FINAL REPORT

ON-FARM OIL SEED PRODUCTION AND PROCESSING

A ONE-YEAR PILOT PROJECT

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The goal of this project was to assess the potential production and processing of oil seed and sugar-containing crops for use as a renewable energy source on a scale that would support small groups of local farmers working together. This report summarizes what we have learned in a short time about the agronomic, economic, and regulatory aspects of these crops and processes, and while there appears to be a lot of promise, many unresolved issues were identified, and much work remains to be done.

Oil Seed Crop Production. A lot of production information already exists on oil seed crops such as canola, flax, mustard, soybean, and sunflower (see references). The challenge is to identify the varieties, equipment and agronomic practices that work best in Vermont, and to design sustainable cropping systems/crop rotations.

Our experience suggests that canola and sunflower have the best potential as oil-producing crops for our region, due to the high oil content of their seeds and the high quality (low cloud point) of their oil. Soybeans may be part of the oil seed cropping system mix due to the high value of the soybean meal as a livestock feed, even though soybean oil yields are relatively low.

The National Renewable Energy Lab reports that both canola and sunflower seeds contain 40% oil, and given average yields of 1,374 and 1,349 lb/acre, respectively, should each yield the equivalent of about 70 gallons per acre of biodiesel. Soybeans contain 18% oil, producing a national average of 2,376 lb/acre, yielding 56 gal/acre of biodiesel. According to Univ. of Missouri research, canola, sunflower, and soybean oils have similar cloud points (where filter clogging can occur due to congealing) of 25, 23, and 24 degrees F, respectively. These oils all contain about 17,000 Btu's per pound, and they all weigh 7.6 pounds of oil per gallon.(http://www.nrel.gov/docs/fy04osti/34796.pdf)

Canola is a genetic variation of rapeseed developed by Canadian plant breeders specifically for its nutritional qualities, particularly its low level of saturated fat and low eicosenoic and erucic acid contents. Canola plants produce yellow flowers that, in turn, produce pods, similar in shape to pea pods about 1/5th the size. Within the pods are tiny round seeds that are crushed to obtain canola oil. Each seed contains approximately 40 per cent oil. The remainder of the seed is processed into canola meal, which is used as a high protein livestock feed.

Canola Production (from Heather Darby, UVM Extension). Plant into a firm seedbed, to a depth of a 1/2 inch. Avoid deep planting especially if soil moisture is good (early-planting). Late planting decreases yield; try to plant early (similar to small grains). Hardened seedlings are fairly frost tolerant. Recommend seeding rate is 5 to 6 lbs per acre. Use 7 to 8 lbs if planting into poor conditions. Suggested N rates are 50 lbs per acre after clover, 90 lbs per acre after small grains. Suggest 1 lb per acre B be applied. Suggest 70 lbs P and K per acre, base applications on soil test. Suggest pH of 6.0 to 6.3. For flea beetles the economic threshold is 25 % leaf area loss. Young seedlings are especially susceptible to flea beetles. Most seed comes treated with a systemic insecticide (e.g. Helix), but we have not seen losses with untreated seed in Vermont. Cutworms are not frequently a problem; the economic threshold is 3 insect per square yard; they tend to appear in late June, and they seem to prefer late-planted fields. They can destroy a whole field in a few days if they consume plants as they germinate and emerge, leaving the impression that the seed never germinated. European Corn Borer is a new development. We think that it probably has relatively little impact on canola yield. However, it means that canola will harbor this pest. No control methods have been developed, and probably are not needed.

Sunflower varieties actually have a wide range of oil in their seed, from 39 to 49 percent. Sunflower oil is generally considered a premium oil because of its light color, high level of unsaturated fatty acids and lack of linolenic acid, bland flavor and high smoke points. Non-dehulled or partly dehulled sunflower meal has been substituted successfully for soybean meal in isonitrogenous (equal protein) diets for ruminant animals, as well as for swine and poultry feeding. Sunflower meal is higher in fiber, has a lower energy value and is lower in lysine but higher in methionine than soybean meal. Protein percentage of sunflower meal ranges from 28% for non-dehulled seeds to 42% for completely dehulled seeds.

Sunflower production (adapted from Purdue University). Many different tillage systems can be used for sunflower production, including moldboard plowing or chisel plowing to invert residue plus several secondary field operations, or minimum till or ridge tillage. Major considerations are: 1) firm placement of seed near moist soil, 2) absence of green vegetation during emergence, 3) maintaining an option to cultivate and 4) reduce the risk of soil erosion. In northern regions, highest yields and oil percentages are obtained by planting early; in the northern midwest and Canada this is often May 1 through 20. Resistance to frost damage decreases as seedlings develop into the 6-leaf stage, so too-early sowings in the northern USA or Canada can be risk. A planting date of early to mid May is recommended in Minnesota and Wisconsin, and applies to most of Vermont, too.

sunflowers growing at State Line Farm

A planting depth of 1 to 3.5 in. allows sunflower seeds to reach available moisture and gives satisfactory stands. Deeper plantings have reduced stands and yields. If crusting or packing of the soil is expected, with silt loam or clay soils, use a shallower planting depth. Sunflower row spacing is most often determined by machinery available. In MN trials, sunflower yield, oil percentage, seed weight, test weight, height, and flowering date did not differ at narrow vs. wide rows over five plant populations. Hence, row spacings can be chosen to fit available equipment. Row spacings of 30 in. are most common. Sunflowers can produce the same yield over a wide range of plant densities. The plants adjust head diameter, seed number per plant, seed size, to lower or higher populations, so that yield is relatively constant over a wide range of plant populations. Plant population does have a strong effect on seed size, head size, and percent oil.

