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# The University of Georgia

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**Center for Agribusiness and Economic Development**

**College of Agricultural and Environmental Sciences**

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## **Economic Analysis of Biodiesel Production in Georgia**

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## EXECUTIVE SUMMARY

### Executive Summary

Biodiesel production is a hot topic and many people are interested in producing biodiesel in Georgia. This study investigates the issues surrounding biodiesel production in Georgia and provides insight into the economic feasibility. There currently are several firms producing biodiesel with many more either exploring entry or already constructing plants in Georgia.

Biodiesel can be produced from fats and oils from a wide variety of plants and animals. Most facilities are designed to use just a few potential feedstocks and generally only those feedstocks with the lowest total cost of production and readiest supply. Feedstocks can be placed into three primary categories: virgin vegetable oils, waste vegetable oils, and rendered animal fats. Georgia could have something slightly in excess of 300 million gallons of feedstock potentially available for biodiesel production from the virgin vegetable oils and rendered animal fats. So, if all the potential feedstock was used to produce biodiesel, then production would approach 300 million gallons.

The potential market for biodiesel just within the state of Georgia could be quite large compared to likely production. Based on data from the Energy Information Administration, in 2004 over 1.9 billion gallons of diesel fuel oil was consumed in Georgia for various purposes. A B2 blend into that stream would require over 38 million gallons and a B20 blend would use over 384 million gallons. It is clear there is a broad market with great potential for biodiesel use in Georgia.

There is considerable price risk in both the feedstock and biodiesel sales prices. There are several methods available for price risk management including direct cash contracting, partnership arrangements, hedging and cross hedging in the futures markets. Successful biodiesel producers will need to carefully manage all price risks.

The study examines five different plant sizes: 5, 10, 15, 30 and 60 million gallon per year plants. There are economies of scale to be realized in larger biodiesel plants compared to small plants however, the gains are not large. The 5 mmGPY plant has the highest cost of production and the 60 mmGPY has the lowest cost of production, but only 6 cents per gallon less than the 10 mmGPY plant. It would appear that plants of modest size should be able to compete very well against the very large plants that are being proposed and constructed across the country.

## **Introduction**

There is great interest in bio-fuels production in Georgia as well as the rest of the United States. One bio-fuel that many Georgians have asked about is biodiesel. There is interest in producing biodiesel in Georgia due to the high fuel prices seen during the first half of 2006 as well as a strong desire to help the U.S. decrease reliance upon politically unstable petroleum producers around the world. The ability of many entrepreneurs to profitably produce and market biodiesel is also a strong driving force behind the interest.

The Center for Agribusiness and Economic Develop (CAED) investigates the feasibility of many different types of proposed projects for a wide variety of clients across the state. Due to the high level of interest in producing biodiesel, the CAED decided to look into the economics of biodiesel production and marketing to help determine if could be produced and marketed profitably in Georgia.

This study will provide information that will assist people and firms in the decision of whether or not to enter into the biodiesel production and marketing business.

## **Biodiesel Characteristics and Benefits**

Biodiesel is a fuel product produced from various vegetable oils and animal fats by the esterification and trans-esterification processes (described later). It is typically produced by a reaction of vegetable or animal fats with an alcohol, typically methanol, along with a catalyst to create esters and glycerin. The mass of biodiesel is about 90 percent from the oil or fat and about 10 percent from the alcohol. Once produced it is commonly blended with petroleum diesel and used in all forms of diesel engines. Biodiesel has many advantages as a fuel supplement including increased lubricity especially with low sulfur diesel fuels, and it is a clean burning fuel that is also non-toxic and biodegradable and its use improves air quality.

Biodiesel differs from straight vegetable oil in that it has been chemically altered to reduce the viscosity of the original so that it can be used as a fuel. Straight vegetable oil must be heated prior to injection into an engine before I will burn cleanly and efficiently. Typically straight vegetable oil must be filtered and de-watered before it can be used.

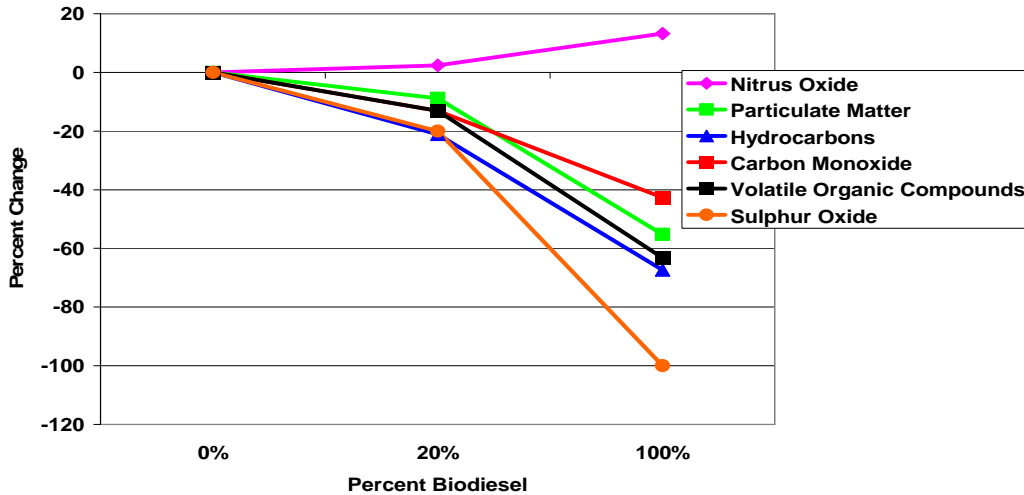
Exhaust emission of many of the most harmful materials are reduced by the use of biodiesel. A 2002 Test Report examining the composition of tail pipe exhausts from using biodiesel by the EPA illustrates the reduction in the following chart. The highest reductions in harmful emission occurred at the highest rates of biodiesel in the fuel blend. However, in common practice, biodiesel is typically blended at the lower end of the scale with good benefits obtained at even a 2 percent blend<sup>1</sup>. Most new model diesel engines

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<sup>1</sup> Biodiesel blends are identified by the shorthand "Bx" where "x" represents the percentage of biodiesel blended with petroleum diesel. In this example a two percent blend would be represented as "B2." Typical blends include B2, B5, B10 and B20.

and many late model engines can run on biodiesel blends with no modification needed. Some older model engines may suffer from seal and other rubber part deterioration. Biodiesel manufactured for sale must meet ASTM (American Society for Testing and Materials) 6751 standards (see appendix for details). It is easily and readily blended with petro-diesel at any step along the marketing channel for fuel.

## EMISSIONS BENEFITS OF BIODIESEL



Source: EPA, 2002 Biodiesel Emissions Test Report

Biodiesel production is a rapidly growing industry expanding from about 100,000 gallons produced in 1998 to a projected production for 2006 of about 300 million gallons. Some observers believe production will exceed 1 billion gallons in 2010 and could approach 2 billion gallons by 2015. This is indeed rapid growth.

The U.S. will consume about 65 billion gallons of diesel fuel during 2006 with about 38 billion gallons used for off road purposes. This compares to about 140 billion gallons of gasoline used. Current biodiesel production would provide about 0.5% of total diesel use. Therefore, one can see that there is great potential for growth in the industry. During 2006, the ethanol industry will provide about 2.8 percent of the total fuel used in the gasoline market for the U.S.

The implementation of biodiesel into the nation's diesel fleets of trucks, tractors, power engines and passenger vehicles can be accomplished in a relatively seamless manner, particularly when used at a low percentage blend. It can be blended into petro-diesel simply by pouring the two liquids together, called splash blending. Its value in providing increased lubricity for low sulfur diesel and its clean burning, low emissions make biodiesel very attractive in the current and future diesel fuel market.

## **Current Biodiesel Production**

In the fall of 2006 there were 67 commercial sized biodiesel production facilities actively making and selling biodiesel in the U.S. Additionally there are a large number of small scale “cottage” producers of biodiesel making fuel for private use. There are a large number of groups across the U.S. and one observer had a tally in excess of 300 groups investigating entering into the market with more popping up on a regular basis. Not all of the groups will ultimately enter the industry for a variety of reasons. If the ethanol industry is any guide, less than 20 percent of the proposed plants will ultimately be constructed.

The scale of the biodiesel industry is also changing rapidly. The first few commercial plants built were of modest size producing less than 15 million gallons per year with most of them between 2 and 12 million gallons. Currently, new entrants have been much larger size between 10 and 30 million gallons capacity per year. A couple of very large plants in the 60 million gallon per year size have been proposed. According to the National Biodiesel Board, the industry trade association, the average proposed plant size has increased from about 14 million gallons capacity in 2005 to about 22 million gallons in the fall of 2006. Clearly the trend is to bigger plants.

Additionally, instead of biodiesel producers buying feedstock where they could, we are now seeing very large vertically integrated commodity companies building biodiesel plants co-located with feedstock supplies. The Archer-Daniels-Midlands, Bunge and Cargills of the world are changing the dynamics of the industry with this large scale, integrated strategy. They will make future entry more difficult and may make life for existing firms perilous as these large firms control a significant share of the potential feedstocks for biodiesel production. It is clear that the future successful biodiesel producer will have either an ownership interest in or a contractual tie to a feedstock source.

According to the National Biodiesel Board there are two producers of biodiesel in Rome, Georgia; Peach State Labs and U.S. Biofuels, Inc with a combined estimated capacity of about 14 million gallons per year. The NBB also indicates there is a producer located in Moundville, AL but does not estimate their production level and lists two producers in Tennessee, Agri-Energy, Inc in Louisburg and NuOil in Counce with a combined capacity of 6.5 million gallons per year. The author also located a small producer in the Atlanta area named VegEnergy Biofuels with an estimated annual production of less than 100,000 gallons. The current total estimated production capacity of the competition in the three state area is about 20.5 million gallons, but that could more than double in one year’s time. The combined current production would satisfy about 14 percent of the potential biodiesel market demand using the B2 standard discussed above.

