A Study on the Feasibility of Biodiesel Production in Georgia

Table of Contents

Introduction . . . 1
Benefits of Biodiesel . . . 1
Potential Drawbacks to Biodiesel . . . 2
Georgia Diesel Demand . . . 2
The Biodiesel Production Process . . . 2
Figure 1. Diesel Utilization by Metro Counties, Georgia 2000. . . . 3
Figure 2. Methyl Ester Process . . . 4
Feedstock Availability . . . 4
Figure 3. County Distribution of Soybean Production in Georgia . . . 6
Figure 4. Poultry Fat Production by County, Georgia 2000 . . . 7
Figure 5. County Distribution of Soybean Production in South Carolina in 1999 . . . 8
Historical Feedstock Costs . . . 9
    Table 1. Historical Feedstock Cost Ranges, 1996-2000 . . . 9
    Feedstock Conclusion . . . 9
    Table 2. Availability and Prices of Feedstock in Georgia . . . 10
The Economics of Biodiesel Production . . . 10
    Table 3. Estimate Capital Cost Comparison of Various Plant Sizes . . . 11
    Table 4. Production Cost Sensitivity to Feedstock Cost by Plant Size, Dollars Per Gallon of Biodiesel . . . 11
    Table 5. Estimated Biodiesel Capital Cost Details for a 15 Million Gallon Capacity Plant . . . 12
Sensitivity to Feedstock Costs . . . 12
Biodiesel Production Costs . . . 12
    Table 6. Breakeven for Biodiesel Production for a 15 Million Gallon Per Year Facility with Feedstock Cost Averaging 15 Cent Per Pound . . . 13
    Table 7. Total Production Cost Per Gallon of 100% Biodiesel at Various Average Feedstock Costs from a 15 Million Gallon Per Year Plant . . . 13
Sensitivity to Changes in Budgeted Costs . . . 14
    Graph 1. Profit/Loss versus Change in Budgeted Costs . . . 14
Breakeven Feedstock Cost . . . 14
    Graph 2. Profit/Loss versus Feedstock Costs . . . 15
Sensitivity to Changes in Selling Price . . . 15
    Graph 3. Profit/Loss versus Change in Sales Price . . . 15
The Bottom Lin - Can Bio diesel from the Proposed Facility Compete with Regular Diesel . . . 16
    Table 8. Added Cost to Retail Price of Diesel Fuel When Blended with 2 Percent Biodiesel . . . 16
    Table 9. Added Cost to Retail Price of Diesel Fuel when Blended with 20 Percent Biodiesel . . . 17
Biodiesel Products and Handling Considerations . . . 17
Environmental Impacts of Biodiesel Use . . . 18
    Table 10. Emission Changes with Biodiesel Fuels . . . 18

Impact Analysis 18
Table 11. Economic Impact on Sales, Employment and Revenue of
a 15 Million Gallon Biodiesel Plant in Georgia 19
Table 12. Comparison of Total Impacts by Plant Size 20
Conclusions 20
Figure 6. Cotton Acreage by County Georgia, 2000 21
Figure 7. Peanut Acreage by County, Georgia 2000 22
Figure 8. Soybean Acreage by County, Georgia 2000 23

A Study on the Feasibility of Biodiesel Production in Georgia

George A. Shumaker, John McKissick, Christopher Ferland, and Brigid Doherty
Professor, Professor and Director, Research Coordinator, Agricultural Statistician

Introduction

The State of Georgia faces two issues that may provide a unique opportunity for rural economic growth. The first issue is that major urban areas of the State have air quality problems that will require actions to reduce sources of pollution. One major pollution source is from exhaust emissions from cars and trucks. The use of alternative fuel sources such as biodiesel can make a significant reduction in certain exhaust emissions thus reducing pollution and improving air quality.

The second issue facing the State is depressed crop farm incomes due to low market prices for the many oilseeds produced. Prices for soybeans, cottonseed and crush quality peanuts have been at very low levels for the last four years. These low prices have reduced farm incomes. Additionally, disposal of animal fat by-products and spent vegetable oils may become increasingly difficult in the future.

The opportunity for economic growth resides in the processing of these oilseeds and other suitable feedstocks produced within the State into biodiesel. The new fuel can be used by vehicles traversing the State thus reduce air pollution and providing another market for Georgia produced oilseeds while creating a value added market for animal fats and spent oils. The benefits of biodiesel go far beyond the clean burning nature of the product. Biodiesel is a renewable resource helping reduce the economy's dependency on limited resources and imports. Also, biodiesel will help create a market for farmers and certain feedstocks and help reduce the amount of waste oil, fat and grease being dumped into landfills and sewers.

The purpose of this report is to provide decision makers with information on the feasibility of producing Biodiesel in Georgia.

Benefits of Biodiesel

There are several benefits to using biodiesel as a blended fuel in diesel engines: Biodiesel has a lower flash point than petroleum diesel and thus helps prevent damaging fires; biodiesel burns cleaner than petroleum diesel and thus reduces particulate matter thus lowering emissions of nitrogen, carbon monoxide and unburned hydrocarbons; the odor of burned biodiesel fuel is considered by many to be less offensive that petroleum diesel; there are only limited or no needed modifications to current engines to use biodiesel; there would be no need to change the transportation and storage systems to handle biodiesel; biodiesel behaves similarly to petroleum for engine performance and mileage; and biodiesel dissipates engine heat better than petroleum diesel.

Potential Drawbacks to Biodiesel

Biodiesel can be corrosive to rubber materials and liner materials. Biodiesel cannot be stored in concrete lined tanks. In some cases, the fuel intake orifices may need to be reduced in size to create a higher cylinder pressures. And, given current petroleum prices, biodiesel is more costly to produce than biodiesel.

Georgia Diesel Demand

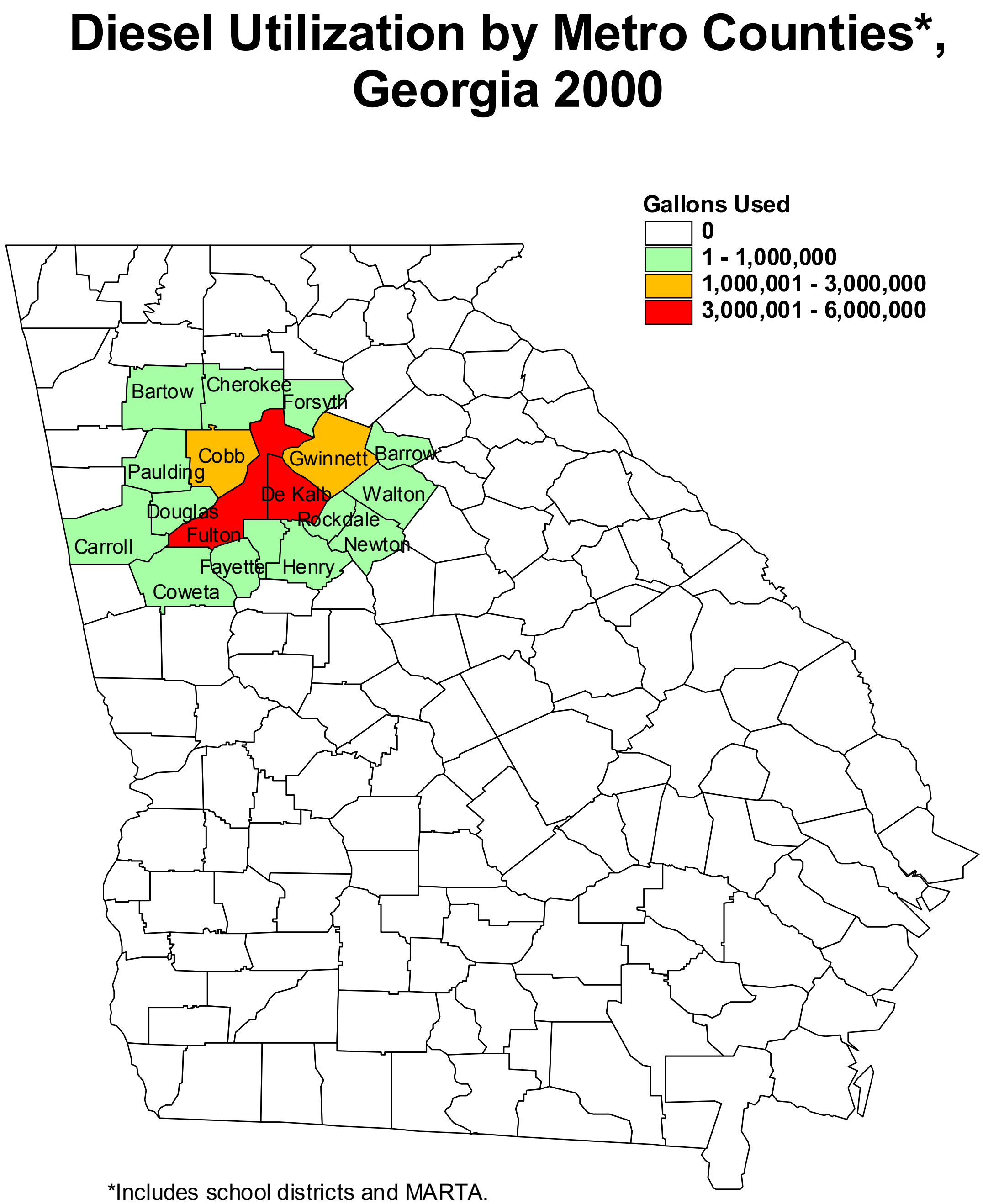
According to the Petroleum Marketing Monthly, published by the Energy Information Administration, 4.64 million gallons of diesel were sold per day in Georgia in 2000. This included all diesels, low and high sulfur, auto and farm, amounting to about 3.89% of the national annual demand.

