Scattergood Friends School Biodiesel Feasibility Study

West Branch, Iowa - Spring of 2014

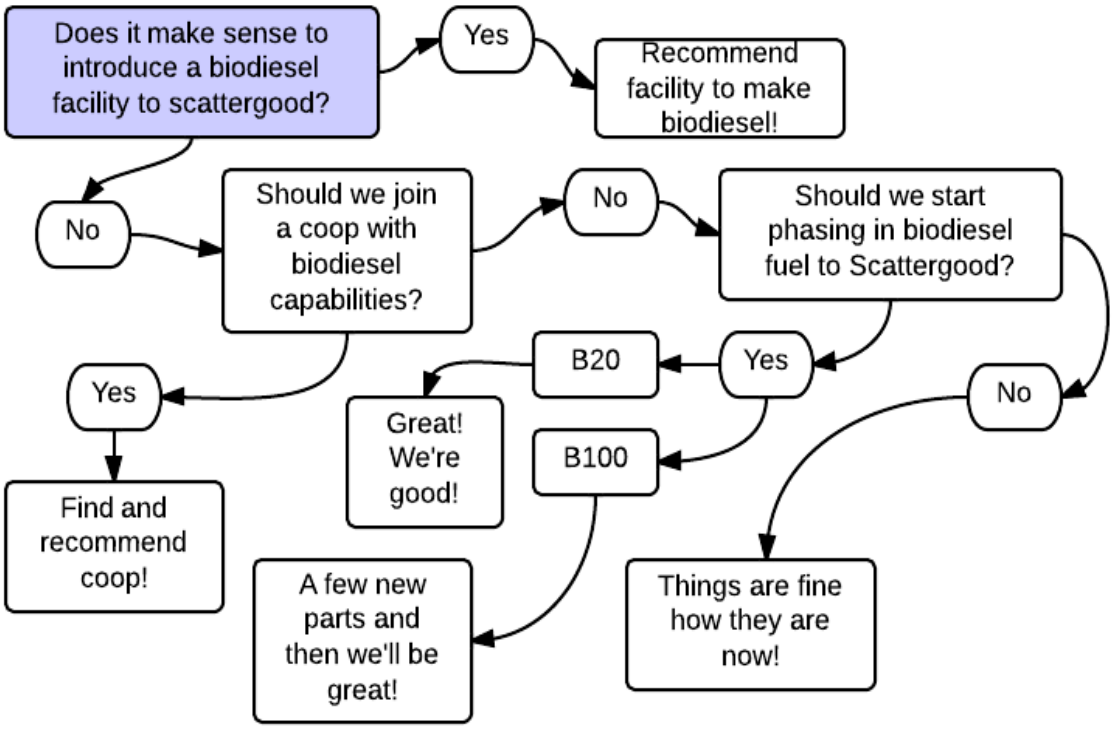
A look at the implementation and logistics of a biodiesel manufacturing facility at the Scattergood Friends School Farm

N.S.

Study Objective

This is a feasibility study. What that means is that through some research and (perhaps even primarily) the compiling and consideration of information, there will be an analysis of **whether or not it makes sense to introduce a biodiesel manufacturing facility at Scattergood Friends School Farm**. It is important to keep in mind that some standards and situations referenced in this paper will be current (or close to) as of 2014 but could possibly be subject to change. Unless noted, the information in this paper is current or relevant to the present situation of both the outside biodiesel economy/information base, and Scattergood Friends School/Farm. It will also address a few specific items recommended for feasibility studies. Making sure to maintain a holistic point of view, keeping in mind cost, safety, and efficiency, a final recommendation will be made. The essential question becomes: "**Can the Scattergood Farm introduce and maintain an efficient biodiesel production facility**?"

The following is an abbreviated flowchart of what this paper will address:



The **scope of the study** will look more closely at the possibility of a small production facility only for use by the vehicles/machines that the Scattergood farm manager (Mark Quee) sees fit. There are additional prospects of selling the fuel that be addressed but not covered in detail.

Biodiesel Overview

Biodiesel is a fuel that is starting to be available to replace the more normal petroleum based fuels in the U.S. "Biodiesel is better for the environment because it is made from renewable resources and has lower emissions compared to petroleum diesel. It is less toxic than table salt and biodegrades as fast as sugar. Produced domestically with natural resources, its use decreases our dependence on imported fuel and contributes to our own economy" (Biodiesel Basics). In the U.S. today, biodiesel is a rapidly growing fuel having in around seven years, multiplied production by 10. The National Biodiesel Board has released the following production volume estimates for the US, per calendar year

2012 - - Nearly 1.1 billion gallons
2011 -- 1.07 billion gallons
2010 -- 315 million gallons
2009 -- 545 million gallons
2008 -- 691 million gallons
2007 -- 500 million gallons
2006 -- 224 million gallons
2005 -- 112 million gallons
(Biodiesel FAQ's)

Biodiesel Manufacturing Facility Justification.

