Community Cooperative Biodiesel Project in Ghana

Project Description and Funding Opportunities

Presented by Jerry Robock and Michael Dibenedetto

Executive Summary:

Ghana is one of the largest producers of palm oil in the world. Ghana is also an importer of petroleum products, specifically diesel fuel. Biodiesel can be manufactured from locally available, and often wasted, palm oil and used as a substitute for petroleum diesel in daily farm uses such as power generation, diesel powered equipment, irrigation, water purification and transportation of goods to markets.

This project is designed as a demonstration to show that biodiesel fuel can be manufactured efficiently at the local farmers' cooperative level and used to increase farm revenue, reduce operating costs, and improve industrial emissions and rural health. Along with practical instruction, this project also seeks to educate the general public about environmental sustainability practices.

The stimulus for this project came from one of our team members, Michael DiBenedetto, who visited Ghana in the summer of 2006 as part of a logistic team for a global food distribution organization where he met with Mr. Frank Aidoo and other farmers. From his background in biodiesel production it was recognized that producing biodiesel from local palm oil would have a significant impact in local food production and distribution. This project was conceived as a means to transfer a simple, low technology manufacturing process to small farmers in order for them to become more self-sufficient.

The goal of this project is to build a very small biodiesel refinery on a farm, and educate the members of the local farmers' cooperative about biodiesel, how to build their own processor and how to handle and use biodiesel as a petroleum substitute. Due to the minimal economic infrastructure in Ghana rather than developing central distribution mechanisms it would be most efficient to develop local and regional pockets of development that are self dependent. By empowering the farmer with less expensive power, economic development can be driven from the farm to villages and factories in small but efficient steps.

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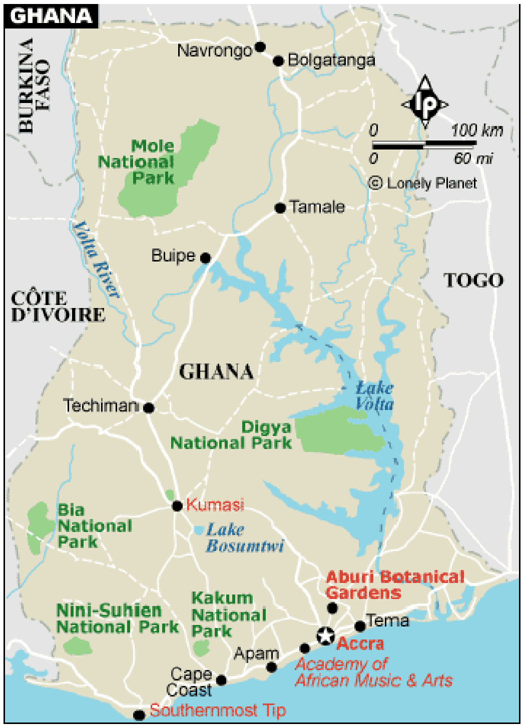
Project Goals:

The project's goals in the first phase are to assemble a small biodiesel processor from locally available components and instruct local farmers in its operation. This single processor will be capable of producing a batch of 50 gallons of biodiesel from palm oil per day, thus could produce up to 250 gallons per week. The impact of this production would allow one farmer to substitute biodiesel for petroleum diesel in his daily operations, expanding his ability to operate diesel powered equipment and vehicles and thus increasing efficiency, lowering his operating costs and potentially creating an additional revenue stream from surplus biodiesel.

At the farmers' cooperative level, this project will be a demonstration of the biodiesel process and serve as a model for other farmers. With the success of this pilot the second phase of this project would be to work to expand the availability of biodiesel by replicating this model to the other members of this cooperative.

Project Background: Ghana



The following is excerpted from **http://www.state.gov/r/pa/ei/bgn/2860.htm**

Ghana, formerly known as the Gold Coast, won its independence in 1957, since then it has had a democratic government. Ghana is located on West Africa's Gulf of Guinea only a few degrees north of the Equator. Its area is approximately 92,000 square miles and its population is approximately 22 million people, concentrated along the coast and in the principal cities. The capital city is Accra, with an estimated population of 3 million. Ghana's climate is tropical with topography of plains, scrubland, rainforest and savanna. About 70% of the land is arable and forested.