Several institutions that are influenced or controlled by the state government are large users of diesel fuel. Demand from school districts in the metro Atlanta (21 counties) amounted to 9,702,798 gallons used in 2000. MARTA estimates using 6,644,070 gallons of diesel in 2000. Finally, the Georgia Department of Transportation used 1,521,957 gallons of diesel in 2000 statewide. These three institutions alone use close to 18 million gallons of diesel per year. Map 1 illustrates the amount of diesel used in the Metro Atlanta counties during 2000.

The Biodiesel Production Process

The technology of converting vegetable oils and animal fats into biodiesel is a well established process. The most commonly used and most economical process is called the *base catalyzed esterification of the fat with methanol*, typically referred to as "the methyl ester process". Essentially the process involves combining the fat/oil with methanol and sodium or potassium hydroxide. This process creates four main products - methyl ester (biodiesel), glycerine, feed quality fat and methanol that is recycled back through the system. The primary product, methyl ester, is better know as biodiesel. The glycerine and fats can be sold to generate added income from the process.

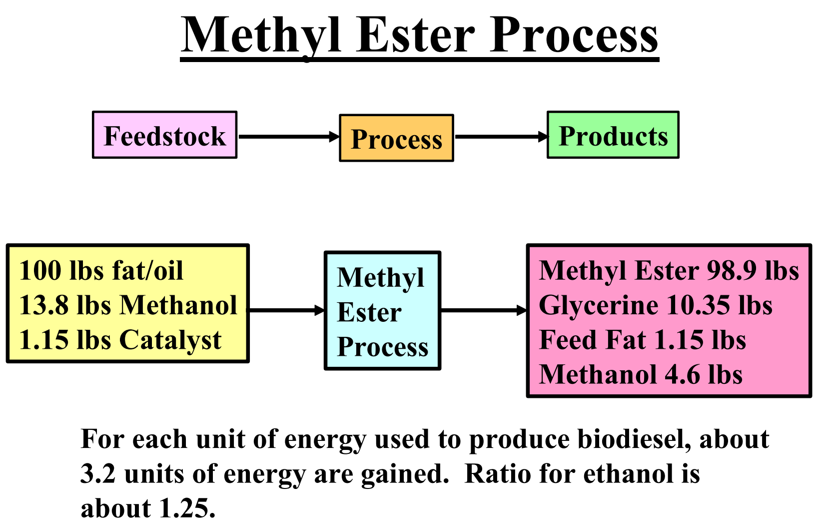
Figure 1. Diesel Utilization by Metro Counties, Georgia 2000.



*Includes school districts and MARTA.

Source: Center for Agribusiness and Economic Development

Figure 2. Methyl Ester Process



Source: Frazier, Barnes & Associates.

The methyl ester process is very energy efficient in that for each unit of energy required by the process approximately 3.2 units of energy are gained. Biodiesel is thus an excellent renewable fuel source. The ratio for ethanol production is 1.25.

Biodiesel can be produced from any type of vegetable oil or animal fat. Some of the suitable feedstocks may require some pre-processing to remove materials that reduce the yield of biodiesel. Crude or unrefined vegetable oils contain free fatty acids and gums that must be removed before entering the methyl ester process. The pre-processing can take the form of refining, degumming and/or filtering to remove the impurities. Degumming involves mixing a small amount of water (about 3-5%) with the feedstock which precipitates the gums which then can be separated by centrifuging the mixture. Refining involves adding sodium hydroxide to the feedstock to form a soap that can be separated by centrifuge from the oil. Yellow grease or spent restaurant fats must be filtered and refined to remove the free fatty acids and residual cooking fines.

Some of these impurities have market value and can be sold to other industries in or near Georgia. The fats can be used in feed rations for poultry and other livestock.

Feedstock Availability

Major feedstocks for the methyl ester process currently available in Georgia include soybean oil, cottonseed oil, peanut oil, spent restaurant fats and rendered poultry fats. Other suitable feedstocks suitable for the methyl ester process but not currently readily available in Georgia include canola oil, beef tallow and rendered pork fat.

It appears that there is an adequate supply of oils and fats available in or near Georgia to produce biodiesel. Two existing Georgia firms, Chickasha of Georgia in Tifton and Mid Georgia Processing in Vienna produce vegetable oils. These two firms crush peanuts and cotton seed and produce an estimated 9.6 million gallons of vegetable oil per year. A proposed farmer owned cooperative, Farmers Oilseed Cooperative, Inc, if developed could produce an additional 13 million gallons of vegetable oil from primarily soybeans and canola. A large soybean crushing facility in Southeast South Carolina also could be a supply of soybean oil with an annual output of about 17 million gallons per year.

Poultry is the leading agricultural commodity in the state. Thus, the volume of broiler fat produced in Georgia is high. On an annual basis, it is estimated that 7.2 billion pounds of birds are slaughtered in Georgia (Georgia Department of Agriculture). Roughly 12 to 15 percent of a bird is fat, thus, a maximum of 1.08 billion pounds of fat is available in Georgia annually. However of this total pounds of fat, half is estimated to be edible fat and will remain on the market as chicken skin on wings or fryers, thus reducing the pounds of available fat to 540 million pounds. The integrators own approximately 80-85% of the processing of poultry. Currently, integrators such as Cargill imports oil and other feeds from outside the state via railways. These integrated firms have been using 99% of their poultry fat rendered into their feed production. The fat serves multiple purposes as : anitdust, milling, nutritional and energy value, and an anti-caking agent in the poultry feed. The poultry industry has spent numerous dollars formulating a feed to raise a 1.5 ounce egg into a 6-pound bird in roughly 42 days. This highly researched diet has been proven and substituting anything into the diet will cost money and be highly questionable. Thus the researcher assumes that little poultry fat will be released from the integrators for use as biodiesel. This leaves 15-20% of the rendered poultry fat, 105 million pounds, available for use in a biodiesel facility or approximately 14 million gallons of marketable fat per year.

Figure 3. County Distribution of Soybean Production in Georgia.