**Planned Biodiesel Production**

The Southeast Farm Press reported that a group plans to construct a 60 million gallon per year plant near Columbus, GA with a scheduled ground breaking in late 2006. A cotton seed crusher in the Tifton area is exploring construction of a biodiesel production facility, presumably to use cotton seed oil and/or canola oil as the feedstock. The capacity of this proposed plant is unknown. Another proposed operation named BullDog BioDiesel in Ellenwood, GA, near the Atlanta metro area, plans to use yellow grease and other oils for feedstock. Its proposed capacity is 15 million gallons per year. PetroGreen, LLC proposes to operate a 5 million gallon per year facility in the North Georgia area, but is still in the planning stage.

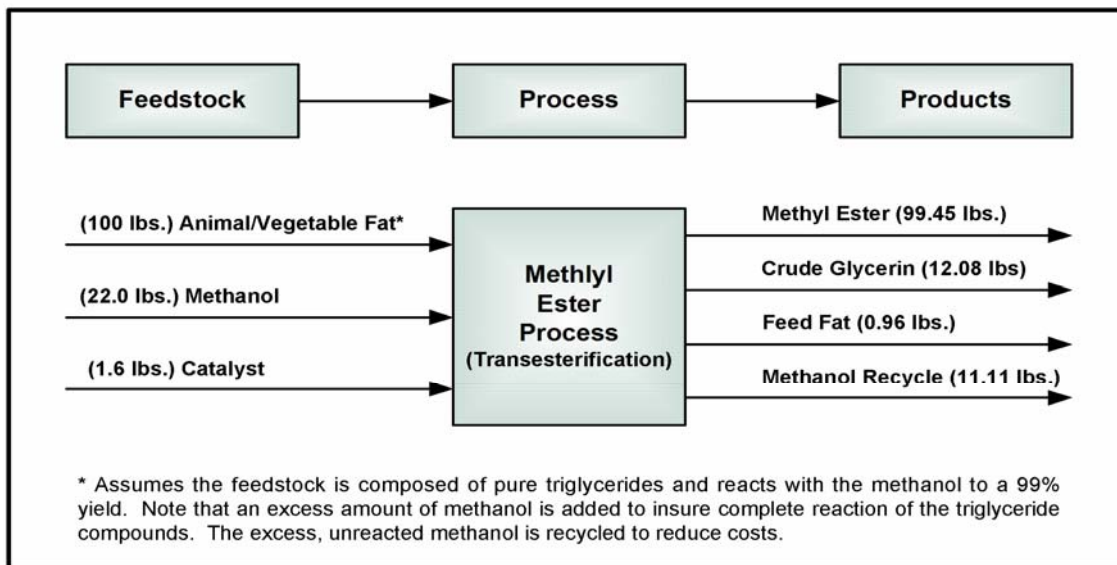
If all these plants were to come on line within the next year, the combined supply to the B2 market would be about 90 percent filled, but that does not imply there would not be a viable market for additional biodiesel. It does imply that there could be some price pressure from the increased production capacity.

Plant Name/Location	Current Capacity	Planned Capacity
Peach State Labs/Rome, Georgia	14 Mgal/year (combined)	
U.S.Biofuels/ Rome, Georgia		
Moundville, AL	Unknown	
Agri-Energy/Louisburg, Tennessee	6.5 MGal/year (combined)	
NuOil/Counce, Tennessee		
Columbus, GA		60 Mgal/year
Tifton,GA		Unknown
BullDog BioDiesel, Ellenwood, Georgia		15 MGal/year
PetroGreen, north Georgia		5 Mgal/year

The total estimated current production capacity in the three state area is about 20.5 million gallons but would rise to over 80 million gallons with the proposed Columbus plant. There are several groups within the state at various stages in the process entering into production. In the fall of 2006 it is unclear how many, if any, of these groups will actually proceed with construction. Their potential capacity is unknown. There are most certainly other groups in neighboring states also investigating the possibilities as well.

## **Biodiesel Production Technology**

The following block diagram illustrates the theoretical mass balance in the transesterification process for producing biodiesel. It is illustrative of the general process of trans-esterification but different technologies will use slightly different methods and will provide slightly differing mass exchanges. The different feedstocks will also have slightly different mass exchanges as well.



Source: Frazier Barnes & Associates, Memphis, TN

## **Process Design Considerations**

There are several commercially available technologies for producing biodiesel. The choice of which technology to use is an economic decision based on the choice of feedstock, the quality of the finished biodiesel and the co-products produced.

Biodiesel is the product being produced. Quality of that product must be paramount in the decision process. It must meet the American Society for Testing and Materials (ASTM) to be sold into the market place. It is important that the ASTM standards are not static and can and will change in the future. The process design should incorporate features to meet current and anticipated future ASTM standards.

The feedstock to be used is a critical decision in how to configure the plant. While the basic principles of converting all feedstocks into biodiesel are essential the same, reactor design and various pretreatment and auxiliary systems will differ with different feedstocks. Availability and cost of feedstocks will play a major role in this decision.

Glycerin is the primary co-product in the process. The main decision is whether or not to proceed with refining the crude glycerin to an improved state in order to seek a higher market price. Some of the available technologies offer refining capability but some do not. Another ancillary choice concerns the targeted market for the refined glycerin in that some regulations may prohibit or restrict glycerin produced from some feedstocks.

### **Basic Production Processes**

There are two basic biodiesel technologies that are commonly in use.

**Trans-esterification** - The predominant method is called trans-esterification that converts feedstock low in free fatty acids into biodiesel. The feedstock is typically a single type with free fatty acids of less than 0.5 percent and is usually a refined oil product. Some firms do source more than one type of feedstock but they are typically very similar. Feedstocks may also be pretreated to remove the free fatty acids, called soap, but this has the side effect of effectively raising the cost of the feedstock by both the pretreatment cost and the percent of soap removed. The pretreatment may also remove some gums from oils that were not refined. This system works well for the better feedstocks such as refined canola, soybean and other vegetable oils.

**Esterification** - The second basic method is designed for feedstocks high in free fatty acids or feedstocks with varying levels of free fatty acids. This process uses direct esterification along with the trans-esterification reaction to use this type of feedstock. This system provides a higher yield of biodiesel from the high free fatty acids feedstocks. This method works best for the animal fats and other lesser quality fats and oils such as yellow grease.

### **Basic Operating Methods**

Given the choice made for the basic production process, the next decision concerns how the plant will actually be operated. There are three basic options: batch, continuous or batch-continuous.

**Batch Operation** – Batch operations are conducted in discrete units. Each batch of feedstock is processed independently of the next for all processes such as pretreatment, reaction, separation and purification. These type operations can be easily started and stopped and are good for facilities that do not operate 24 hours a day. The product flow can be easily traced and documented and alternate feedstocks can easily be substituted into the next batch. Most smaller operations are of the batch variety.

**Continuous Operation** – As the name implies, the process is an on-going flow of feedstocks, reactions and purification. These type facilities are typically the largest and most efficient operations. They often can get by with lower inventories and thus less storage space. These processes rely upon a consistent feedstock, typically single sourced, and are sensitive to process changes.

**Batch-Continuous** – This approach attempts to reap the benefits of both of the above processes as it adapts characteristics of both. In practice it typically consists of batch reactors making independent batches of product followed by a continuous separation and purification process. It garners the efficiencies at the back end of the process while enjoying the ability to control the reaction process and change feedstocks more rapidly than the continuous systems.

The following box compares characteristics of the batch with the continuous systems.

<b>Comparison of Biodiesel Technology Characteristics</b>		
<b>Characteristic</b>	<b>Batch</b>	<b>Continuous</b>
Typical Capital Cost	Less	Greater
Economy of Scale	Less than 10 Million Gallons per year	Greater than 10 Million Gallons per Year
Feedstock Flexibility	Greater Flexibility	Less Flexibility
Consumption of Inputs	Greater	Less
Operating Cost per Gallon	Greater	Less
Automation	Less	Greater
Product Yield	Less	Greater
Product Quality Consistency	Less	Greater
Typical Plant Size	Smaller	Larger

Source: Frazier Barnes & Associates, Memphis, TN

### **Product Separation and Purification**

Upon completion of the reaction process, the product is placed in centrifuge where residual gums and other materials are removed. The product then proceeds to the purification stage. There are four primary methods that can be used.

**Water washing** – Water is used to remove water soluble impurities such as free glycerin, soaps and traces of methanol from biodiesel. Since water has no affinity for biodiesel can be easily removed or dried, usually in a flash dryer. Water will not remove any un-reacted glycerides or other oil-soluble materials such as phospholipids and sulfur compounds. The ASTM specifications for biodiesel require very low levels of phosphorous and the best way to accomplish this is to use degummed, bleached feedstocks. The sulfur compounds are typically very low in the virgin oils but may be a good bit higher in the animal fats.

Water washing requires constant monitoring as the amount of water used must be adjusted to the impurity load of the product. If the product contains too much soap due to even a small error in the reaction recipe, water washing will be very difficult.

Water washing can be a low energy user if the water is not recycled. However, waste water treatment costs or even disposal costs can off set the energy savings.

**Active Filtration** – Active filtration use a bed of material that will filter out the impurities as the product passes through. This is a very simple and easy process but must be monitored as to flow rates, impurity levels and contact time. The down side to this method is the cost of the filtration agent, its cost of replacement and disposal as a solid waste product.

**Ion Exchange**- The principle of the methods is a resin that will exchange a hydrogen molecule with the ion sodium portion of the soap molecule and convert the soap into a free fatty acid. It does not actually remove the soap from the product. This process works well with low soap feedstocks but not so well for others. ASTM specifications have a measure for acid values and biodiesel made from high soap carrying feedstocks purified by this method can have some problems meeting the specs. The resin used in the exchange process will capture any residual glycerin in the product.