Ghana has many natural resources, such as gold, timber, diamonds, bauxite, manganese and fish with its major industries consisting of mining, lumber, fishing, aluminum and tourism. Its largest export was cocoa followed by raw materials such as aluminum, timber, diamonds and manganese. Ghana's exports were $2.9 billion dollars in 2005 while its imports were $4.27 billion dollars. Imports consisted of petroleum ($563 million), food, machinery, industrial raw materials and equipment.

Ghana opted to seek debt relief under the Heavily Indebted Poor Country (HIPC) program in March 2001. As part of the agreed-upon plan, Ghana in 2002 and 2003 raised electricity, fuel, and municipal water rates to market prices, and took additional revenue-enhancing measures (i.e., more taxes) to stabilize its fiscal position. Ghana again raised pump prices for gasoline, kerosene, and diesel in February 2005. A key goal for the government remains oil sector deregulation.

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In August 2006, a $547 million Compact, or agreement, was signed between MCC (Millennium Challenge Corporation) and the Republic of Ghana. The five-year, $547 million anti-poverty grant, the largest to date for the agency, is expected to benefit more than one million Ghanaians and aims to improve the lives of the rural poor by raising farmer incomes through private sector-led, agribusiness development.

Ghana's stated goals are to accelerate economic growth, improve the quality of life for all Ghanaians, and reduce poverty through macroeconomic stability, higher private investment, broad-based social and rural development, as well as direct poverty-alleviation efforts. These plans are fully supported by the international donor community.

Biodiesel

The current price for a gallon of diesel in Ghana is $3.80 while the price for refined palm oil is approximately $2.00; palm kernel oil is $1.30. Raw palm kernel oil can be extracted from palm nuts using a simple mechanical press for the nominal cost of the nuts at a cost of less than a dollar per gallon and then converted into biodiesel with a total cost of less than $2.00 per gallon.

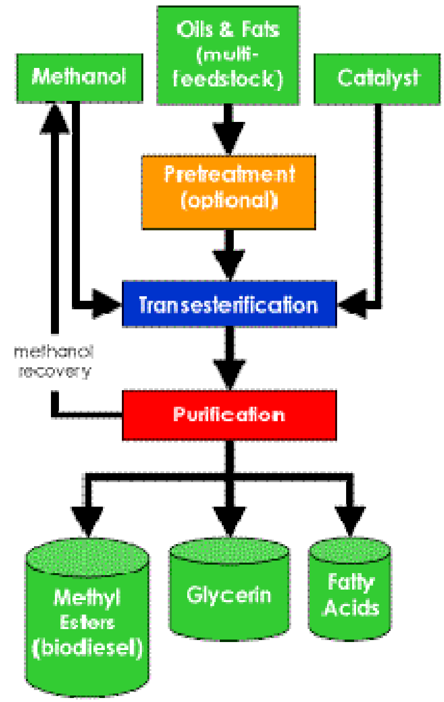
Biodiesel is a renewable fuel that can be manufactured from vegetable oils, animal fats, or recycled restaurant greases. Biodiesel is safe, biodegradable, and reduces serious air pollutants such as particulates, carbon monoxide, hydrocarbons, and air toxins. Blends of 20% biodiesel with 80% petroleum diesel (B20) can be used in unmodified diesel engines. Biodiesel can also be used in its pure form (B100).

Advantages of Biodiesel	
❖ Renewable	Made from domestically grown vegetable oils
❖ Environmental	Biodegradable, non-toxic, cleaner, lower emissions
❖ Versatile	Can be mixed or substituted with #2 diesel in any blend
❖ Lubricity	High lubricity, no sulfur content
❖ Pricing	Cheaper than imported petroleum

Our mission is to develop an efficient model for refining locally available vegetable oil into biofuels on a community scale using proven technology and sound business practices. Leveraging core competencies of domain expertise in the petroleum business, leadership and innovation, we will work with rural communities to capture local energy dollars otherwise spent on imported energy and for these communities to turn nominally valued vegetable oils into cleaner burning biofuels that can displace or replace imported petroleum diesel without any major modifications in engines, generators or other diesel powered equipment.