There are **several** things that justify the introduction and use of a Scattergood biodiesel manufacturing facility on the Scattergood Farm. First is the financial justification. It seems that the generally accepted amount of money that biodiesel will cost per gallon, once all the facilities have been built (essentially the material cost) would be somewhere in the range of $.50 up to $3.00[1]. What this means is that to produce biodiesel, there are compounds one needs. Methanol, vegetable oil, etc. The amount of money spent to gallon of biodiesel made would be less than if regular petrol-diesel were bought.

This is compared to the current cost of regular diesel of around three dollars and twenty five cents. That means it comes to around a dollar or two of savings per gallon of gas. That being said, it would be very cost efficient to maintain a biodiesel manufacturing center **AFTER** the cost of the facility itself has been cleared and paid off. Second are the environmental benefits. According to fuel economists, biodiesel fuels produces far less greenhouse gasses than do the normal fuels of today. In some cases it can reduce carbon dioxide output by 15%.

> "Biodiesel is a renewable, clean-burning diesel replacement that is reducing U.S. dependence on foreign petroleum, creating jobs and improving the environment. Made from a diverse mix of feedstocks including recycled cooking oil, soybean oil, and animal fats, it is the first and only EPA-designated Advanced Biofuel in commercial-scale production across the country and the first to reach 1 billion gallons of annual production. Meeting strict technical fuel quality and engine performance specifications, it can be used in existing diesel engines without modification and is covered by all major engine manufacturers'

[1] http://www.udobiodiesel.com/Biodiesel/FuelMeister.html, http://www.eia.gov/petroleum/gasdiesel/

warranties, most often in blends of up to 5 percent or 20 percent biodiesel. It is produced at plants in nearly every state in the country" (Biodiesel Basics).

Third is the safety side of the fuel. Biodiesel, once made, is less volatile and safer to handle than normal fuels. Fourth is that it is a more self sufficient way to make fuel (on a national level). Biodiesel can also be produced domestically without great use of foreign petroleum based products.

Product/Service Description/Safety.

Two aspects are crucial when looking at the introduction of a biodiesel manufacturing facility.The construction of the production facility and the maintenance, running, materials cost of the biodiesel components. The production facility has several requirements to be safe and functional. Is must be well ventilated as in the production process, many volatile and harmful chemicals are used. Next, security measures would need to be taken as there will be a couple highly unsafe/volatile compounds in the building (including the final product) and only the people qualified to be making and manning the production should have access. Numerous houses, barns and facilities have been destroyed in fire involved accidents (chemical fire, overheating, oil based fires). In the event of an emergency, four things are necessary. There would need to be a kill switch for power so reactors and processors can be immediately shut down. Fire extinguishers (and possibly other countermeasures such as fire blankets and overhead sprayers), easily accessible exits, and a building up to current fire code could mean the difference between life and death. The building will also need to be outfitted with all of the proper equipment to produce biodiesel in the first place.

The location of the facility is also important. Though logistically it would be ideal for the facility to be at the Scattergood Farm (close proximity of the supply and demand locations) there are no unused building on the that could be easily outfitted to meet the facility needs so a new structure would have to be created. If the facility was located on campus, there is a cement base (with a shack that would be easy to dismantle on it) that is large enough for a facility on the west side of the current Scattergood gymnasium.

Materials, Manufacturing, and Maintenance.

Once a proper facility is installed, the materials, manufacturing, and maintenance are all very important, once a safe and functional facility is made. The materials in making biodiesel need to be readily available. Luckily, this is generally the case and most of the chemical components can be procured from an auto store to a fast food oil dump. One of the key components of biodiesel is methanol, also known as wood alcohol. It is **highly** flammable and therefore should be kept and used in a facility with good ventilation and very low to nonexistent risk of sparks, electric charges (static too) to prevent possible fires. Another thing to note about methanol is that along with being highly flammable, due to its natures, burns with a flame that is nearly invisible which can slow a proper and timely response.

> "In general, the standard storage and handling procedures used for petroleum diesel can be used for biodiesel. The fuel should be stored in a clean, dry, dark environment. Acceptable storage tank materials include aluminum,

steel, fluorinated polyethylene, fluorinated polypropylene and Teflon. Copper, brass, lead, tin, and zinc should be avoided" (What is Biodiesel).