**Fractional Distillation** – Distillation is the method to produce the highest quality of biodiesel and will meet all current and anticipated ASTM standards. Another nice feature of distillation is that it can be adjusted to alter the gel point of biodiesel by selecting which fractions to recover and it can produce multiple products of different composition. The down sides to distillation are a small loss of product during the process, the energy costs of operation although some of that can be recovered by burning some of the waste product at the bottom of the column. Another issue is the stability of the product is stored for a long time. That can be over come by the addition of anti-oxidants at a small added cost.

### **Potential Feedstock Supplies**

Biodiesel can be produced from fats and oils from a wide variety of plants and animals. While there are many different potential feedstocks that can be converted into biodiesel that will meet ASTM standards, the differences between their physical and molecular structure require differing pre-processing measures to insure a satisfactory product. The varying characteristics of the potential feedstocks require differing technologies and as such, each feedstock will have a different capital cost for the appropriate equipment and a different cost of production. As a result, most facilities are designed to use just a few potential feedstocks and generally only those feedstocks with the lowest total cost of production and readiest supply.

Feedstocks can be placed into three primary categories:

- 1) **Virgin Vegetable Oils** – soybean, canola, rapeseed, corn, sunflower, peanut, cottonseed, etc.
- 2) **Waste Vegetable Oils** – used oil collected from primary users such as restaurants, fryers, etc (often called yellow grease)
- 3) **Rendered Animal Fats** – beef tallow, pork fats, fish oils, poultry fats, etc.

In Georgia there are primary sources for many of the above feedstocks. There are two large soybean crush facilities in Georgia, two nearby in Alabama and one in South Carolina. These five facilities have recently produced an estimated 218 million gallons of soybean oil on an annual basis. There are two cotton seed crush facilities in Georgia with an undisclosed production. There is also some undisclosed peanut crush capacity in Georgia as well.

Palm oil or palm olein is a feedstock source that may also be used in Georgia under the right location and price conditions. In early August, 2005 the IRS issued a guidance document that extended the virgin feedstock definition to palm oil. Industry sources indicate that at present no palm oil is produced in the U.S.; all sources are international, primarily from Indonesia, Malaysia, and Africa, with some additional sources in South America. With the Gulf Coast as one of the primary points of entry, palm oil could work its way into Georgia and other southern states biodiesel production. Palm oil is available in both crude and RBD (refined, bleached, deodorized) as well as palm olein (fractionally separated palm oil). The annual production of palm oil is enormous. World-wide palm oil production in 2002 was over 57 billion pounds (over 7.6 billion gallons) (from Soya and Oilseed Bluebook-2003). Palm olein is the separated liquid fraction of palm oil.

Another potential source of feedstock is yellow grease or the inedible fat, oil and grease from the food service industry. The majority of the yellow grease produced in Georgia is collected by renderers who process it by cleaning and refining it for further use such as in various chemicals, soaps, cosmetics, plastics, lubricants and livestock and poultry feed. There is also an export market for reprocessed yellow grease. One major yellow grease collector/processor operating in Georgia operates a biodiesel plant in Kentucky using the reprocessed product as a feedstock. Yellow grease is a favorite source of feedstock for the very small cottage industry type biodiesel producers.

It is difficult to estimate the volume and selling price of rendered yellow grease available in Georgia. It is a potential source of feedstock but one that has yet to prove a reliable source of consistent quality that most biodiesel processors could exploit.

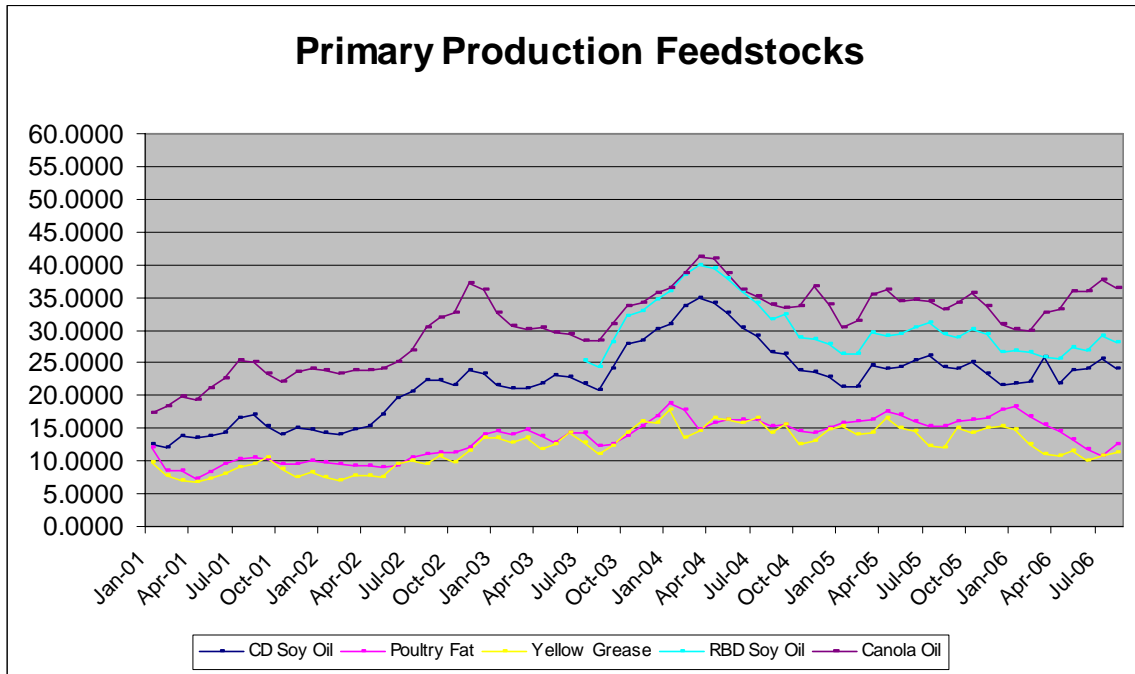
In 2005, Georgia had a poultry slaughter of about 1.26 billion birds providing a supply of poultry fat. If each bird provides ½ pound of fat, then total poultry fat available in Georgia would be about 84.1 million gallons of feedstock. Approximately 75 percent of Georgia's broiler production occurs in the northern half of the state. Georgia has very limited swine and cattle slaughter; thus we do not feel there is a viable local supply of fats from those sources. Georgia could have something slightly in excess of 300 million gallons of feedstock potentially available for biodiesel production from the virgin vegetable oils and rendered animal fats. As noted, the amount of waste vegetable oils available is not known. So, if all the potential feedstock was used to produce biodiesel, then production would approach 300 million gallons.

Each of these sources is currently finding markets for the fats and oils they produce as Georgia does not have supplies of unused products. Some of the used oils are recycled

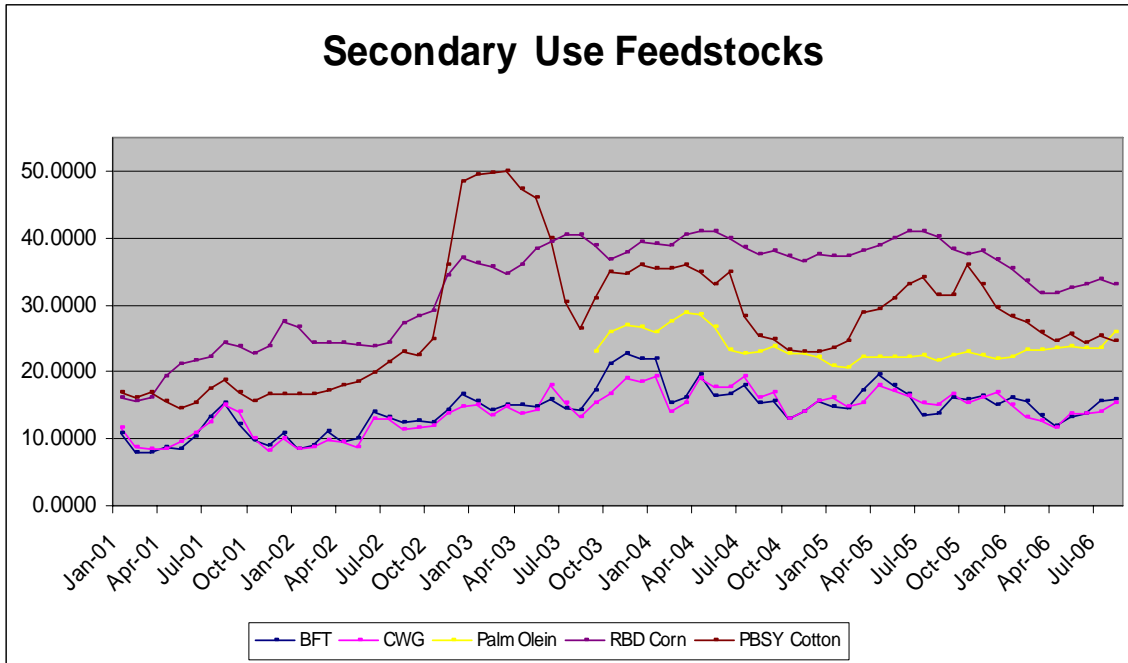
for feedstock use, some are re-refined for further human use and some of the oils are used for biodiesel production in other areas of the U.S. New users, such as biodiesel producers will need to bid those supplies away from the current use. This will surely place some upward pressure on available feedstock prices. The amount of the price impact is uncertain.

**Feedstock Costs and Issues**

The following charts illustrate the price relationships between various potential primary feedstocks sources and some potential future secondary sources.