Strategy

Frank Aidoo is a farmer in Ghana who graduated with a degree in sociology and information studies from the University of Ghana, Legon. He also holds a Higher National Diploma in marketing (H.N.D) from the Cape Coast Polytechnic. Frank branched into agriculture due to his passion for farming and discovered that a major part of the agriculture sector in Ghana has been left for the less educated.



As the founder and Chairman of Dumpong Pineapple Growers Association, Frank hopes to collectively address some of the pressing issues facing local farmers. The cooperative is located at Dumpong in the eastern region of Ghana; an 8-minute drive from Aburi township.

In Frank's words:

"Our primary crop is pineapple; however those with very large land are able to add up some few things like vegetables. Our greatest problem is marketing of our produce. And this has actually come as a result of lack of resources to be able to sell the produce in the right markets. High cost of fuel makes it very expensive for farmers to transport their fruit to the part of the country where the demand of the fruit is better.

Again, many are not able to undertake any form of mechanical methods of farming; though there are tractors around for hiring they turn out to be very expensive due to fuel cost. Farmers are always at the mercies of buyers of their fruits because of lack of storage facilities.

Currently one gallon of petrol Diesel sells for the equivalent of $ 3.80. And I personally use about 3 drums (150 gallons) in a week.

Palm nuts fruits are very common here. There are great numbers of plantations scattered around the country. We can always buy and extract the oil ourselves or further still buy it from the local market. I believe that Biodiesel, if started, will come to solve the crust of our problem of high cost of production."

Frank's farm does not have electrical service from the national electricity network but is serviced by a 15 KVA diesel generator in the main farm building. Electricity is used for only a few hours a day for specific farm processes as it is too expensive to operate the generator for most agricultural needs. One major use for power is to pump well water for irrigation and also to power a small water bottling plant which provides clean potable water

The initial biodiesel processor would be built at Frank's farm and owned by the farmers' cooperative. Frank agrees to fully participate in training programs to educate other cooperative members after he has mastered the process himself. The second phase should begin within four months of the beginning of production. At this time additional biodiesel processors would be built at other farms or at a central cooperative location.

Their ownership would depend on the type of funding for this project and whether individual grants are available.

Due to the high cost of electrical generation, farming operations are significantly impacted. Without consistent refrigeration the shelf life of harvested produce is short. Without electricity to operate food processing equipment, such as canning, washing and food preparation equipment, food that is harvested must be brought to market immediately. And, with the high cost of diesel fuel, transporting produce to market is a significant cost.

Palm nuts are abundant and often left to rot due to inefficient processing mechanisms or uneconomical resources. Palm kernel oil is also abundantly available. Due to the 'just in time' nature of most third world agriculture, up to 40% of the harvest is wasted due to inefficient distribution and flooded markets. With the ability to locally process food into a storable product, the need to get the crop to market would no longer be as critical. Also, with refrigeration available at the farm, a single days' harvest can be brought to market over a series of days with nominal effects on quality.

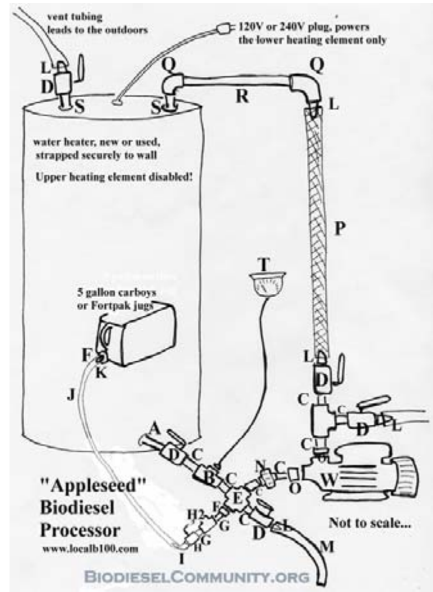
By converting low cost palm kernel oil into biodiesel at the local level, a farmer will be able to supply the necessary 'diesel' fuel to generate electricity and power his farm equipment. More importantly, as Frank has stated, the lowered cost of fuel for transporting crops to markets will increase the farmer's profit. By creating a farmers' cooperative and producing biodiesel as a function of the collaborative cooperative, production responsibilities and costs can be shared.