Maintenance of the facility will most likely be primarily nothing out of the ordinary from a regular building (burnt out lights and quick sweeps). However, it is important to note that someone with a fair amount of experience with biodiesel should be at least on hand and a phone call away in the event that something unpredicted happens whether it be a fire or chemical spill. Though, it is true that with the internet, most knowledge is seconds away at any time, limited access at the Scattergood Farm could present problems and so a person with experience is preferable. Said experience person is also more likely to be able to accurately factor different variable of any given situation with more speed and precision than the internet (the internet has examples of things but a human can adapt, especially with knowledge of the farm).

Biodiesel Grades/Classifications.

First, the way biodiesel is classified is basically the percentage of biodiesel to the to amount regular diesel (petrol-diesel) in any given blend. The type of names and classes associated with biodiesel might read: "B20 blend" or "B6" blend. The number that follows the "B" is the percentage of biodiesel there is to petrol-diesel. These are some common blends:

B2 = 2% biodiesel 98% petrol-diesel
B5 = 5% biodiesel 95% petrol-diesel
B20 = 20% biodiesel 80% petrol-diesel
B100 = 100% biodiesel

Process Summary[2]

To make biodiesel, there needs to be a good amount of heated vegetable oil, this can be obtained from restaurants or collection companies. Then a mixture of methanol and sodium hydroxide (methoxide) is introduced. Simply put, the three components combine and then are offloaded into a different tank. After settling, there will be two sections in the tank. The first (and lighter) will be the biodiesel which will be at the top and underneath is the byproduct, glycerin. Once the glycerine is removed, the biodiesel must be "washed". By introducing water (like glycerin heavier than the fuel) the rest of the by-products will be removed. Then the biodiesel must be dried, a process of letting the water in the fuel evaporate out and then the remaining biodiesel will be filtered and ready to store or use.

Economic Impact.

The economic impacts of this project would be fairly limited to Scattergood. The project is large enough to required a large amount of financial planning, but not great enough to

[2] Picture from "Commercial and Large Scale Biodiesel Production Systems" http://www.extension.org/pages/27537/commercial-and-large-scale-biodiesel-production-systems#.U1m7sFVdVwU

drastically change other aspects of Scattergood living. Things such as salaries and tuition would remain the same but a longer term capital campaign would make a good deal of sense. Once the facility is established, there would be a net gain as far as materials vs. diesel cost. Another thing to keep in mind is that along with a project such as this, there is a good cause behind it all and so in the case that the total expenditure leads to a net loss, it might be worth sustaining for the cause and environmental implications.

Production Volume.

It seems that with most of the current kits available[3], the general amount of biodiesel that is possible to make is around 20 to 200 gallons a day. This would be B100 (ASTM certified) and could then potentially be added to a petrol diesel to made something along the lines of B6 to B20. Of course, with the tractor on the Scattergood farm using around 10 to 20 gallons of fuel a month, 50 to 100 gallons a day seems extremely excessive. Because of the high potential amounts of fuel that would be able to manufacture with a kit, it stands to reason that a less elaborate kit would be more ideal. The Scattergood Volkswagen Bug would be the only other potential vehicle that would use the Scattergood produced fuel and still that would not come close to the potential amount of excess fuel. If Scattergood did start producing high amounts of biodiesel, this would require even more specifically made facilities. It also would not make an abundance of sense to for a coop as there has been one established in the Iowa City area (Though recently the degree at which they are active seems unclear).

There are some kits that seem to be usable on a much smaller scale. Because of the size, they could have the potential to be academically rewarding for chemistry or physics. These yield a much smaller amount and, generally, produce an amount smaller than what would be ideal (generally measuring around one pint).

The third and just right production amount (in terms of volume) would be to design and implement a system specific to Scattergood. Of course it would have to be done with great precision, care, and attention to detail. It is fortunate that Scattergood also has several resources as far as people who could advise (John Zakelj, Don Laughlin, Dennis Love, Derek Roller). A smaller more customized system also means a smaller facility (compared to one needed when using one of the previously designed kits).

Essentially, the amount that would be ideal as far as volume would be nice right around 10 gallons a day, using it around once a month. This would let Scattergood produce a high enough volume for its own needs and would minimize the cost for a facility meant to house a larger scale operation. Finally, it is important to note that whatever system ends up being used, an experienced person should make monthly checkups for the first year or so to assure safety until Scattergood has a larger abundance of experience.

Certification.

