodiesel will be used by the biodiesel industry to find new uses and protect existing markets.

The experience of the ethanol industry offers some useful lessons. Because of its negative energy balance and high costs, few economists would have been able to create a convincing case for corn producer funding of ethanol. However, with hindsight it is clear that ethanol was a long shot that paid off for the state of Iowa and for corn producers. It is also clear that the ethanol industry will work to protect its existing market and develop new ones. Now that this momentum has been created, little further input is required from corn producers.

Summary and Conclusions

Based on the information available in mid-1995, there does not appear to be a major potential demand for biodiesel. This low potential demand occurs because the large cost of biodiesel will restrict its use in regulated markets and encourage development of less expensive alternatives in these markets. In the absence of a substantial national market, it is difficult to show a major potential benefit to Iowa soybean producers. All the above arguments could quite easily have been used against ethanol, however, and the best counter-argument may be that the industry, once established, will create a momentum of its own.

The eventual outcome will depend on regulations and technologies that are very different from those that exist today, and, given these uncertainties, it would be wrong to make a strong case for or against the involvement of Iowa soybean producers in this process. In terms of research priorities, this is equivalent to using a medium to high funding priority if the association is prepared to take risks, and a medium to low priority if other, less risky options are available.

The results of this study are more supportive of the state's participation in the biodiesel market than for soybean producer participation. If plans to build a biodiesel plant in Iowa can be positively influenced by the state's participation in the biodiesel process, the biodiesel policy clearly makes sense. If this plant does not materialize, the biodiesel policy becomes a gamble. Whether this gamble should be made depends on policymakers' personal attitudes toward risk and their subjective estimates of the probability that future regulatory changes will favor biodiesel.