The strategic model of this project is to expand horizontally from community to community, replicating a mature social and community based program to the benefit of these cooperatives.

Technology

The basic chemical process described above, transesterification, is typically done in the United States using a common electric hot water heater as the reaction vessel. The water heater is adapted using common plumbing components such as black pipe and brass ball valves. An example of an Appleseed processor is depicted to the right. This is taken from the Biodiesel Community website: http://www.biodieselcommunity.org/appleseedprocessor/

A materials list follows for the system pictured to the right.



Quantity	Legend	Item
Processor (electric heater)		
1		50 gal electric hot water heater
1		Replacement 2000W 110V heating element
1		electric plug and heavy gauge wire for outlet plug for heater
Valves		
10	D	3/4 " brass ball valves F-F
1	H	1/2 " brass ball valve F-F for methoxide
1	H2	1/2 " check valve for methoxide
1		Garden hose connector with 3/4" pipe end
Black Pipe all fittings with female ends, all pipe with male threads		
5	B	T' (tee)
1	E	cross piece
6	Q	elbows
2	S	threaded caps (one for upper element, one for anode opening)
2	C	5 " pipe
3	A	3" pipe
2	C	8" pipe
1	C	1 foot pipe
1	F	1/2" to 3/4" coupling for methoxide check valve to standard pipe
1	G	2" pipe, 1/2 diameter, to connect check valve to ball valve for methoxide
Clamps		
12		3/4" hose clamps
6		1/2" hose clamps
Hose Barbs		
12	L	3/4" male pipe end to 3/4" hose barb
1	I	1/2" male pipe end to 1/2" hose barb (methoxide)
Other parts		
1		Electric Drill pump
2		Hose fittings with 1/2" barb
1	W	Harbor Freight clear water pump
1	P	10 ft braided 3/4" hose
1	J	6 ft braided 1/2 hose (methoxide)
1		Inline hose strainer plus additional hose barbs(2) and clamps(2)
1		Hand drum pump
1		Undersink water filter assembly with clear casing and 5 micron filters
1		power strip with rocker switch for pump
1		Carboy with easy connector for methoxide
1		garden hose for vent and for drain of glycerin
		power cords