For something to be seen as biodiesel in the eyes of the government, more specifically the IRS (This is for the tax incentives, the IRS does not directly regulate facilities or the fuel), it needs to be certified. There is an organization called ASTM international (the American Society

[3] Here are a couple kits: http://www.udobiodiesel.com/Biodiesel/FuelMeister.html, http://www.homebiodieselkits.com/frfuspl.html

for Testing and Materials) that is “a globally recognized leader in the development and delivery of international voluntary consensus standards. Today, some 12,000 ASTM standards are used around the world to improve product quality, enhance safety, facilitate market access and trade, and build consumer confidence” (ASTM International). When something is ASTM certified it is head to certain standards which make it what it is. ASTM has certified biodiesel blends of 6% to 20% (B6 – B20) and pure biodiesel (B100).

ASTM has certified B100 Diesel as a viable bio fuel but it must meet certain standards. These standards include things such as certain temperatures (cloud point, flash point) and percentages of materials in the compound that are and are not allowed. ASTM has also certified blends B6 through B20. These have similar requirements as the B100, but slightly different in the fact that it is 80 to 94 percent petrol-diesel . This has over 30 standards that it must meet to be classified a biodiesel to ASTM international.

With these standards set in place the question becomes if Scattergood were to produce biodiesel, would Scattergood want to have it be ASTM certified. On the one hand, it would be good to have the credentials to back up our process and facilities. It would also be good because most of the standards are there to insure safety. Some of the standards also seem to have the intention of being preventative of damage to a vehicle with the biodiesel being used on it. On the other hand, it would be another financial burden on the school and farm to but test and standards kits required. It would also require someone with enough time to implement all of the tests and for the scale of operation that would make sense for Scattergood, it would not necessarily make an abundance of sense.

Impact on Scattergood.

If there was going to be biodiesel manufacturing site on the Scattergood school or farm campus, there would be additional work. Some of the extra things that would be added would be things like regular checks to make sure the facility is still maintaining a safe environment for any chemicals or compounds that may be in it at any given time. Make sure the temperature and humidity are maintaining at the correct levels, making sure the facility had any necessary ventilation systems going etc. next there would be the work of actually making the biodiesel. Which depending on the volume, could take anywhere from a few hours to a day. Some of the parts of the process would need manual attention and careful inspection.

Another question to keep in mind is “how would a biodiesel facility affect Scattergoods image?” on the one hand, it has many advantages. It would make Scattergood look progressive and forward thinking. Environmentally friendly and resourceful. Educationally it would provide many benefits and it could help us establish more contacts and people for many things (possible students, possible donations, possible people who would spread word about the school). However there are possible disadvantages that go along with it. Depending on how the facility is, does it really look good to have what is essentially a fuel plant, biodiesel or not, on an organic farm? There are still a lot of chemicals involved, no matter the positive environmental impacts. Second, there are the safety concerns that have already been talked about some. Then there are safety issues, what could happen to the community if things were found stolen or missing. Finally, it has been pointed out that the facility is what could be very easily converted into a meth lab and so that might not necessarily be a positive image to have associated with Scattergood.

Of these advantages and disadvantages it seems that the advantages outweigh the disadvantages (excluding economic factors). First with the volume of fuel that is likely to be made, the whole industrial organic farm image is very unlikely to be created. Second, the meth lab association is very unlikely to stick. Scattergood has already enough credibility for this. Finally, the educational factor heavily weighs in, making it definitely more of a positive than a negative.

Financial logistics.

Last fiscal year, the farm spent $618.23 on fuel for the tractor. Now, dividing $618.23 by 3.60 (around the cost of regular diesel as it fluxuates) gives a quotient of 171.73 which represents the number of gallons of fuel used by the tractor. Now multiplying that number by $2.05 (The amount of money that one might save per gallon if making biodiesel) gives the product of around $352.05 which is the amount of potential savings in a year by using biodiesel. Do some more math and the number of years that will pass before the savings will pay for itself becomes clear (all of this is assuming the initial savings, fuel cost, and fuel use numbers remain about the same).

$3300 (approximate cost of biodiesel kit) ÷ $352.05 (approximate savings) **=** 9.38 (around the number of years for the savings to pay for the biodiesel kit)

$12,000 (approximate cost of facility) ÷ $352.05 (approximate savings) **=** 34.08 (years for the savings to pay for the facility)

Vehicle Upgrades.

A few more things to note about vehicles that are going to be used with any Biofuel. First of all, when using materials such as vegetable oil or grease, whether it is new or used, **is must** be converted into some form of biodiesel or bio fuel. If straight grease or vegetable oil is used to fill a fuel tank, it will damage the engine of the vehicle. This is extremely hard to clean and repair and in addition to engine damage, it also has the potential to start to degrade certain petroleum based parts, mainly used in older vehicles. It is also noteworthy that this can also happen with blends of more than 20%. In fact, most problems with biodiesel use are related to blends over 20%.