Notes: CD Soy oil = Crude soybean oil; RBD Soy oil = Refined, bleached deodorized soybean oil. Source: The JACOBSEN Publishing Company



Notes: BFT = beef tallow; CWG = crude white grease; RBD Corn = refined, bleached and deodorized corn oil; and PBSY Cotton = prime bleachable summer yellow cotton seed oil. Source: The JACOBSEN Publishing Company

The following chart lists the approximate current FOB (Freight On Board, i.e., the loaded price) prices for various feedstocks that may be used to produce biodiesel in Georgia.

#### Relative Prices for Various Feedstocks October 18, 2006

Feedstock	FOB Price	
	Per pound	Per Gallon
Yellow Grease	\$0.1525	\$1.12
Poultry Fat	\$0.1325	\$0.97
Crude Soybean Oil	\$0.2594	\$1.91
Cottonseed Oil	\$0.2869	\$2.11
Refined Soybean Oil	\$0.2994	\$2.20
Canola Oil	\$0.3794	\$2.79

Source: The JACOBSEN Publishing Company

The cost of the feedstock typically comprises 70 to 90 percent of the cost of production depending on the size of the plant, the value of the feedstock and the amount of pre-processing the feedstock needs prior to conversion. Generally, the percent of total cost associated with feedstock will increase with higher priced feedstocks and as the

capacity of the plant increases. Under current market conditions, feedstock costs would be higher for a plant using refined soybean oil than a similar plant using less expensive rendered yellow grease. However, often the lower priced feedstock required extensive pre-processing that may off set the lower purchase price. Additionally, lower valued feedstocks may have lower biodiesel yields if they contain higher free fatty acid content and/or other impurities. There are technologies that can convert the free fatty acids into biodiesel but they have somewhat higher capital costs.

Another concern when selecting feedstock is the quality of the biodiesel subsequently produced. Some of the lower valued feedstocks tend to produce a biodiesel product with a higher “pour point”. A layman’s definition of pour point would be the temperature at which the biodiesel will not flow. The lower the pour point the better the fuel will flow in cold weather. The implication is that during colder temperatures the biodiesel will not flow and will create problems for users. Minnesota had some problems with the fuel gelling during cold weather in 2005. The marketability of the product was thus jeopardized during the colder months. Neither pre-processing nor the biodiesel production process can change the pour point characteristic of the feedstock although non-gelling additives can be mixed with the fuel to improve its pour ability during cold weather. This may not be a major problem for biodiesel consumption for most of the year in Georgia but could be a limiting factor for biodiesel sales to more northern states.

There are some issues concerning the future price of yellow grease and poultry fat that bear keeping an eye on that could have major impacts upon price. Given the current low price of these two products relative to other feedstocks and the rapid growth in biodiesel production, it is expected that their prices will rise relative to other feedstocks as demand strengthens. A second issue revolves around future potential prohibitions on the use of animal fats as feed ingredients. There are some stirrings about the possible elimination of animal fats used as feed ingredients for livestock rations. If there is a ban on their use, then demand may weaken and prices could indeed fall. A third issue involves the entire price level for energy in general and natural gas in particular. If energy (natural gas) prices return to the peaks seen during early 2006 or even go higher, then there may be a move to burn the fats and spent oils for fuel as a substitute. This would be an increase in demand and would likely pressure prices higher. These issues highlight the importance of the selection of feedstocks and the resulting decision consequences for plant design and construction.

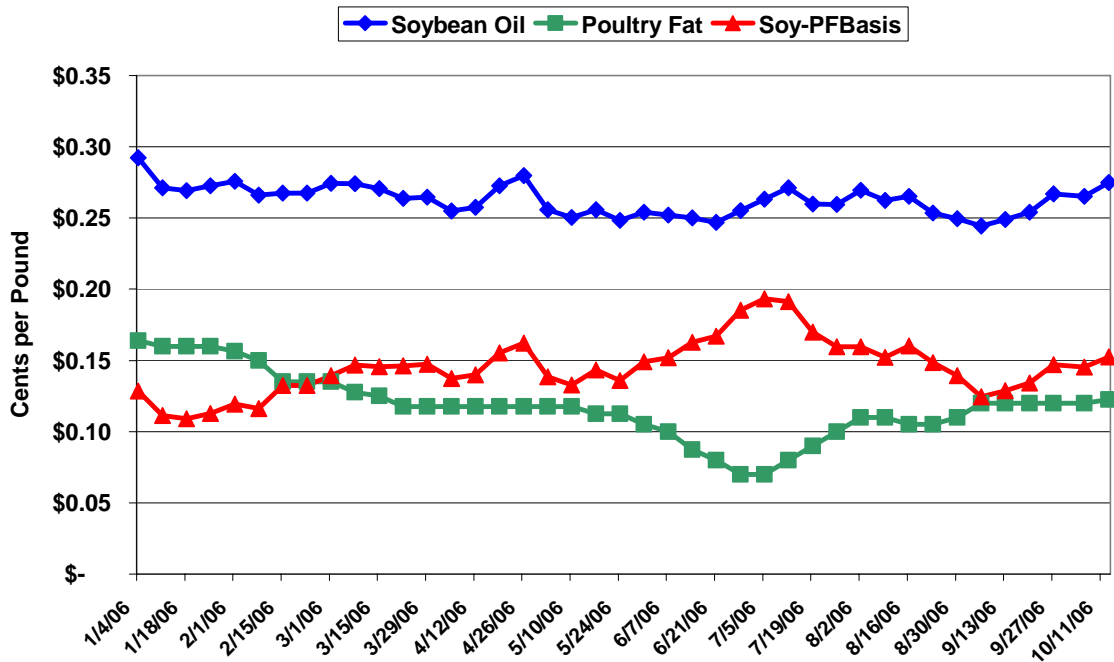
Given the above concerns, biodiesel production in Georgia based solely upon spent oils and poultry fat may face an uncertain future. Potential entrants into the industry would be well served to either secure long term supply commitments for spent oils and/or poultry fats or incorporate design features that would allow the plant to switch to other more readily available oils.

## Feedstock Price Risk Management

As discussed above, feedstock costs are a major part of the cost of producing biodiesel. Managing the risk of price change will be a priority for the long term success of the business. The major vegetable oils such as soybean oil and canola oil are traded on the major futures market and thus provide the biodiesel producer the opportunity to directly hedge future price risks. The remaining feedstocks currently do not have futures contracts and thus the risk management tools are limited. There may be some ability to cross hedge some of the feedstocks with either soybean oil or canola oil since many of the oil markets seem to move in the same general direction. Further research on this issue is warranted, especially in the case of poultry fats.

The general rule for determining whether or not it is possible to cross hedge one commodity with another commodity is that the variance in the basis must be less than the variance in the price of the commodity to be hedged. The basis is defined as the difference in the prices of the two commodities. A smaller variance in the basis than the commodity means that there is a good direct relationship between the prices of the two commodities and less total price risk from a hedge position than in an unhedged position. The following chart illustrates the price relationship between soybean oil and poultry fat over calendar 2006 to date. Given this weekly price data and the brief period, it appears poultry fat can be hedged successfully by using soybean oil. In fact the variance of the basis is slightly less than the variance in poultry fat. This relationship should be further studied over time.

### Price Relationship - Soybean Oil & Poultry Fat



Another viable price risk management tool would be to secure long term contracts for feedstock with the price tied to one of the major oil futures contracts. That would be a type of cross hedging although forward contracting is not widespread at this time. Innovative thinking is needed to discover ways to manage the risk of changing feedstock prices. The possibility of joint ownership or a joint venture of some form with a feedstock provider would provide assurance of supply and open avenues for price management as well.

### **The Market**

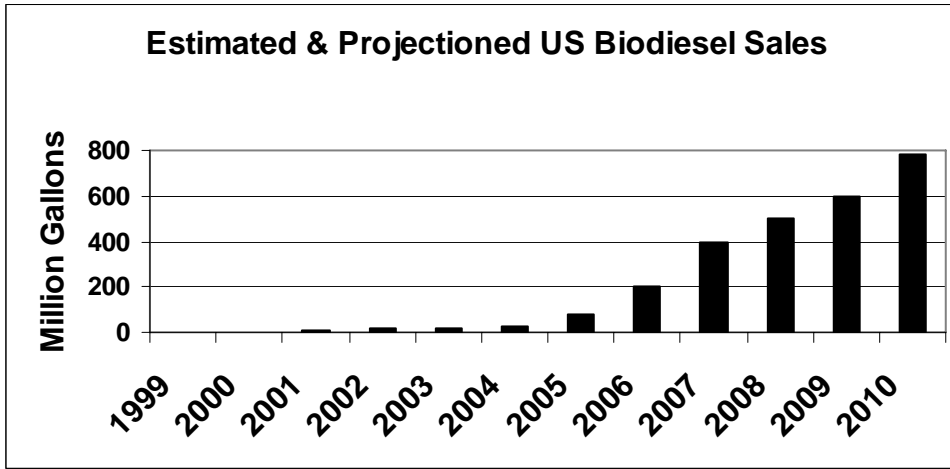
According to the Department of Energy, the combined use of fuel oil for transportation purposes in the states of Georgia, Alabama and Tennessee for 2004 totaled about 3.79 billion gallons with 1.578, 1.001 and 1.212 billion gallons for each of the states, respectively. There is an estimated additional non-highway use of about 2.26 billion gallons for a total market of just over 6 billion gallons. Biodiesel can be said to be a direct competitor to diesel in the market place and thus the potential market could be that same amount. In more practical terms however, biodiesel is most likely to be a complementary product to diesel fuel and thus its potential market is some percentage of that total market. A practical estimate of the market might be when biodiesel is used at a 2 percent blend or B2. Using B2 as the use level, then the total estimated market for the states of Georgia, Alabama and Tennessee would be about 120 million gallons.

The market for biodiesel is open and rapidly finding acceptance by consumers. Current concerns over high fuel prices and both federal and state efforts to improve air quality by reducing exhaust pipe emissions have created a market for the product. Concerns of international fuel supplies have also encourage buyers to seek out domestically produced fuels and the “renewability” factor of biodiesel is also a plus for marketing efforts.