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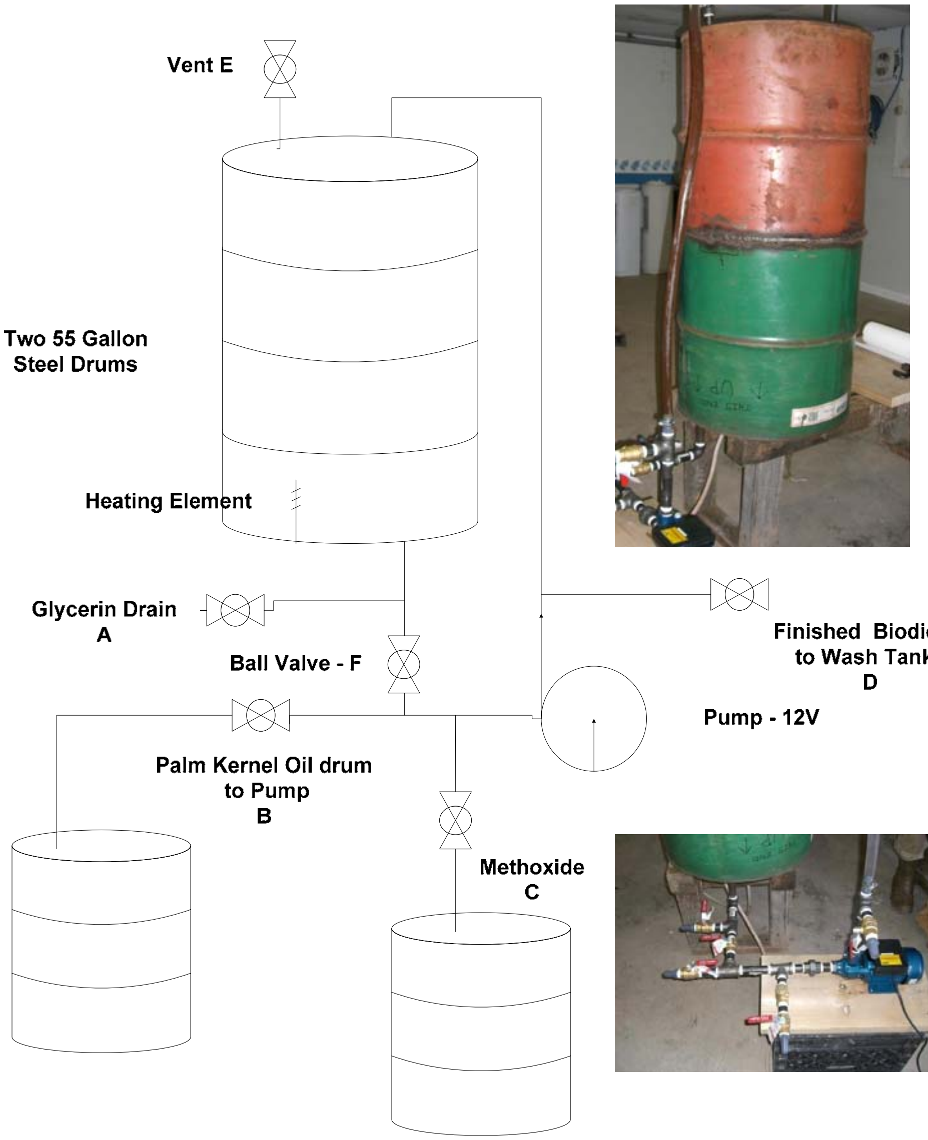
The processor model we propose is similar in function the Appleseed design above but would comprise two 55 gallon steel drums welded together, having the bottom third of each barrel removed. These basic components are readily available and inexpensive. The diagram shows the basic plumbing configuration and a parts list follows. The photos are of a complete processor that has been used to make biodiesel.



Item	Quantity	Item	Quantity
Ball Valves	7	Electric plug and heavy gauge wire	1
Pipe - Tee	4	2000 Watt Heating Element	1
Pipe - 2"	6	1/2 " check valve for methoxide	1
Pipe - 1"	4	Clear Water Pump	1
Pipe - Elbows	2	Methanol mixing barrel	1
Pipe - 3"	2	Aquarium pump	1
Hose Barb	6	Aquarium air hose	1
Clear Vinyl Hose (feet)	10	Aquarium connectors	1
Hose Clamps	6	Hand barrel pump - Methanol	1

Project Scope

This proposal is to fund an initial onsite training and proof of concept project with a follow up larger scale intervention based on the initial results. A team of two adults and two high school students, through Community BioFuels, LLC, would travel to Ghana to work directly with Dumpong Pineapple Growers Association, of which Frank Aidoo is a member. The student team members have been involved in biodiesel processing and would participate through sponsorship of their high schools. Their expenses would be covered by the initial grant that makes this project possible.

Materials would be sourced in advance and basic training and operating instructions produced. Upon arrival this team would spend two days assembling the processor and doing training. On the following day a batch of biodiesel would be produced and washed. It would be ready for use the following day.
The team anticipates spending 9 days in Ghana on the initial visit to build a processor and train Frank Aidoo and others in its operations. The team would be able to continue to support and advise Frank via the internet in the following months. This team would return to Ghana within 4 months of the initial visit to work with other members of the cooperative and assemble additional processors or a larger version to be used collaboratively.