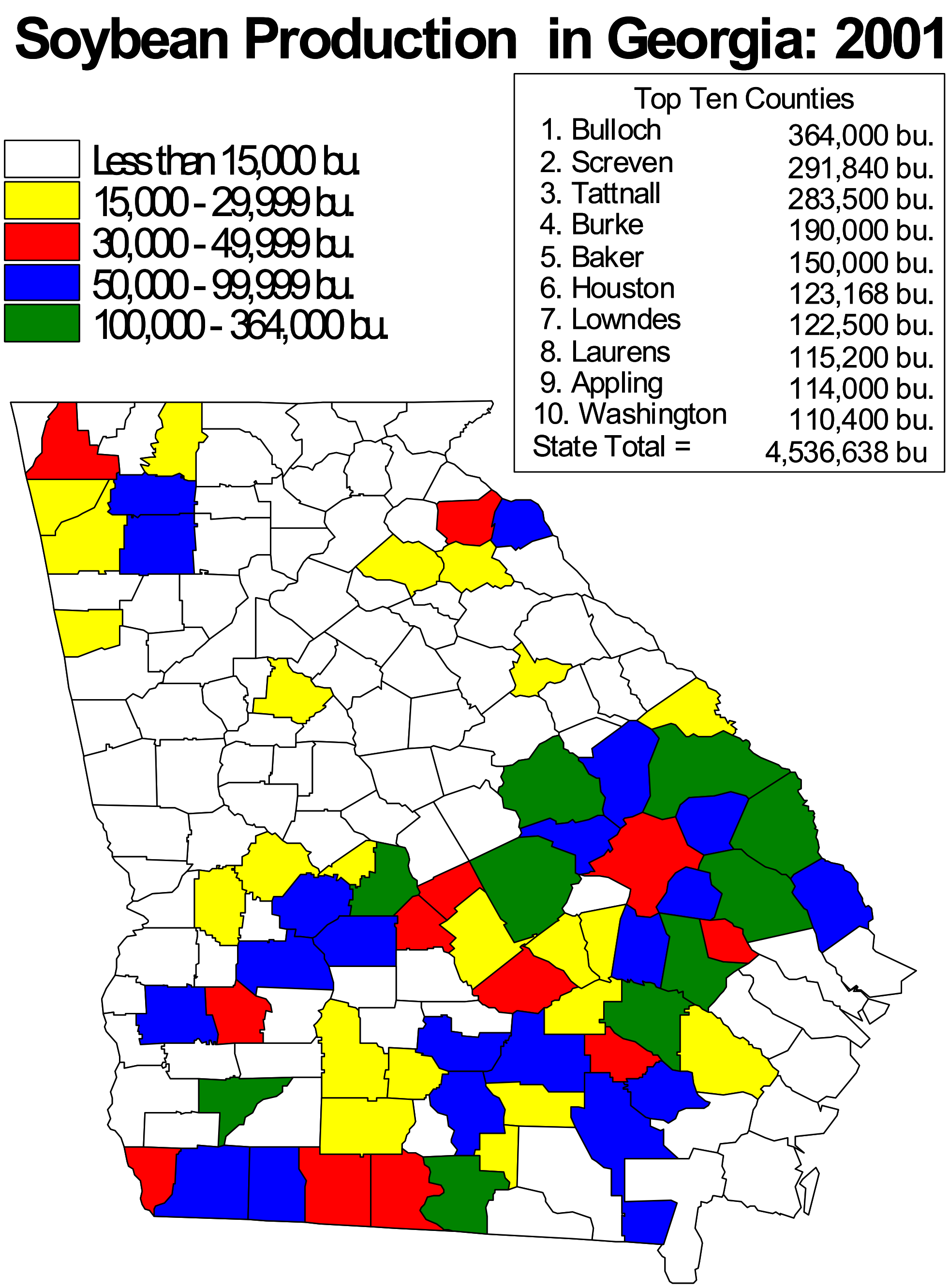


Figure 4. Poultry Fat Production by County, Georgia 2000

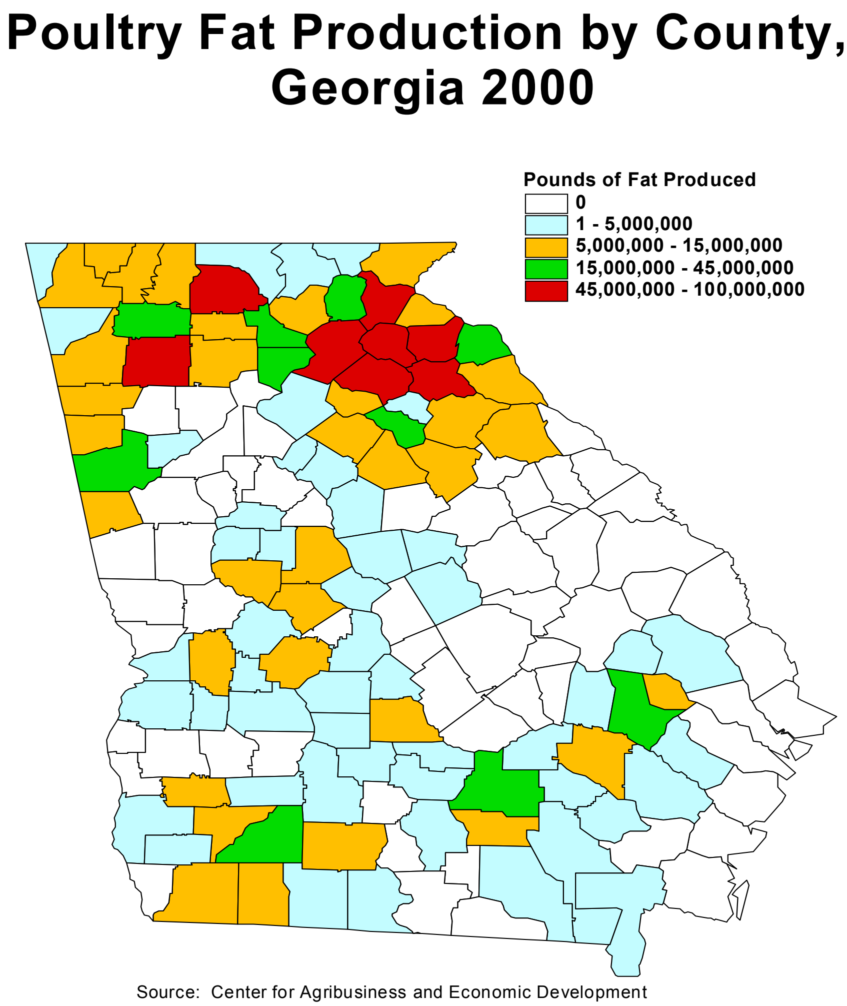
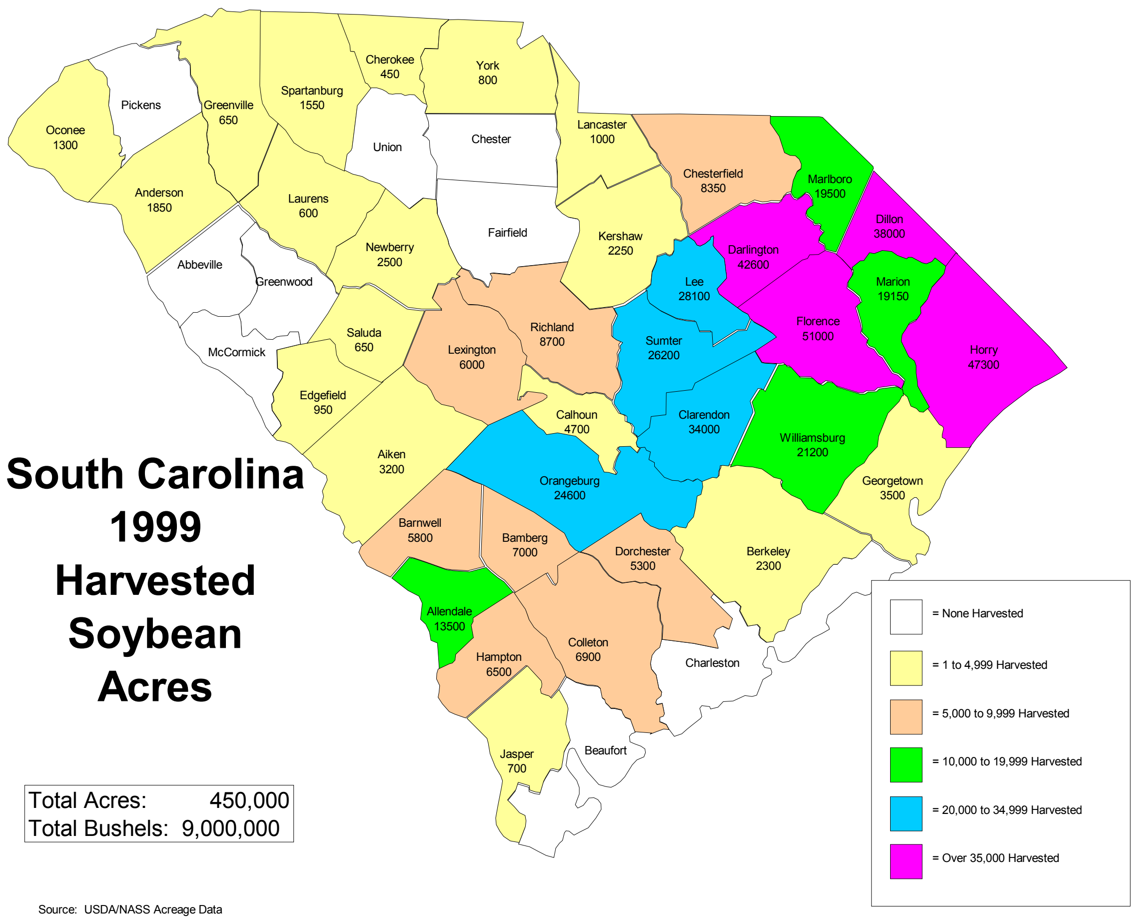