The biodiesel production industry is in the early stages of development here in the U.S. although biodiesel is widely used in Europe. The National Biodiesel Board estimates that production and sales of biodiesel are growing very rapidly as illustrated in the chart below. The above concerns on the part of consumers along with subsidies from the Federal and in some cases the States fuel the growth in biodiesel production. Under current Federal legislation, blenders of biodiesel into the fuel supply receive a tax credit of \$1.00 per gallon of neat (pure) biodiesel made from virgin oils and a 50 cent per gallon credit on neat biodiesel made from reused oils such as yellow grease. This subsidy is passed along back to the producer through the pricing process.

The Renewable Fuels Standards require the use of biofuels in increasing percentages in certain areas of the country, especially those with air pollution problems. This provision creates a market for biodiesel by Federal mandate.

Source: Frazier Barnes and Associates



The potential market for biodiesel just within the state of Georgia could be quite large compared to likely production. Based on data from the Energy Information Administration, in 2004 over 1.9 billion gallons of diesel fuel oil was consumed in Georgia for various purposes. A B2 blend into that stream would require over 38 million gallons and a B20 blend would use over 384 million gallons. It is clear there is a broad market with great potential for biodiesel use in Georgia. The following chart details the amount of diesel fuel used in Georgia and projections for the amount of biodiesel that could conceivably be used.

### Diesel Fuel Oil Use - 2004

	<u>Diesel</u>			<u>Projected Biodiesel Use</u>	
	<u>U.S.</u> <u>(Thou. Gal.)</u>	<u>Georgia</u> <u>(Thou. Gal.)</u>	<u>% of U.S.</u>	<u>Georgia</u> <u>B2 Blend</u> <u>(Gallons)</u>	<u>Georgia</u> <u>B20 Blend</u> <u>(Gallons)</u>
Residential	6,644,939	1,687	0.03%	33,740	337,400
Commercial	3,383,061	45,141	1.33%	902,820	9,028,200
Industrial	2,326,604	73,123	3.14%	1,462,460	14,624,600
Oil Company	472,920	1,451	0.31%	29,020	290,200
Farm	3,189,014	69,893	2.19%	1,397,860	13,978,600
Electric Utility	823,380	16,154	1.96%	323,080	3,230,800
Railroad	3,047,491	121,454	3.99%	2,429,080	24,290,800
Vessel Bunkering	2,139,643	25,364	1.19%	507,280	5,072,800
On-Highway	37,125,239	1,449,793	3.91%	28,995,860	289,958,600
Military	358,682	3,866	1.08%	77,320	773,200
<u>Off-Highway</u>	<u>2,746,960</u>	<u>113,946</u>	<u>4.15%</u>	<u>2,278,920</u>	<u>22,789,200</u>
<b>Total</b>	<b>62,257,933</b>	<b>1,921,872</b>	<b>3.09%</b>	<b>38,437,440</b>	<b>384,374,400</b>

\*Energy Information Administration

Source: Frazier Barnes & Associates, Memphis, TN

### Governmental Support for Biodiesel Production

The Energy Policy Act of 2005 provides a significant incentive to produce and distribute biodiesel in the United States. The biodiesel tax credit provides diesel fuel distributors 1 cent for each percent of biodiesel blended with petroleum diesel fuel up to \$1.00 per gallon for biodiesel produced from virgin feedstocks such as vegetable oil and animal fat. The incentive for non-virgin based biodiesel is 50% of the virgin rate. Non-virgin feedstock would include yellow grease or “recycled” vegetable oil from restaurants. A major portion of this incentive is typically reimbursed to the biodiesel producer from the blender in the form of higher payments for the biodiesel (effectively paying market prices). This study assumes that 95 percent of the incentive is returned to the producer and is in tune with current industry practices and is included in the “B100 Sales Price” line item in the biodiesel pro format below.

In Georgia, state agencies and departments are required to prioritize the procurement of high fuel efficiency and flexible fuel vehicles when such technologies are commercially available and economically practical. Additionally, all state-owned refueling facilities are required to maximize the purchase of gasoline blended with ethanol and diesel fuel blended with biodiesel for use in state vehicles, when available and economically practical. Furthermore, the Georgia Environmental Facilities Authority, Division of Energy Resources is required to lead a statewide stakeholder process to

develop a Comprehensive State Energy Strategy to be completed by December 15, 2006. (Reference [Executive Order](#) 02.28.06.02, 2006)

### **Market Channels for Biodiesel**

The market for biodiesel can be broken down into segments such as wholesale, retail and the government/public sectors. Producers can sell to each or all of these segments but should strive to maximize the retail and government sectors due to higher margins and the potential for long term commitments.

**Wholesale Marketers:** The wholesale market is dominated by a few large firms, for example World Energy and West central. There may be smaller wholesale outlets available with small market potentials. World Energy specializes in biodiesel marketing and distribution. The advantages of wholesale sales include wider market penetration potential and a reduced need for a sales staff. The primary disadvantage to wholesale selling is that per unit margins will be less than other alternatives.

**Retail Distributors:** Rather than retailing the biodiesel direct to the fuel tank, retail sales concentrates on selling direct to business that put the fuel into the consumer's tanks. Examples would be fueling stations, oil companies, independent gas station owners, marinas and fleet operators. The producer will need a sales staff to develop and service the market and this requires extensive effort and experienced personnel. Retail sales may offer a higher per unit margin but sales costs will be higher as well.

**Government/Public Sector:** Local, state and national governments all use plenty of fuel. Many military and other federal agencies are directed to purchase renewable fuels when available at competitive prices. Local school districts are large diesel users. The advantages of selling to these outlets are the possibility of long term contracts and retail-like margins. Quality of the product and assurance of supply are integral to repeat sales.

Biodiesel produced in Georgia can reach a wide and diverse market. A firm that has the ability to supply the market via both truck and rail will be positioned to take advantage of all the potential market outlets. Any plant should have rail access to be competitive over the long term.

### **Export Potential**

There is a potential for export sales of biodiesel from Georgia. Our position on the east coast with major port facilities in both Savannah and Brunswick create an opportunity to sell biodiesel abroad. The European Union is projected to use about 1.8 billion gallons of biodiesel during 2006 and expectations that consumption will increase in the future. Further research on market access is warranted.

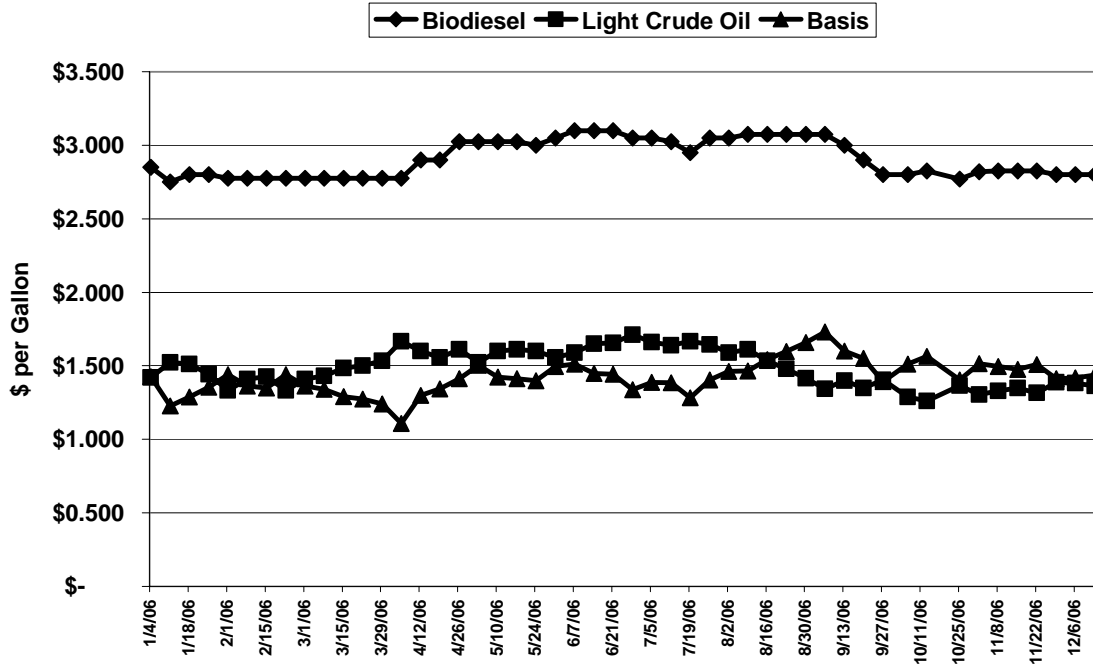
## **Biodiesel Prices**

The following chart illustrates the FOB producer price of biodiesel quoted for the Southeast U.S. for calendar year 2006 to date. As can be seen, FOB producer biodiesel prices have risen over that period from about \$2.50 per gallon to around \$3.00 per gallon. There also appears to be a strong direct relationship between biodiesel prices in the Southeast and crude oil prices. During the period shown on the chart crude oil prices were at about \$48 per barrel in February 2005 and rose to a peak of about \$74 in July 2006. Biodiesel prices tracked that rise although not in the same percentage terms. Crude oil rose about 54 percent while biodiesel rose only about 20 percent. This relationship may provide insight into the general direction of biodiesel prices as crude oil prices change. Biodiesel would seem to rise in price with crude oil but will likely decline as well if crude oil prices fall.

Some market observers have indicated that biodiesel price risk could be managed by hedging against crude oil futures. The basis is plotted on the following chart indicating a good relationship between the two markets. However, the variance in the basis is greater than the variance for SE biodiesel prices indicating that at least over this time period, hedging would not have reduced total price risk.