This team would explore, with local farmers, the viability of manufacturing biodiesel using locally available components and supplies. In addition to the initial expense to build the biodiesel processor, the ongoing operating costs include the feedstock (palm kernel oil), potassium hydroxide flakes (KOH) and methanol. Initial research shows that all of the required components are available at reasonable costs such that the cost to manufacture biodiesel would be less than $2 per gallon.

The byproducts of the biodiesel process are glycerin and the wash water that contains potassium. The wash water can be used as a low grade fertilizer and dispersed on fields. The glycerin is a hydrocarbon that can be used for compost, burned for heat, made into soap, mixed with feed for animals, or put to various other uses. It may have an additional value and become a source of revenue to the farmers. These opportunities need to be explored but are not necessary to make this venture viable and cost effective.

One other necessary input, beside the materials, is energy to heat the oil and run the pump. In the Appleseed model this would be electricity which could be generated using a diesel generator running on biodiesel. If the biodiesel processor was built using solar heating technology, electricity would only be needed to run the pump. On the output side storage tanks or drums are needed to store the biodiesel until used. Biodiesel has a shelf life of approximately 6 months, but based on demand this should not become an issue. Depending on labor required for farming and its seasonality, biodiesel could be made during slow times and stored for future use. Biodiesel can also become a revenue stream for some farmers that can produce it and supply other members of the cooperative.

Funding

The initial project and visit requires $20,000 of funding. This funding includes transportation and accommodations for the team of 4 members, the cost of the initial biodiesel processor and supplies for manufacturing 1,000 gallons of biodiesel, and the cost of training and operating materials. Team members would be compensated only for expenses incurred on this trip. Follow up and remote support would be provided by the team for 6 months following the installation.

Building on the success of the initial installation this team would return to Ghana to expand the local knowledge about processing biodiesel and work with the farm cooperative to commission additional biodiesel processors, either on individual farms or to be jointly operated at a central location. This additional three week project would require $30,000 to support the team and additional funds for supplies and equipment, which would be sourced locally.

Ghana Project		
Approximate Costs - Phase 1		
	Per Person	Team
Transportation and transfers	$2,000	
Hotels - 7 Night @$80	$560	
Meals	$350	
Incidentals	$200	
	$3,110	$12,440
Car rental - 1 week (Fuel)		$400
Equipment		
Processor components	$1,000	
Wash Tank Components	$100	
Chemicals - Local		
Methanol - 55 gal drum (4)	$1,000	
KOH - 50 lb bag (2)	$200	
Palm Oil (1,000 gallons)	$2,000	
Operating Equipment		
Titration (Lab) Equipment	$100	
Titration Supplies	$50	
Add't equipment	$50	
Hand tools to be left behind	$100	
Operating Manuals	$50	
Total Operating Costs		$4,650
Subtotal		$17,490
Administrative Expense 10%		$1,749
Total expenses		$19,239

Keeping the Wheels in Motion

With the initial round of funding, specific to the biodiesel process, each installation is intended to be self sufficient within 3 months. Assuming a micro-loan, or grant, of $2,500 per installation, which would include enough supplies to process 1,000 gallons of biodiesel (200 gallons of methanol and 100 pounds of KOH), with projected savings of $1.30 per gallon, each installation would break even in less than 6 months if one batch was brewed each week or in 3 months if two batches were processed each week.

Breakeven implies that the farmer would have saved enough by replacing the petrol diesel required to operate his farm and have sufficient funds to purchase the next round of supplies. This analysis does not include the price of palm kernel oil as the feedstock, which would be the farmer's responsibility, as the project is designed to substitute palm kernel oil derived biodiesel for petrol diesel which presently is a cost to the farmer. Ongoing operating costs would be approximately a dollar per gallon. Depending on the farmer's ability to utilize local palm nuts and press them for their oil or purchase processed palm kernel oil, the real savings would be between $1.00 and $2.00 per gallon.