Figure 5. County Distribution of Soybean Production in South Carolina in 1999.



Another potential feedstock is spent fats or yellow grease. Yellow grease is inedible fat, oil and grease used and removed from the food service industry. Fryolators, grills, and water-to-oil separators are the major producers of yellow grease. Handling of yellow grease begins at the source, the food service industry. Most grease will be placed into a closed container waiting for disposal from a rendering service.

Most of the yellow grease produced in Georgia is collected by renderers who clean the grease and prepare it for other use in chemicals, soap, cosmetics, plastics, lubricants, and livestock and poultry feeds. Recent concerns about BSE in the beef industry may lead to reduced use of the rendered yellow grease as a feed ingredient potentially making it available for biodiesel. The Agricultural and Bioengineering Department at the University of Georgia estimates that 95% of the yellow grease produced by the food service industry in Georgia is currently used in animal feeds.

Across the United States, another large market for yellow grease is the export market accounting for 35% of disappearance. It is estimated that this will continue to rise absent other emerging domestic markets. A study done at the University of Georgia mentions that the high value of yellow grease has made it a target for theft in certain areas. Yellow grease has been used in the commercial food production industry where petroleum lubricants cannot come in contact with food.

It is difficult to get an exact estimate of the volume of rendered yellow grease availability in Georgia. While there is a significant volume handled, the amount available for sale is not yet determined. It is estimated that given a profitable return from biodiesel production, rendered yellow grease could be a good feedstock source.

Historical Feedstock Costs

Vegetable and animal fat prices vary depending upon supply and demand for each of the products and also upon the overall supply and demand situation for the entire fat/oil complex due to substitutability between products in some uses. In general, the vegetable oils have a higher unit value than do the animal fats. The following table shows the recent historical range of prices for some of the leading potential feedstock sources.

Table 1. Historical Feedstock Cost Ranges, 1996-2000.

Feedstock	Price Range Per Pound	Pre-processing Cost Per Pound	Feedstock Cost Per Pound
Crude Soy Oil	$0.15-0.27	$0.005-0.01	$0.16-0.28
Refined Cottonseed Oil	$0.15-0.28	suitable as is	$0.15-0.28
Crude Canola Oil	$0.12-019	$0.05-0.01	$0.13-0.20
Crude Corn Oil	$0.15-0.29	$0.005-0.01	$0.16-0.30
Crude Peanut Oil	$0.20-0.50	$0.005-0.01	$0.21-0.51
Yellow Grease	$0.08-0.14	$0.02-0.025	$0.105-0.165
Poultry Fat	$0.06-0.12	$0.005-0.10	$0.07-0.13

Feedstock Conclusion

It appears that only a limited supply of viable feedstocks exist in Georgia for a large-scale biodiesel operation. One of the problems is the high concentration in the poultry industry in Georgia demanding similar feedstock for poultry feed. Another problem is the other uses for recycled oil and beef tallow existing in the Southeast with soap, lubricant, cosmetics, and further processing of poultry.

Regional vegetable oils sites which use their oil production internally were not counted. Those oil sites available totaled 26.9 million gallons.

Table 2 provides the apparent quantities available of the feedstock investigated along with the prices paid for as indicated in the Feedstock publication.

Table 2. Availability and Prices of Feedstock in Georgia

Feedstock	Quantity (7.5lbs=gallon)	Price(Raw)	Price Per Gallon	Total Gallons
Beef Tallow	Limited	$.13-.17	$.97-1.27	N/A
Poultry Fat	Est. 105 million lbs	$.06-.12	$.45-.90	14 million
Recycled Oil	Est. 27 million lbs	$.08-.14	$.60-1.05	2.7 million
Oilseed	Est. 202 million lbs	$.15-.29	$1.12-2.17	26.9 million
Total Available	Est. 334 million lbs			**43.6 million**

The proposed biodiesel production facility would be capable of using any or all of the above feedstocks. Obviously, it would be in the best interest to secure as much feedstock as possible at the least cost in order to reduce the cost to the consumer of the biodiesel product. However, it is unlikely that enough yellow grease and poultry fat could be secured to run the plant full time so that other oils would also be needed. The most likely other higher valued oils would be soybean oil, cotton seed oil and peanut oil.

In summary, it appears that there is currently an adequate volume of feedstock produced in the State to meet the needs of a medium sized biodiesel production facility. The facility would need approximately 115 million pounds of feedstock or 1/3 of the estimated available market. The question yet to be answered is whether or not sufficient feedstock can be purchased at a price that would make biodiesel production economically feasible.

The Economics of Biodiesel Production

The Center for Agribusiness and Economic Development at the University of Georgia secured the services of Frazier, Barnes & Associates (FBA) of Memphis, TN, a consulting firm specializing in vegetable oil processing, to assess the capital cost of various sized biodiesel production facilities. Each of the plant cost estimates are for a facility capable of handling a wide variety of feedstocks for biodiesel production. The capital cost estimates include the cost of facilities needed to pre-process any feedstock such that it could be converted to biodiesel using the methyl ester process described earlier. FBA evaluated four different sized biodiesel site production plants looking closely at estimated construction and operating costs. Tables 3 and 4 present a summary of the findings:

Table 3. Estimated Capital Cost Comparison of Various Plant Sizes.

Plant Size (million gallon/yr)	.5	3	15	30
Capital Cost	$950,000	$3.4 mill.	$9.6 mill.	$15 mill.
Feedstock Needed Pounds Gallons	 3.75 mill. 500,000	 22.5 mill. 3 mill.	 112.5 mill. 15 mill.	 225 mill. 30 mill.

Source: Frazier, Barnes & Associates
Assumes a green field site. Estimated Accuracy +/- 25%. Total includes capital cost for preprocessing feedstock.

The capital cost range from $950,000 to $15 million depending on the capacity of the operation. The feedstock needed to run at full capacity ranged from 3.75 million pound at the smallest level of production to 225 million pounds at the highest level of production.

Table 4. Production Cost Sensitivity to Feedstock Cost by Plant Size, Dollars Per Gallon of Biodiesel.