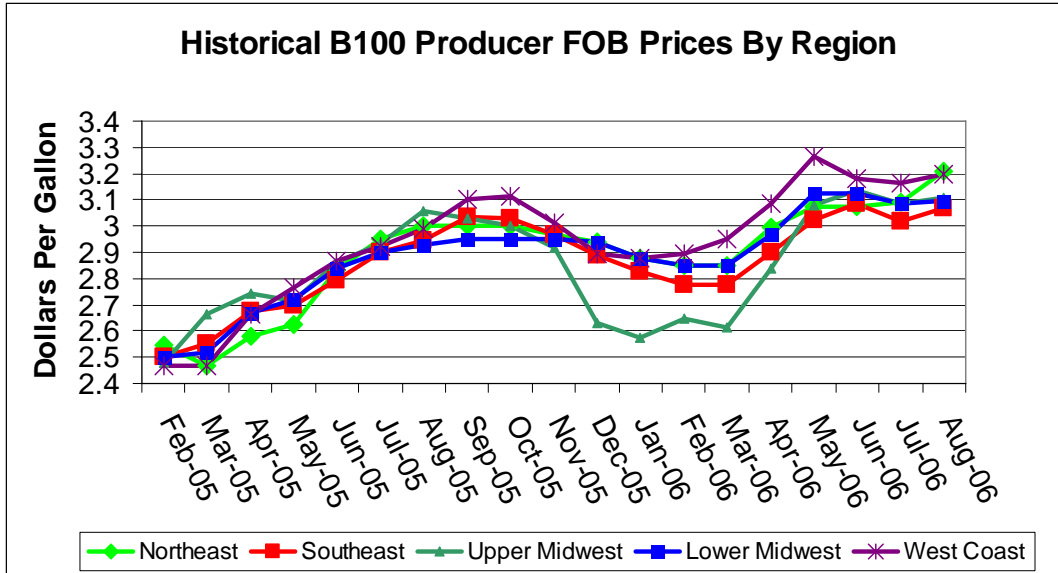
It has been reported by The Jacobson Company that some Midwestern biodiesel producers have negotiated basis contacts with buyers using the heating oil futures contract on the NYMEX with a basis of \$1.00 per gallon. The following chart demonstrates that price relationship over calendar year 2006 to date. The relationship appears to be a good fit but over this time period the variance of the basis was greater than the basis of SE biodiesel prices meaning that price risk would not be reduced for SE biodiesel producers.

## Price Relationship - Biodiesel vs Light Crude Oil



Perhaps one reason that the statistics do not indicate that hedging would work as a price risk reduction technique is that SE biodiesel price have not fluctuated widely and tend to remain steady for periods of time. As more businesses enter into the market one would expect greater price volatility that has been observed in the recent past and that hedging or basis contracts will be a better fit than during 2006.

FOB producer prices for biodiesel in the Southeast are not greatly different from other parts of the country according to the following chart and they track the trends seen in other parts of the U.S. The case of the FOB price decline for the upper Midwest during the late fall of 2005 and into early 2006 was the result of the gelling problem observed. Prices sagged as demand dried up until the problem was addressed and solved.



Source: The JACOBSEN Publishing Company

Currently biodiesel prices can be found both above and below petro-diesel prices as the market looks for a firm price relationship. As production and thus supply of biodiesel increases and its notion as a ‘boutique’ fuel declines, it is likely there will be some price pressure. Industry observers feel that biodiesel must ultimately be priced competitively with petro-diesel in order to assimilated large volumes of biodiesel into the on-road market.

Biodiesel price risk cannot be hedged directly at present as there is no futures market contract for biodiesel. There is the possibility of cross hedging using the heating fuel futures contract to manage price risk. Another alternative is to secure long term contracts although there is little evidence this method is widely used in the industry.

Currently biodiesel prices can be found both above and below petro-diesel prices as the market looks for a firm price relationship. As production and thus supply of biodiesel increases and its notion as a ‘boutique’ fuel declines, it is likely there will be some price pressure. Industry observers feel that biodiesel must ultimately be priced within one cent of rack prices for petro-diesel in order to assimilated large volumes of biodiesel into the on-road market.

**Prices and Market for the Co-Product Glycerin**

The primary co-product from biodiesel production is glycerin. The amount produced will be about 10 percent of the volume of biodiesel produced. The crude glycerin produced must be cleaned and concentrated in order to command good market prices. Glycerin is a very versatile product that has many uses as an ingredient in many products including cosmetics, toiletries, drugs and food products. It has many valuable properties including being a good moisturizer, plasticizer, emollient, thickener, solvent,

dispersing medium, lubricant, sweetener and an anti-freeze agent. It has over 1,500 known uses.

The glycerin suitable for the above uses must be stringent requirements of the U.S. Pharmacopeia (USP) and the Food Chemicals Codex (FCC). There is also a market for lower grade glycerin but at a discounted price. A good working number for the value of USP & FCC grade glycerin is around \$0.20 per pound. Crude, non-refined glycerin has a working price of around 2 to 3 cents per pound. At these price levels, the refining of glycerin is not economically feasible for plants less the 20 million gallons of biodiesel production.

### **Finances and Economics of Biodiesel Production**

The following section looks at the capital and operating costs of various sized biodiesel production facilities. Several assumptions are made and must be understood to make any comparisons meaningful:

1. The capital and operating cost estimates are for a typical “generic” operating system.
2. Actual costs will vary depending upon the types of systems and technologies employed.
3. The capital costs assume a “green field” site with no existing facilities or infrastructure.
4. The two smallest plants, 5 and 10 mmgpy, are batch type systems using the trans-esterification process with no glycerin purification, while the 15, 30 and 60 mmgpy plants use the combined esterification and trans-esterification process and incorporate glycerin refining.
5. The feedstock used in all base cases is refined, bleached and deodorized soybean oil. Other feedstocks are also considered.

### **Capital Costs of Biodiesel Plants**

The following table shows estimated capital costs for various sized and varying types of biodiesel production facilities. These capital cost estimates are based on quotes from various technology providers. Capital costs do vary by providers and the technology included in the plant. These estimates should be considered as representative of the capital outlay required for various sized plants but not as exact predictions.

The two smaller plants are modular built at the factory, delivered to the plant site, set up, tested and are then ready to produce biodiesel. In general, the smaller plants can be brought into production faster than the larger plants. One draw back to the smaller plants is that due to the relatively low production level, it is not cost effective to purify the glycerin co-product. Thus, the crude glycerin is marketed at a steep discount. The three larger plants are constructed on-site, stick built as it were. In general, these plants are of a more specific design and more complex than the modular units and they incorporate glycerin refining to maximize co-product revenues.

## Estimated Capital Costs for Various Sized Biodiesel Production Facilities

<u>Item</u>	<u>5 mmGal Plant</u>	<u>10 mmGal Plant</u>	<u>15 mmGal Plant</u>	<u>30 mmGal Plant</u>	<u>60 mmGal Plant</u>
Process Equipment	\$2,400,000	\$4,125,000	\$7,500,000	\$10,000,000	\$15,700,000
Glycerin Processing	NA	NA	\$2,500,000	\$3,100,000	\$4,000,000
Utility Facilities	\$175,000	\$175,000	\$2,200,000	\$3,000,000	\$4,600,000
Process Buildings	\$875,000	\$875,000	\$2,600,000	\$3,000,000	\$5,000,000
Storage & Logistics	\$1,040,000	\$1,290,000	\$4,100,000	\$6,900,000	\$9,700,000
Construction Cost	\$200,000	\$200,000	\$8,300,000	\$10,000,000	\$16,600,000
sub total	\$4,690,000	\$6,665,000	\$27,200,000	\$36,000,000	\$55,600,000
Construction Contingency (15%)	\$703,500	\$999,750	\$4,080,000	\$5,400,000	\$8,340,000
Subtotal	\$5,393,500	\$7,664,750	\$31,280,000	\$41,400,000	\$63,940,000
Land	\$500,000	\$500,000	\$1,000,000	\$1,000,000	\$1,000,000
Site Survey	\$25,000	\$25,000	\$25,000	\$25,000	\$25,000
Feedstock/Working Capital/Start-up	\$600,000	\$900,000	\$1,200,000	\$1,800,000	\$2,500,000
sub total	\$1,125,000	\$1,425,000	\$2,225,000	\$2,825,000	\$3,525,000
<b>Total Capital Expenditures</b>	<b>\$6,518,500</b>	<b>\$9,089,750</b>	<b>\$33,505,000</b>	<b>\$44,225,000</b>	<b>\$67,465,000</b>

At first glance one should question the rather large increase in capital cost when moving from the 10 mmgal plant to the 15 mmgal plant. The difference is accounted for by the technological shift that occurs for the small plant to the larger plant. Modular construction is less expensive whereas on site construction more so. Additionally, the larger plants incorporate glycerin processing as well as both esterification and transesterification processes. All these add-ons, add to the cost, some to a large degree.

### Financial Analysis

The following comparison of the relative costs of production of biodiesel from various sized plants is based upon the following assumptions:

1. Prices for biodiesel, soybean oil feedstocks and other inputs are assumed to be at or very near the levels readily attainable in fall of 2006.
2. The operating costs are based upon estimates derived from plants currently in operation in the U.S. and were provided by industry representatives and observers. Some of the data is proprietary in nature and is used in confidence in the calculations underlying the results presented.
3. It is understood that differing technologies or plant designs can and will have slightly different efficiencies and costs which may differ from those illustrated.
4. All the plants operate at 100% capacity and all the product produced is sold as market grade.
5. The 5 and 10 mmGPY plants sell the glycerin co-product as raw glycerin at \$0.02 per pound while the three larger plants sell refined glycerin at \$0.20 per pound.