Once the farmer begins to make biodiesel it will cost him $2.50 per gallon, a savings of $1.30 per gallon compared to $3.80 for petroleum diesel. Therefore, if he substituted 100 gallons of biodiesel for petrol diesel he would start to save $130 per week. In 11 weeks he would have saved $1,430, or the amount of the initial investment in the processor. If he made two 50 gallon batches per week, he would breakeven in less than 3 months. This assumes that he can fund the initial cost of the methanol and KOH, which would be about $300 if he started with one drum of methanol and one bag of KOH. With these supplies he would be able to make 250 gallons of biodiesel and save $325, which would be enough to buy more supplies and then start paying back the initial investment.

The model described above would be a business model that assumes, basically, that the farmer is loaned $1,400 and taught how to operate the processor and no interest is charged on the loan. He would repay the loan in 3 months and then begin saving money, operate in a more environmentally responsible manner and improve his ability to increase his profits through reducing operating costs.

If the farmer is given a grant then the grant should be for $2,500 per farmer to include the processor and some initial supplies.

The whole project is predicated on having a team of implementers beginning the process by teaching one or a group of farmers, supporting them through their first few months and then transferring to them the responsibility (opportunity) to train others.

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Breakeven Business Model

		Quanity	Unit Cost	Unit Measure
Initial Funded Capacity - Gals	1,000			
Cost of Equipment (Capital)				
Processor	$1,000			
Other Equipment	$400			
Total Capital Cost	$1,400			
Initial Supplies				
KOH - 50 lb bag (@$100) (to make 500/gal)	$200	2	$100	50 lb bag
Methanol - 55 gal drum (4)	$800	4	$200	55 gal drum
Total Startup Supplies	$1,000			
Initial Investment	$2,400			
Working Capital				
Palm Oil (wholesale gals)	$1,500	1000	$1.50	Gallon
Total Start Up Costs	$3,900			
Production Costs				
Palm Oil	$1,500			
Methanol & KOH	$1,000			
Total Production Costs	$2,500			
Petro Diesel Equivalent	$3,800	1,000	$3.80	Gallon
Biodiesel Cost	$2,500	1,000	$2.50	Gallon
Gross Savings	$1,300		$1.30	Gallon
Total Initial Investment	$3,900			
Net Project Costs	$2,600			
Farmer funded substitution for Petro diesel	$2,500			
Breakeven Analysis				
Batch Size	50			
# Batches per week	2			
Savings per gallon	$1.30			
Savings per Batch	$65.00			
# of batches to breakeven (Initial/Saving)	22			
# of gallons to breakeven	1,077			
# of weeks to breakeven	11			
Additional funds needed to breakeven				
Initial production capability (gals)	1,000			
Additional gallons to produce (gals)	77			
Production cost per gallon	$1.00			
Additional Funding to Breakeven	$77			
Additional Weeks to Breakeven	1			

About the Team

Michael DiBenedetto was raised on a dairy farm in the Catskill Mountains of NY. He has 20 years of experience as a science teacher, and has traveled extensively around the world. He volunteered in relief efforts after Hurricane Katrina, and was recently sent to Ghana as a Food Specialist for CitiHope, Int'l., where he realized the enormous potential for biodiesel in the country. Michael currently produces biodiesel on a small scale for his personal automobile fuel.

Jerry Robock has over 25 years in the petroleum distribution industry. He has been involved in the biodiesel sector for over 10 years and helped found the Hudson Valley Biodiesel Cooperative. Jerry works for Sprague Energy, a large energy company in the Northeast, and has been supporting their efforts to expand in the biodiesel area. He is president of Community BioFuels, LLC, a two year old alternative energy consulting firm. Jerry has traveled and lived in many areas of the world. He holds an MBA from Columbia University among other post graduate degrees.

Max Robock is a high school junior and has been working on this project in conjunction with his high school's sponsorship.

Please contact Jerry Robock for further information regarding this project:
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