Plant Size (million gallon/yr)	.5	3	15	30
$0.10 per lb cost	$1.96	$1.33	$1.11	$1.10
$0.15 per lb cost	$2.34	$1.70	$1.48	$1.48
$0.20 per lb cost	$2.72	$2.08	$1.85	$1.85
$0.25 per lb cost	$3.09	$2.46	$2.21	$2.21

Based on the data provided in Tables 3 and 4, it appears the most appropriate size facility for Georgia is the one that produces about 15 million gallons of biodiesel per year with a capital cost of about $9.6 million. In Table 3 we see that most of the economies of scale are realized in a 15 million gallon plant. Unit costs of production do not appear to fall by doubling the size to 30 million gallons. Therefore, the remainder of this report will focus on a plant size of 15 million gallon capacity.

Capital Costs for the 15 Million Gallon Biodiesel Facility

The following table presents a breakdown of the capital cost components of a 15 million gallon per year capacity biodiesel production facility. The cost estimates represent a ‘turn-key’ facility placed upon a green site near transportation access.

Table 5. Estimated Biodiesel Capital Cost Details for a 15 Million Gallon Capacity Plant.	
Equipment	$3,600,000
Buildings	$1,200,000
Utilities	$720,000
Civil/Mechanical/Electrical	$2,736,000
Land/Prep/Trans Access	$192,000
Engineering/Permitting	$192,000
Set-up Consulting	$3,000
Contingency (10%)	$960,000
Total Installed Cost	$9,603,000
Source: Frazier, Barnes & Associates	

The physical plant would require approximately 7 to 10 acres for the building, tank farm and transportation areas. A buffer zone may require more land depending upon the surrounding level of development. The building needed to house the plant would be approximately 5,000 square feet and about 60 feet in height. It would contain all the processing equipment plus a laboratory for quality control and offices. The processing area would use about 3,400 square feet. The tank farm may utilize about 20,000 square feet and would contain tanks totaling 650,000 gallon capacity divided between both holding tanks for feedstock and finished product. This plant would operate continuously and stop production only for maintenance and repair. It would require an operating employment force of eight people plus six people in management, sales, accounting and clerical.

Sensitivity to Feedstock Costs

The actual physical costs of production of biodiesel is a relatively small proportion of the total production costs (see Table 6). Costs of feedstocks are the dominant factor in determining final production cost. In the 15 million gallon per year plant, total annual operating costs would be about $22.947 million. Actual estimated operating costs are about 25 percent of total cost while feedstock acquired at $0.15 per pound average cost would represent about 75 percent of total cost. Clearly, the ability to acquire low priced feedstocks in imperative to minimize the cost of biodiesel production.

Biodiesel Production Costs

The cost of producing a gallon of methyl ester is highly dependent upon the average cost of the feedstocks used to produce it. The following table presents a detailed breakdown of biodiesel production costs for a 15 million gallon facility with average feedstock costs of 15 cents per pound.

Table 6. Breakeven for Biodiesel Production for a 15 Million Gallon per Year Facility with Feedstock Cost Averaging 15 Cents per Pound.		
Item	**Total**	**Per Gallon**
Income	$18,123,000	$1.21*
Feedstock & Direct	$20,213,640	$1.35
Labor	$722,500	$.05
Variable Cost	$678,043	$.05
Fixed Cost	$1,332,780	$.09
Total Cost	$22,947,363	$1.48
Profit/Loss	**($4,824,362)**	**($.032)**
* includes glycerin & feed fat by products		

Table 6 exhibits that the greatest portion of the cost in manufacturing biodiesel is the feedstock and direct cost. The direct cost consist of the catalyst and methanol. These cost total $1.35 or 90% of the total cost when the feedstock is purchased for $.15 per pound.

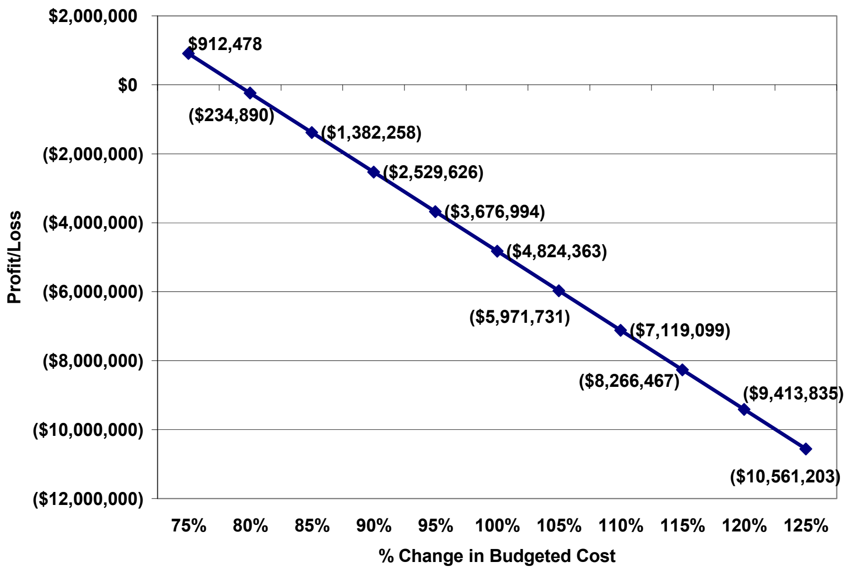
Table 7. Total Production Cost Per Gallon of 100% Biodiesel at Various Average Feedstock Costs from a 15 million Gallon Per Year Plant.	
Average Feedstock Cost	**Total Production Cost Per Gallon**
$0.10	$1.11
$0.15	$1.48
$0.20	$1.85
$0.25	$2.21
$0.30	$2.58
$0.35	$2.94

The results in Table 7 reveal the strong relationship between the final product cost and the feedstock cost. If Georgia wishes to compete and produce biodiesel a relatively cheap ($.10 to $.15) feedstock needs to be used in the biodiesel production.

Sensitivity to Changes in Budgeted Costs

Sound analysis of a proposed project calls for a look at what would happen if the assumed production cost structure changes. The following chart demonstrates the impact of both higher and lower costs of production upon the net returns of the operation. As one might expect, net return increase with lower costs and decrease with higher costs. The point to made is not that relationship but rather the magnitude of changes in net return given various changes in costs.

Graph 1. Profit/Loss versus Change in Budgeted Costs

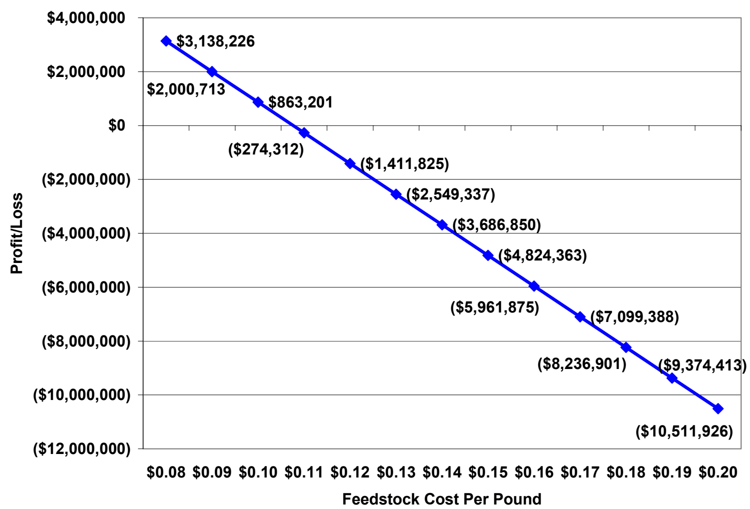


Graph 1 indicates the 15 million gallon facility needs to reduce cost by 22% to breakeven. This may be achievable with a subsidy on the feedstock.

Breakeven Feedstock Cost

The following graph clearly illustrates the relationship between the profitability or loss of a 15 million gallon facility as feedstock costs change. The breakeven cost of feedstock, assuming all other costs remain constant is about $0.108 cent per pound. Returns above costs would obtain if average feedstock cost is below $0.108 per pound while operating losses would result if average feedstock cost is above $0.108 per pond.