**COMPARISON OF PROJECTED FINANCIAL PERFORMANCE OF VARIOUS  
SIZED BIODIESEL PLANTS**

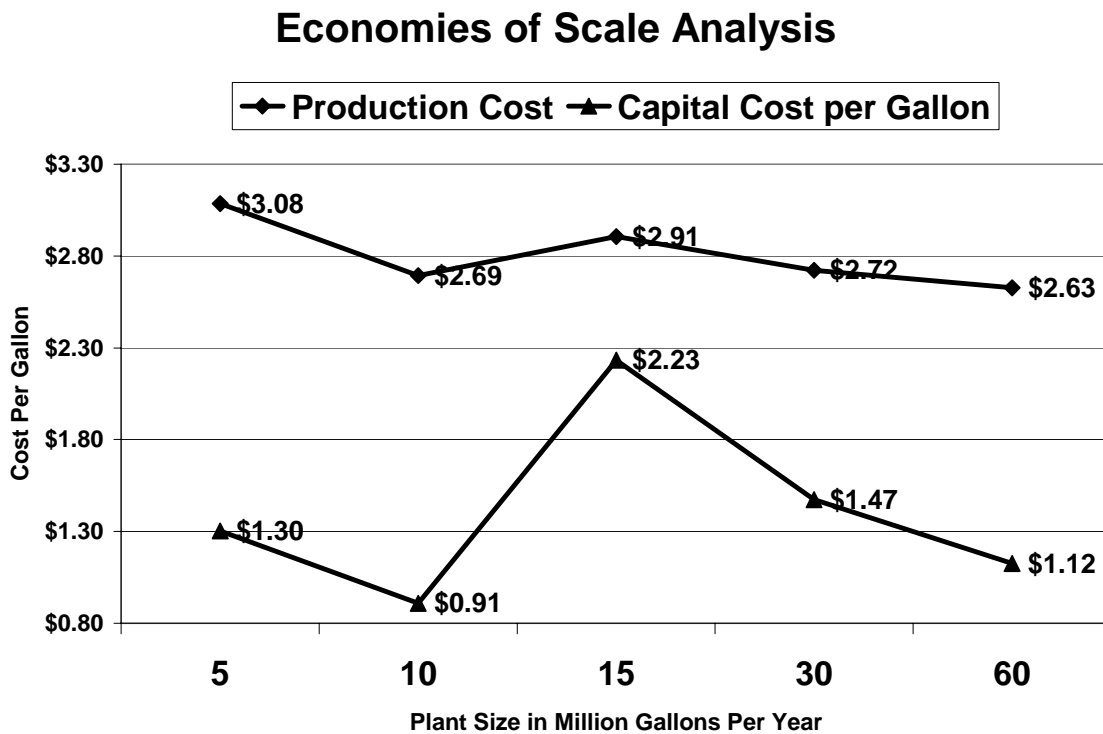
	<b>PLANT SIZE</b>				
	<b>5 Million Gallons</b>	<b>10 Million Gallons</b>	<b>15 Million Gallons</b>	<b>30 Million Gallons</b>	<b>60 Million Gallons</b>
<b><u>Revenue</u></b>					
Biodiesel @ \$2.75 per gal.	\$14,093,750	\$28,187,500	\$42,281,250	\$84,562,500	\$169,125,000
Glycerin @ \$0.02 per lb	<u>\$794,000</u>	<u>\$1,588,000</u>	<u>\$2,382,000</u>	<u>\$4,056,000</u>	<u>\$8,004,000</u>
<b>Total</b>	<b>\$14,887,750</b>	<b>\$29,775,500</b>	<b>\$44,663,250</b>	<b>\$88,618,500</b>	<b>\$177,129,000</b>
<b><u>Production Costs</u></b>					
Feedstock Costs	\$10,246,778	\$19,758,687	\$30,740,335	\$61,480,671	\$122,896,963
Chemicals	\$1,036,788	\$2,073,575	\$3,110,363	\$6,220,725	\$12,441,450
Utilities	\$238,825	\$477,650	\$1,949,550	\$3,899,100	\$7,798,200
Supplies and Services	\$480,725	\$456,125	\$427,425	\$479,700	\$590,400
Labor plus Benefits	\$1,068,563	\$1,167,475	\$1,166,963	\$1,580,550	\$1,906,500
Repairs & Maintenance	\$344,467	\$504,300	\$369,000	\$461,250	\$498,150
Insurance	\$102,500	\$205,000	\$307,500	\$615,000	\$1,230,000
Other/Gen./Admin	\$866,638	\$1,027,050	\$1,028,588	\$1,027,050	\$1,205,400
NBB Dues	<u>\$65,000</u>	<u>\$65,000</u>	<u>\$77,500</u>	<u>\$92,500</u>	<u>\$122,500</u>
<b>Total</b>	<b>\$14,450,283</b>	<b>\$25,734,862</b>	<b>\$39,177,223</b>	<b>\$75,856,546</b>	<b>\$148,689,563</b>
<b><u>Fixed Costs</u></b>					
Depreciation	\$543,208	\$757,479	\$2,792,083	\$3,685,417	\$5,622,083
Long Term Interest	<u>\$429,638</u>	<u>\$436,308</u>	<u>\$1,608,240</u>	<u>\$2,122,800</u>	<u>\$3,238,320</u>
<b>Total Fixed</b>	<b>\$972,846</b>	<b>\$1,193,787</b>	<b>\$4,400,323</b>	<b>\$5,808,217</b>	<b>\$8,860,403</b>
<b><u>Total Cost of Operation</u></b>	<b>\$15,423,129</b>	<b>\$26,928,649</b>	<b>\$43,577,546</b>	<b>\$81,664,762</b>	<b>\$157,549,967</b>
Feedstock Cost as % of Total Cost	66%	73%	71%	75%	78%
Cost per Gallon	\$3.08	\$2.69	\$2.91	\$2.72	\$2.63
<b><u>Return Before Income Taxes</u></b>	<b>-\$535,379</b>	<b>\$2,846,851</b>	<b>\$1,085,704</b>	<b>\$6,953,738</b>	<b>\$19,579,033</b>
<b><u>Return on Equity Before Income Taxes</u></b>	<b>-20.53%</b>	<b>78.30%</b>	<b>8.10%</b>	<b>39.3%</b>	<b>72.6%</b>

As the above table illustrates, the 5 mmGPY plant is not profitable under the assumptions listed above. Each of the other sized plants will generate a positive return above costs, given the \$2.75 selling price for biodiesel and 26 cent per pound feedstock. The 10 mmGPY plant which uses the modular construction, trans-esterification technology is profitable and yields the highest return on equity before taxes of the five cases studied. The three larger plants are profitable as depicted and yield return to equity before taxes of between 8 and 72 percent. As has been previously mentioned, the cost of the feedstock is a major cost component but expressed as a percent of total cost, rises as

plant size increases. That is the result of being able to spread fixed costs over larger output volumes.

### Economies of Scale Analysis

The question has often been raised about whether or not there are economies of scale to be realized in the biodiesel industry. The trend toward larger sized plants across the country would indicate that there are but no published studies have substantiated the case. The following chart illustrates the relationship between relative capital costs per gallon of capacity and the total production costs per gallon of capacity or the economies of scale potential.



In terms of the total cost of production as illustrated above, there are economies of scale to be realized in larger biodiesel plants compared to small plants however, the gains are not large. Clearly, the 5 mmGPY plant has the highest cost of production and the 60 mmGPY has the lowest cost of production, but only 6 cents per gallon less than the 10 mmGPY plant. It would appear that plants of modest size should be able to compete very well against the very large plants that are being proposed and constructed across the country.

## **Keys to Success**

The keys to success in the biodiesel business are:

1. Securing an assured source of feedstock at competitive prices.
2. Using good price risk management tools to reduce price risk exposure on both the buying and selling side.
3. Producing a quality product that meets ASTM standards all the time.
4. Hiring and retaining a quality labor force dedicated to producing and selling a quality product at minimum cost.
5. Operating the plant at near maximum safe operating capacity.
6. Maintaining good business relationships with all suppliers and associated businesses as well as all purchasers of the product.
7. Continuation of the Federal \$1.00 per gallon subsidy on biodiesel production.
8. Getting up and running is a short of a time frame as possible.

## **Economic Impacts of Biodiesel Production in Georgia**

### **Executive Summary**

Construction and operation of a biodiesel plant in Georgia has the potential to create economic benefits throughout the state. Total revenue is the direct output of the operation and is projected as \$88.6 million from biodiesel sales and sales of glycerin as a by product. Construction of a 30 million gallon biodiesel plant creates a one-time economic output impact of \$17.6 million to the Georgia economy. Economic activity related to construction generates \$6.5 million in labor income for 178 jobs. Production of biodiesel creates annual economic output impacts of \$181.5 million. Plant operations account for 24.5% of the total output impact, while 75.5% of the output impact is attributable to soybean oil from soybeans produced in Georgia. Biodiesel production leads to \$35.2 million in labor income for 978 jobs in the Georgia economy. Not including any sales or fuel taxes, biodiesel production generates \$3.3 million for the state treasury and \$2.7 million for local governments in the state.

## **Economic Impacts of Biodiesel Production in Georgia**

Construction and operation of a biodiesel plant in Georgia has the potential to create economic benefits throughout the state. Impacts due to construction of a biodiesel plant are one-time benefits occurring within the period of construction. Total construction costs of a 30 million gallon plant are \$36.0 million. Biodiesel production impacts occur annually and derive from operating inputs utilized. Total revenue is the direct output of the operation and is projected as \$88.6 million from biodiesel sales and sales of glycerin as a by product.

### **Input-Output Models and Economic Impact Analysis**

Economic impacts are estimated with input-output models that separate the economy into various sectors, such as agriculture, construction, manufacturing, trade, and services. The input-output model calculates how a change in one industry changes output, income, and employment in other industries. These changes, or impacts, are expressed in terms of direct, indirect, and induced effects. Direct impacts represent the initial impact on the economy of some feature (i.e. construction or operations) of an enterprise. Indirect impacts are changes in other industries caused by direct effects of an enterprise. Induced impacts are changes in household spending due to changes in economic activity generated by both direct and indirect impacts. Thus, the total economic impact is the sum of direct, indirect, and induced impacts. This report combines indirect impacts and induced impacts into one category referred to as indirect impacts. Input-output analysis interprets the impacts of an enterprise as output (sales), labor income (employee compensation and proprietary income), employment (jobs), and tax revenue.