The most commonly seen and used of the blends are those in the B6-B20 range. This is for a couple reasons. One is that the only ASTM certified (again, as of early 2014) are the B6-B20, and B100 blends. Two; B6 through B20 blends do not generally require any change in parts and are generally not likely to cause problems with build ups and filter problems. These are the two biodiesel fuel types still ASTM certified that can be used on any vehicle that is already sing a diesel fuel. When one gets closer to B100, standard parts and filters will need to be replaced.

> "Automotive Breakdowns - Biodiesel can clog filters due to the release of deposits that attached to tank and pipe walls from previous diesel use. This problem is most associated with mixes over B20, however once the old deposits have been released the clogging of filters no longer becomes an issue. Using mixtures over B20 has been found to degrade gaskets and seals over time" (National Biodiesel Board).

In order to recommend a full on bio diesel manufacturing facility at Scattergood, there are certain needs and requirements that either have to be met or fully addressed. Basically, it breaks down into having to financially, socially, and logistically make sense.

Checklist Breakdown.

1. Logistically
    a. There must be a designated space available for a manufacturing facility.
    b. It must make enough fuel to supply the farm equipment with enough.
    c. There must be a person designated to start/monitor/end the process.
        i. This person must have the time, skill set, knowledge and physical capabilities of monitoring the actual process.
2. Financially
    a. The facilities and kit must be affordable within a two or three year span starting the time construction begins.
        i. Otherwise this can leave things undone or with little to no consistent financial backing which could lead to the eventual stop of construction and a waste of money. Of course this is not guaranteed but the longer a project drags out, discrepancies tend to increase and motivation drops.
    b. The biodiesel facility will need to be acknowledged as an entity where money is being sent partially as a cause (environmental and what not) as opposed to a money saving investment.
        i. While over a time (given it continues to produce) the facilities will pay for itself in money saved on gas, it would be a long time (Around ten years to make up for the processor and more around 50 for the facility, not factoring in maintenance costs).
    c. There has to be room in the budget for maintenance to both the facility and instruments, but also for the vehicles.
        i. Things such as filters (if high grades of biodiesel are used) or regular upkeep things like light bulbs, small repairs from weather or other unforeseen events that transpire.
    d. Room in the budget for someone to monitor the process?
3. Socially
    a. The facility must fit in with the Scattergood image and not have any detriment to the community.
    b. The facility must not be hazardous to nearby people/buildings/animals.

Recommendation:

Taking all of the factors above into account, it seems (from my perspective with my knowledge set) that adopting a biodiesel manufacturing facility does not at this point in time make sense for Scattergood Friends School and Farm. There are two primary reasons that it does not. First, financially, Scattergood does not seem to be in a position for a major expenditure of this kind. The fairly recent installment of a vegetable washing facility has cost somewhere in the ballpark of $20,000 to $25,000. Of course this building is larger and has better insulation than what would be needed but the facility would probably cost at least

$10,000. Plus anywhere from $2,000 to $5,000 for the actual processor. Second, the amount of vehicles that use diesel and the demand of the fuel is relatively low and so the potential production volume would most likely not match the consumption rate.

It is unfortunate that the status of the near by Biodiesel Coop is unknown. Though it is unclear what has happened, the dismantle of their website and lack of recent updated has made it challenging to believe that they are still active and thus hard to join. Keeping in mind that biodiesel does help reduce dependency on foreign resources and is less damaging to the environment, it should be seriously considered to use a bio fuel of some sort, regardless of personal manufacturing. Because of advantages and implications (both politically and environmentally) **we should start using biodiesel from fueling stations with the Scattergood Farm vehicles.** It would be wise be to use one of the grades between B6 and B20 so new parts would not be required. Within 50 miles of The Scattergood Friends School Farm, there are 11 fueling stations that supply biodiesel in grades from B2 to B20. As mentioned before in this paper, it would help reduce our environmental impact and reduce our foreign dependency. Though right now and it does not make sense to bring a biodiesel facility to Scattergood, it has many environmental, financial, and educational benefits and is an endeavour worth pursuing.

To make that happen there are two primary things that would have to fall into place. The first necessity is that around $20,000 would have to be allotted to this project (going of current prices and estimates). Most of that money would go to the building and outfitting of the facility, leaving the rest to buy the processor materials (whether it is a kit or custom designed), and to pay for staffing of the process and cleanup. This brings into light the second main requirement which would be someone to oversee the construction of the facility, assembly of the actual reactor/processor, and operate and clean up the reactor/processor. Once those two large requirements have been met, it will be possible to integrate a system into Scattergood.

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