Graph 2. Profit/Loss versus Feedstock Costs

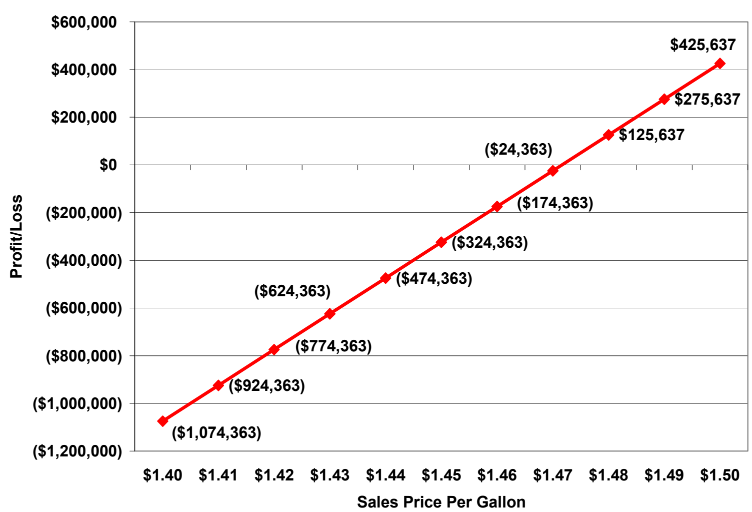


Graph 2 exhibits the strong relationship between the feedstock and breakeven. When the feedstock price approaches $.10 per pound the facility creates a positive net return.

Sensitivity to Changes in Selling Price

Another source of risk involves changes in the selling price of the methyl ester product. The following chart illustrates the relationship between net returns and differing methyl ester sales prices. The breakeven selling price of methyl ester is about $1.48 per gallon when feedstock costs average 15 cents per pound.

Graph 3. Profit/Loss versus Change in Sales Price



Graph 3 shows a sales price of $1.48 is needed to create a positive return.

The Bottom Line - Can Biodiesel from the Proposed Facility Compete with Regular Diesel?

Perhaps the question is a bit misleading. The cost of producing biodiesel given current average feedstock costs of about \$0.15 a pound is about \$1.56 per gallon (see Table 6). This value should be compared to the wholesale price of diesel fuel to get a proper comparison. Wholesale Diesel Prices can be estimated by the following formula:

WDP = Crude Oil Price per Barrel / 42 gallons + Processing (\$0.05/gal) + Transportation (\$0.02) + Profit (\$0.05)

WDP = \$25.11 (March 19, 2002) /42 + \$.12 = \$0.72 per gallon

Current early 2002 estimated wholesale diesel fuel prices are about \$0.72 per gallon. Thus it appears biodiesel is not competitive at current prices.

However, biodiesel is used primarily as a fuel additive and is seldom used in 100% form. Most commonly it is mixed as either 2 or 20 percent blends. When you look at the added cost of the blended product, then the question becomes more appropriate, especially in light of the challenges facing Georgia in terms of both the environmental impact and low farm incomes.

Tables 8 and 9 illustrates the added cost to the retail price of fuel when biodiesel is blended at 2 and 20 percent levels. The point to gain from the tables is that the added cost to the retail price is relatively small from blending in biodiesel, especially with 2% biodiesel. Furthermore, at higher fuel prices, similar to what we have seen during early 2001, biodiesel can even reduce the retail price.

Table 8. Added Cost to Retail Price of Diesel Fuel When Blended with 2 Percent Biodiesel.

	Retail Diesel Prices Per Gallon						
	\$0.60	\$0.75	\$0.90	\$1.05	\$1.20	\$1.35	\$1.50
Biodiesel Cost 100%	Added Cost in Cents per Gallon						
\$1.25	0.013	0.010	0.007	0.004	0.001	(0.002)	(0.005)
\$1.50	0.018	0.015	0.012	0.009	0.006	0.003	
\$1.75	0.023	0.020	0.017	0.012	0.011	0.008	0.005
\$2.00	0.028	0.025	0.022	0.019	0.016`	0.013	0.010
\$2.25	0.033	0.030	0.027	0.024	0.021	0.018	0.015

Table 9. Added Cost to Retail Price of Diesel Fuel When Blended with 20 Percent Biodiesel.

	Retail Diesel Prices Per Gallon						
	$0.60	$0.75	$0.90	$1.05	$1.20	$1.35	$1.50
Biodiesel Cost 100%	**Added Cost in Cents per Gallon**						
$1.25	0.130	0.100	0.070	0.040	0.010	(0.020)	(0.050)
$1.50	0.180	0.150	0.120	0.090	0.060	0.030	
$1.75	0.230	0.200	0.170	0.140	0.110	0.080	0.050
$2.00	0.280	0.250	0.220	0.190	0.160	0.130	0.100
$2.25	0.330	0.300	0.270	0.240	0.210	0.180	0.150

Biodiesel can be produced and marketed in a 2% blend formulation at competitive price if:

1. Feedstock costs are near 10 cents per pound and retail diesel prices near $1.15 per gallon.
2. Retail diesel prices are above $1.25 per gallon with feedstock costs of 15 cents per pound.
3. There is a tax reduction (State or Federal or both) that would make up the difference between the delivered cost of the biodiesel and diesel.

Biodiesel Products and Handling Considerations

The methyl ester from the plant can be used directly to run a diesel engine. However, in most cases, the product is blended with regular diesel fuel. The most commonly used blends are 2 and 20 percent blends where either 2 or 20 percent of the blend is the methyl ester and the dominant remainder is regular diesel fuel. These products are easily mixed and require no special equipment to accomplish the blending process. Typically the methyl ester is placed in a container and the diesel fuel is then poured into the methyl ester and ‘splash blended’. No further stirring is needed to accomplish blending. Once blended the two products are reported to remain stable.

According to the National Biodiesel Board in Jefferson, MO, biodiesel can be stored in the same containers as petroleum diesel, however concrete storage tanks should not be used. Biodiesel is non-toxic and biodegradable. If stored above ground in a blended form the requirements are the same as for petroleum. When held as 100% methyl ester, it should be handled similar to vegetable oils.

Biodiesel can gel in cold weather conditions similar to diesel. This problem is solved either through storage in heated environments or by the addition of additives that inhibit gelling.

Gelling of biodiesel varies depending upon the chemical composition of the feedstock used in its production. The higher the saturated fat of the feedstock , such as in animal fats, the higher the temperature at which gelling occurs. The converse is also true. Canola oil, with low levels of saturated fats, derived biodiesel provides the lowest gelling temperature biodiesel. Pure biodiesel should be stored and transported at temperatures above 50 F and blending temperatures should be above 40 F.

Environmental Impacts of Biodiesel Use

Studies completed by the Environmental Protection Agency (NREL/TP 2001) state that a 20% blend is "basically a trade off between cost, emissions, cold weather, material compatibility and solvency issues". Researchers believe the 20% blend to be the best blend for general use without encountering major issues. Higher blends often cause problems in winter and with nitrogen oxide emissions.

Table 10. Emission Changes with Biodiesel Fuels

Emission	100% Biodiesel*	20% Biodiesel Blend*
Carbon Monoxide	-43.2%	-12.6%
Hydrocarbons	-56.3%	-11%
Particulates	-55.4%	-18%
Nitrogen Oxides	+5.8%	+1.2%
Air Toxics	-60% to -90%	-12% to -20%
Mutagenicity	-80% to -90%	-20%
Carbon Dioxide**	-78.3%	-15.7%

* Average of data from 14 EPA FTP Heavy duty test cycle tests, variety of stock engines
** Life Cycle Emission

It would appear that the use of biodiesel can be an effective means for reducing exhaust emissions. The relevant question becomes how does the cost of reducing emission using biodiesel compare to other means of obtaining the same level of emission reduction. The answer to that question is beyond the scope of this inquiry.