Economic impacts result from a multiplier effect that begins with expenditures of an enterprise stimulating business to business spending, personal income, employment, and tax revenue. IMPLAN models include a regional purchase coefficient (*RPC*) for each impact variable that represents percentage of demand that is satisfied by production within an impact area. Enterprises vary in their multiplier effects due to differing expenditure levels, *RPC*'s, and sectors in which their expenditures are directed. Impact analysis involves quantification of spending levels and proper allocation to impacted sectors.

Output impacts are a measure of economic activity that results from enterprise expenditures in a specific industrial sector. Output is equivalent to sales, and this multiplier offers insights into how initial economic activity in one sector leads to sales in other sectors. Personal income impacts measure purchasing power that is created due to the output impacts. This impact provides the best measure of how standards of living are affected for residents in the impact area.

An enterprise involves a specified number of employees that is determined by the technology of the enterprise. Employment multipliers indicate the effect on employment resulting from the enterprise initiating economic activity. IMPLAN indirect and induced

employment includes both full-time and part-time jobs without any distinction. Jobs calculated within an IMPLAN industrial sector are not limited to whole numbers and fractional amounts represent additional hours worked without an additional employee. With no measure of hours involved in employment impacts, IMPLAN summations for industrial sectors which include fractional employment represent both jobs and job equivalents. Since employment may result from some employees working additional hours in existing jobs, instead of terming indirect and induced employment impacts as “creating” jobs, a more accurate term is “involving” jobs.

## Construction Impacts

One-time construction impacts for Georgia are presented in Table 1. Direct output of \$10.7 million is less than total construction costs because many construction items involve economic activity outside the impact area of Georgia. Economic activities occurring outside of Georgia that are related to plant construction are leakages to the state economy. Direct output during the construction period leads to additional output resulting in a total output impact of \$17.6 million. This output generates income of \$6.5 million for proprietors and employees. A total of 178 full-time and part-time jobs are involved in construction, and total labor income averages \$36,285 in wages and benefits. Georgia realizes \$497,758 in state tax revenue, while local governments throughout the state receive \$320,693 during the construction period. Appendix 1 shows the distribution of output, income, and employment in the major industrial sectors.

Table 1. Plant Construction: One-time Georgia Economic Impacts

	Direct Impact	Indirect Impact	Total Impact
Output (\$)	10,739,541	6,836,395	17,575,936
Labor Income (\$)	4,216,762	2,241,890	6,458,653
Employment	119	59	178
State Taxes (\$)			497,758
Local Taxes (\$)			320,693

## Operation Impacts

Annual benefits accrue in the state economy each year a plant is in production. Reported impacts in this section do not include potential impacts from utilizing Georgia soybean oil as a feedstock. Impacts due to Georgia soybean oil production are reported in the following section. Impacts for Georgia presented in Table 2 indicate that plant operations have a direct output impact of \$27.1 million. Direct impacts lead to an additional \$17.3 million in output for a total output impact of \$44.4 million from biodiesel plant operations. Total direct salaries and benefits for production and administrative employees is \$1.6 million for 20 employees. Additional income of \$5.1 million for impacted proprietors and employees results in \$6.7 million of income due to operation of the

biodiesel plant. Total labor income averages \$52,987 for 127 full-time and part-time jobs. State tax revenues generated are \$561,302 and local tax revenues are \$443,784. Reported tax revenues in this report do not include any sales tax on output sold as a finished product by the operations. The distribution of output, income, and employment among the major industrial sectors is presented in Appendix 2.

Table 2. Biodiesel Production Without Feedstock: Annual Georgia Economic Impacts

	Direct Impact	Indirect Impact	Total Impact
Output (\$)	27,137,829	17,260,594	44,398,423
Labor Income (\$)	1,580,550	5,148,741	6,729,291
Employment	20	107	127
State Taxes <sup>1</sup> (\$)			561,302
Local Taxes <sup>1</sup> (\$)			443,784

<sup>1</sup>Does not include sales or fuel taxes on biodiesel sales.

### Impacts of Georgia Soybean Oil as Feedstock

Utilization of soybean oil produced in Georgia as a biodiesel feedstock generates additional output, employment, labor income and taxes in the Georgia economy. Annual feedstock needs of a biodiesel plant are \$61.5 million. State economic impacts for soybean oil with soybeans produced in Georgia are presented in Table 3. Soybean oil produced in Georgia for a 30 million gallon biodiesel plant leads to a \$75.6 million indirect output impact for a total output impact of \$137.1 million. Total labor income impacts are \$28.5 million for 851 jobs. Wages and benefits average \$33,458 per job. Sector analysis in Appendix 3 indicates that much of the soybean oil impacts occur in the agricultural sector and are due to soybean production. Results in Table 3 are only valid for circumstances in which soybean production beyond current levels consists of new agricultural land going into production that is presently idle. Soybean acreage that replaces acreage currently in other agricultural production such as cotton and peanuts generates economic impacts only at the expense of lost impacts due to displaced production.

Table 3. Soybean Oil Feedstock: Annual Georgia Economic Impacts

	Direct Impact	Indirect Impact	Total Impact
Output (\$)	61,480,670	75,608,929	137,089,599

Labor Income (\$)	1,422,124	27,051,012	28,473,136
Employment	24	827	851
State Taxes (\$)			2,783,536
Local Taxes (\$)			2,251,243

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Summing direct output impacts in Table 2 and Table 3 result in a \$88.6 million total direct impact of biodiesel production for a 30 million gallon plant. Indirect output impacts sum to \$92.9 million. Total output impacts are \$181.5 under assumptions that all feedstock is soybean oil from soybeans produced in Georgia. Plant operations account for 24.5% of the total output impact, while 75.5% of the output impact is attributable to soybean oil as a feedstock. Biodiesel production leads to \$35.2 million in labor income for 978 jobs in the Georgia economy. Not including any sales or fuel taxes, biodiesel production generates \$3.3 million for the state treasury and \$2.7 million for local governments in the state.

### **Summary**

Construction of a 30 million gallon biodiesel plant creates a one-time economic output impact of \$17.6 million to the Georgia economy. Economic activity related to construction generates \$6.5 million in labor income for 178 jobs. Production of biodiesel creates annual economic output impacts of \$181.5 million. Plant operations account for 24.5% of the total output impact, while 75.5% of the output impact is attributable to soybean oil from soybeans produced in Georgia. Biodiesel production leads to \$35.2 million in labor income for 978 jobs in the Georgia economy. Biodiesel production generates \$3.3 million for the state treasury and \$2.7 million for local governments in the state.

Appendix 1. Plant Construction: One-time Economic Impacts to Major Sectors, Georgia

Sector	Labor		
	Output (\$)	Income (\$)	Employment
Agriculture	49,193	14,934	1
MC <sup>1</sup>	4,333,654	2,143,298	52
Utilities	187,556	37,781	0
Manufacturing	1,458,195	329,664	6
Transportation, Warehousing	305,606	131,627	3
Trade	1,187,354	457,962	13
FIRE <sup>2</sup>	1,010,998	272,944	6
Services	8,433,300	3,046,039	97
Government & Non NAIC's	610,080	24,403	1
<b>Total</b>	<b>17,575,936</b>	<b>6,458,653</b>	<b>178</b>

<sup>1</sup>Mining and Construction

<sup>2</sup>Finance, Insurance, and Real Estate

Appendix 2. Biodiesel Production Without Feedstock: Annual Economic Impacts to Major Sectors, Georgia

Sector	Labor		
	Output (\$)	Income (\$)	Employment
Agriculture	61,531	18,508	1
MC <sup>1</sup>	157,539	76,027	2
Utilities	3,994,413	929,438	7
Manufacturing	31,311,042	2,463,864	30
Transportation, Warehousing	445,819	185,629	4
Trade	1,311,433	508,779	14
FIRE <sup>2</sup>	1,759,726	487,946	9
Services	4,519,462	2,025,314	59
Government & Non NAIC's	837,459	33,787	1
<b>Total</b>	<b>44,398,423</b>	<b>6,729,291</b>	<b>127</b>

<sup>1</sup>Mining and Construction

<sup>2</sup>Finance, Insurance, and Real Estate

Appendix 3. Soybean Oil Feedstock: Annual Economic Impacts to Major Sectors, Georgia

Sector	Output (\$)	Labor	
		Income (\$)	Employment
Agriculture	26,911,120	11,513,507	463
MC <sup>1</sup>	367,758	152,782	4
Utilities	2,096,421	413,007	3
Manufacturing	66,578,610	2,019,720	35
Transportation, Warehousing	4,020,649	1,654,212	36
Trade	13,605,085	5,165,525	103
FIRE <sup>2</sup>	7,323,919	1,922,766	42
Services	13,196,201	5,451,304	162
Government & Non NAIC's	2,989,837	180,314	4
Total	137,089,599	28,473,136	851

<sup>1</sup>Mining and Construction

<sup>2</sup>Finance, Insurance, and Real Estate

# **The Center for Agribusiness & Economic Development**



The Center for Agribusiness and Economic Development is a unit of the College of Agricultural and Environmental Sciences of the University of Georgia, combining the missions of research and extension. The Center has among its objectives:

To provide feasibility and other short term studies for current or potential Georgia agribusiness firms and/or emerging food and fiber industries.

To provide agricultural, natural resource, and demographic data for private and public decision makers.

To find out more, visit our Web site at: <http://www.caed.uga.edu>

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**J. Scott Angle, Dean and Director**