Impact Analysis

Impact analysis is a key component of any feasibility study. An impact analysis indicates the effect of a new venture on the economy. Building a new biodiesel facility in Georgia will impact the economy on two levels. The new plant will generate output as it begins selling biodiesel and its byproducts. These sales will, in turn, generate additional sales as the plant purchases inputs. The suppliers to the plant will increase the purchase of their inputs, thus increasing demand for those items. These increased sales will ripple through the economy. An input-output model will capture and quantify these effects.

The input-output model, IMPLAN (IMpact Analysis for

PLANning, Minnesota IMPLAN Group 1999) was utilized for this project. IMPLAN can predict the effects of a new venture on output (sales), employment and tax revenue. IMPLAN models can be constructed for a state, a region or a county. Input-output models work by separating the economy into its various sectors, such as agriculture, construction, manufacturing, and so on. An IMPLAN model will show each sector and industry in the specific region's economy. The model can capture how a change in one industry (for example, biodiesel) will change output and employment in other industries.

A new sector was developed in IMPLAN to represent the biodiesel industry. The production function was created from the cost estimates provided by the research team. The production function was assumed to remain constant over the sizes of the plant. This may or may not hold true as returns to scale dictate.

The changes in the initial industry (biodiesel) are labeled direct effects and the changes in the other industries and household spending are called indirect effects. The direct and indirect effects are summed to give the total economic impact. Direct impacts are those at the plant. For instance, direct output is equal to total sales of the plant. Direct employment equals the number of people working at the plant. Indirect impacts are those that exist due to the plant's functioning. This would include people such as chemical suppliers, oil refiners, feedstock producers, and so forth.

Direct output of the 15 million gallon plant is $17.4 million annually. This leads to indirect sales in the Georgia economy of $16.9 million. In total, the economic impact of sales of the plant will be $34.3 million. Fourteen jobs will be created at the plant. The operation of the plant will cause another 119 jobs to be developed in Georgia, thus total employment creation will be up 132 jobs. State and local non-education tax revenues will increase by $2 million per year.

Table 11. Economic Impact on Sales, Employment and Revenue of a 15 Million Gallon Biodiesel Plant in Georgia.

	Direct	Indirect	Total
Sales (Output)	$17,373,000	$16,899,714	$34,272,716
Employment	14	119	132
Tax Revenue	NA	NA	$2,116,870

The job creation is a one time occurrence in that it indicates the total number of jobs created by the project. However, those jobs remain year-after-year. The money flows indicated by the economic impact and the tax revenues are recurring events year-after-year. This project has an economic life time of about 25 years, thus one can expect a total economic impact over the twenty five year period of about $858 million dollars. The total tax flows over the twenty five year period would be about $52.75 million.

This study focused upon the 15 million gallon plant size as it was felt it was the most appropriately scaled facility. One final summary table present the IMPLAN results for each of the four plant sizes that were evaluated.

Table 12. Comparison of Total Impacts by Plant Size

	Total Output	Total Employment	Total Tax Revenue
500,000 Gallons	$1,495,955	18	$205,656
3 Million Gallons	$7,982,526	53	$806,029
15 Million Gallons	$34,272,716	132	$2,116,870
30 Million Gallons	$76,838,499	364	$4,561,222

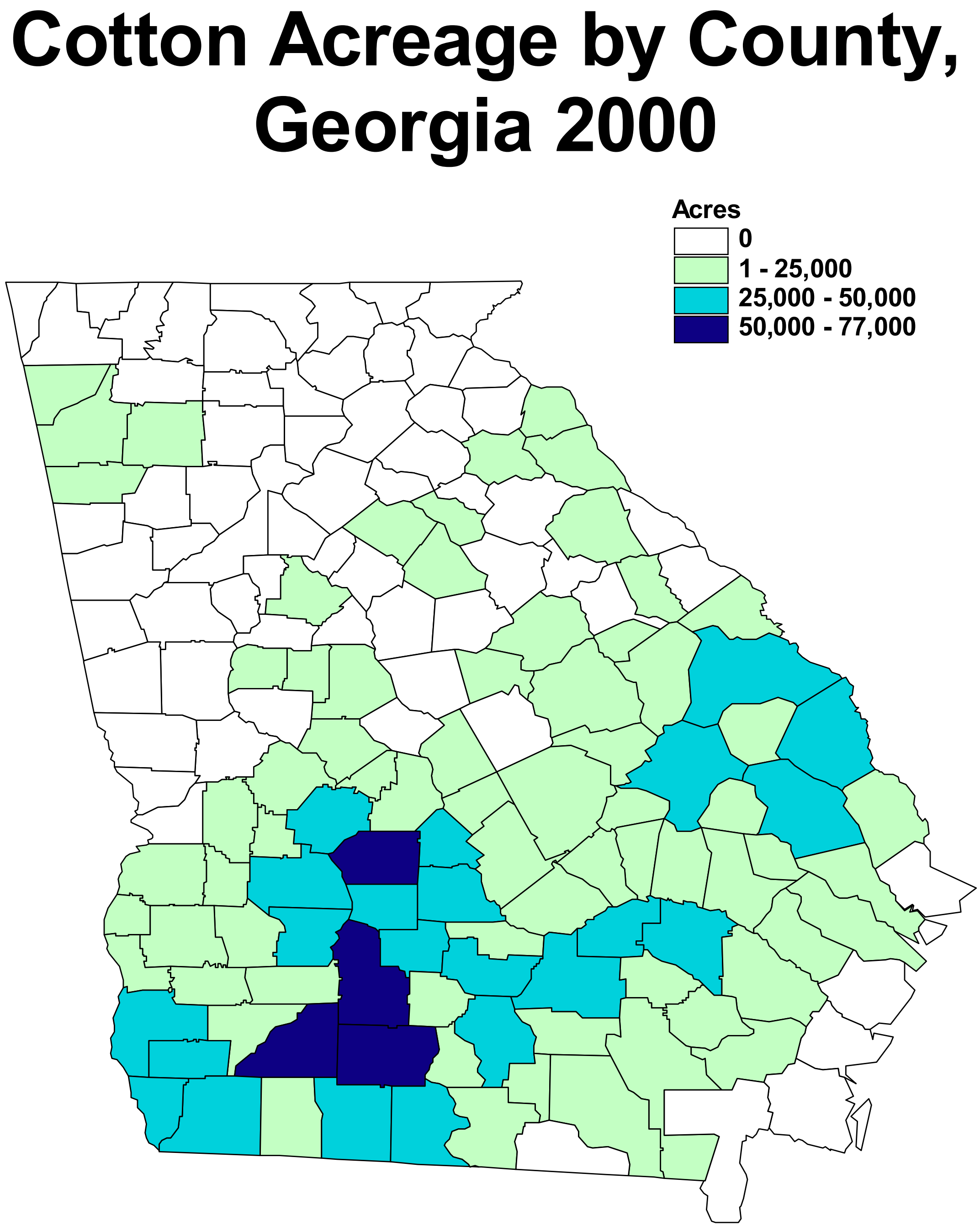
Conclusions

There exist a variety of potential feedstocks both in Georgia and nearby states that could be utilized to produce biodiesel. These feedstocks vary significantly in price depending on supply and demand condition as well as market structural conditions. Feedstock costs represent between 50 and 75 percent of the cost of producing biodiesel and thus a reliable source of low priced feedstocks is critical to success. A 15 million gallon biodiesel plant would require about 27 % of the vegetable and animal fats currently available within the State of Georgia. This facility would produce 750 million gallons of 2% blend for approximately twice the state demand. A 20% blend will create 75 million gallons of B20 or roughly 20% of the Georgia diesel market.

The processing technology for producing biodiesel is well established and presents little technological risk. The production of biodiesel is a very efficient process returning about 3.2 units of energy for each unit used in production. Biodiesel is thus an excellent renewable fuel source. Biodiesel can be very easily integrated into the existing petroleum distribution system from the handling, chemical, physical and performance perspectives.

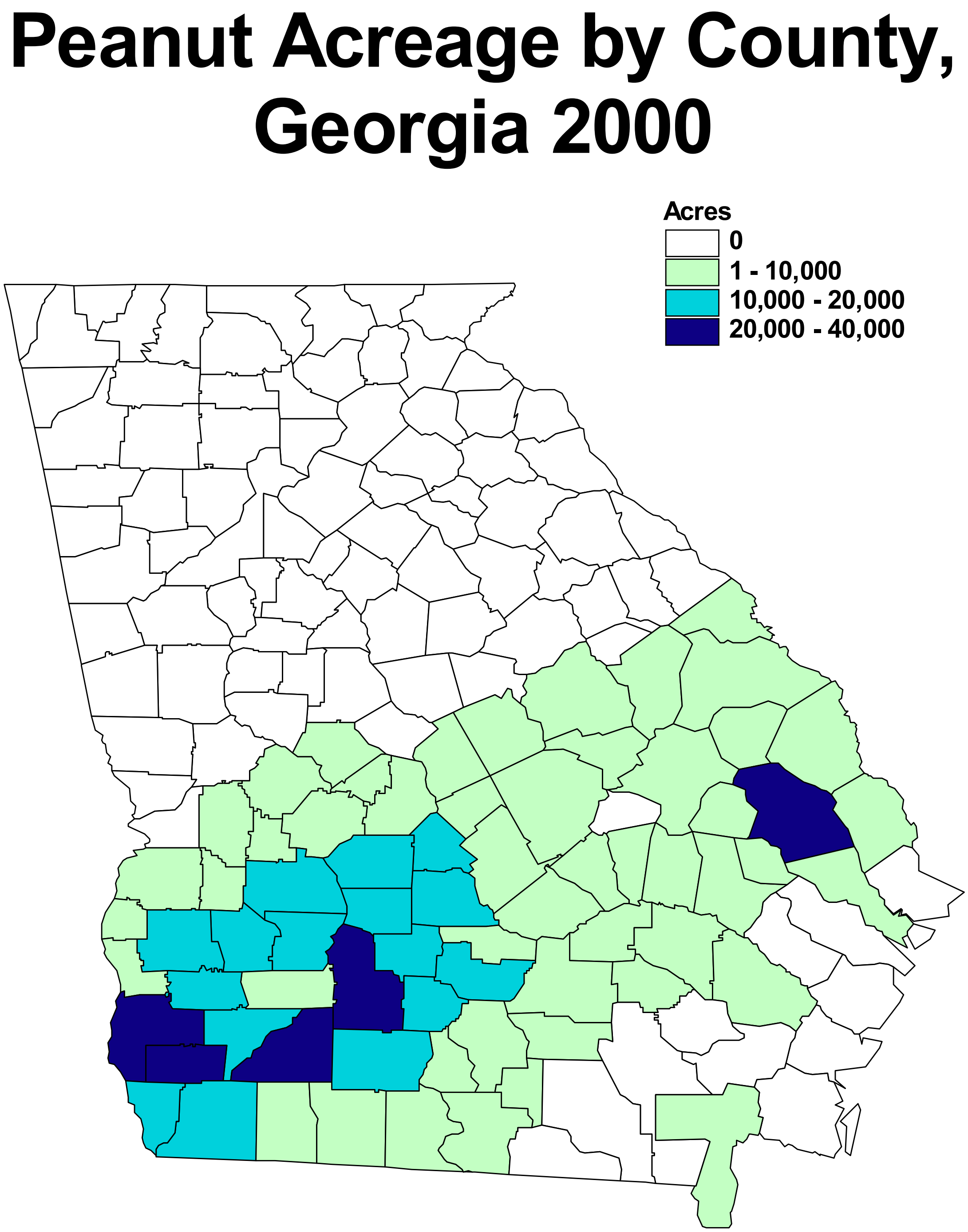
Lacking government mandates or subsidies, a feedstock cost of about 10 cents per pound or less, given current diesel fuel prices, for biodiesel to be cost competitive.

Figure 6. Cotton Acreage by County Georgia, 2000



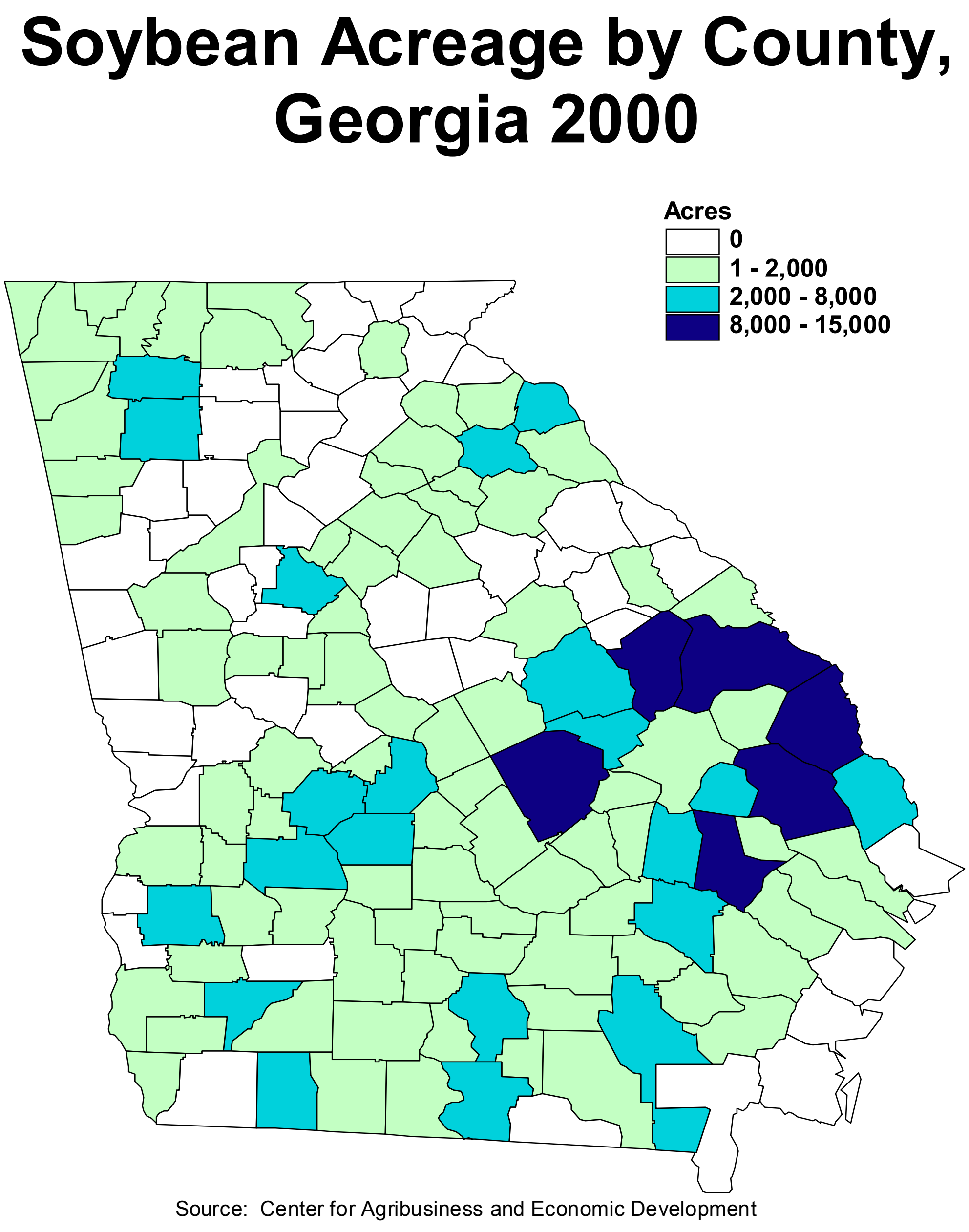
Source: Center for Agribusiness and Economic Development

Figure 7. Peanut Acreage by County, Georgia 2000



Source: Center for Agribusiness and Economic Development

Figure 8. Soybean Acreage by County, 2000



APPENDIX