A medium to high population produces higher oil percentage than does low populations, and the smaller heads dry down faster at higher plant populations. Recommendations in MN and WI are for 23,000 plants/acre (~3 lb seed/acre) for oilseed production. Some have suggested that north-south orientation of rows produce higher yields than east-west rows, but studies to examine this effect have found no differences in yield.

Nitrogen is usually the most common limiting fertility factor for yield, but excess N fertilizer tends to reduce oil percentage of the seed, although yield increases from N fertilizer rates up to 175 lb/acre have been observed. Rates considerably lower than this are usually recommended. In the wetter regions of eastern and southern MN and WI, recommendations of approximately 18 lb N/acre after fallow or legume sod, 60 lb N/acre after small grain or soybean and 80 to 100 lb N/acre after corn or sugarbeet are common. On higher organic matter soils, amounts should be lowered. Nitrogen can be supplied from mineral or non-mineral sources (manures, legumes, compost). Row placement of P and K may be important for maximizing efficiency of fertilizer use, as it is with many species. Sunflower is not highly sensitive to soil pH. The crop is grown commercially on soils ranging in pH from 5.7 to over 8, with 6.0 to 7.2 optimal for many soils.

Sunflower is a strong competitor with weeds, especially for light, but does not cover the ground early enough to prevent weed establishment, so early season weed control is essential for good yields. Almost all North American sunflower plantings are cultivated and/or harrowed for weed control, and over 2/3 are treated with herbicides. Post emergence cultivation with a coilspring harrow, spike tooth harrow or rotary hoe is possible with as little as 5 to 7% stand loss when sunflowers are at the four to six leaf stage (beyond cotyledon), preferably in dry afternoons when the plants are less turgid. One or two between row cultivations are common after the plants are at least 6 in. tall.

The most serious diseases of sunflower are caused by fungi. The severity of these disease effects on total crop yield might be ranked: 1) sclerotinia, 2) verticillium, 3) rust (recently more severe), 4) phoma, and 5) downy mildew. Resistance to rust, downy mildew, and verticillium wilt has been incorporated into improved sunflower germpla

Field Trials. In 2006, field-scale trials were conducted at State Line Farm and Clear Brook Farm in Shaftsbury (southwest Vermont); and field-scale replicated trials were conducted by Dr. Heather Darby of UVM Extension and Roger Rainville of Borderview Farm in Alburg (northwest Vermont).

Related work with canola and biodiesel production in was also done by Dr. Peter Sexton of Univ. of Maine working with local farmers, and Dr. Becky Grube at Univ. of New Hampshire working with farmer Dorn Cox on sunflower trials this year. Some information from their projects is provided here.

The conclusion of work done in these three states is that *oil seed crops can successfully be grown in the northern New England states*. However, additional study and experience is needed to improve production methods and thus optimize yields and economic returns. It will likely take several more years of research looking at species, varieties, seeding rates, seeding dates, fertility rates, and especially harvesting methods in order to make this system work well. Obviously, viable markets and/or on-farm processing will also need to be worked out, and much work remains to do on those issues. As the price of fossil fuel and/or animal feed changes, the economic viability of growing and processing oil seed crops for fuel will be affected.

Crop trial results - State Line Farm, Shaftsbury VT – 2006

Crop	Variety	Date: Sow/	Emerge/	Harvest	Moisture	Yield/Acre: lb seed	gal.oil	lb meal
canola	Hyola 401	5/9	5/16	8/25	7.7%	1,404	26	1,205
canola	601	5/9	5/16	8/25	7.9%	1,128	19	985
canola	Oscar	5/9	5/16	8/25	8.3%	996	11	910
canola	Hyola 420	5/9	5/16	8/25	8.0%	984	18	846
canola	KAB	5/9	5/16	8/25	9.4%	756	*press malfunction*	
mustard	Pacgold	5/9	5/15	8/11	5.6%	732	*accidentally mowed*	
mustard	Idagold	59	5/15	8/11	6.6%	504	17.2*	373
flax	Brown	5/9	5/17	8/31	7.0%	*.43* gal oil from 14 lb seed		
sunflower	IS 6521	5/10	5/23	10/6	8.0%	2,200	84	1,563
soybean	IA 24, IF 61	5/10	5/25	*crop failure due to wet weather*				

* pressed at Tuckaway Farm

There were challenges adjusting the seed press to properly extract the canola oil, and the canola seed had apparently absorbed moisture in storage. A 100 lb sample of mixed canola varieties was subsequently dried down by placing near a woodstove for several days and then run thru the seed press. That sample yielded 3.75 gal of oil, or the equivalent of 52.5 gal per acre given a 1,400 lb yield.

Canola seed yields of 2,000 lb/acre should be achievable with optimum growing and harvesting practices, so therefore 75 gal of canola oil/acre is a reasonable 'high yield' to expect for our area in the future.

Canola trial results - Clearbrook Farm, Shaftsbury VT - 2006

Crop	Variety	Plant	Harvest	Moisture	Seed lb/Acre
canola	Oscar	6/13	9/15	~9%	471
canola	Oscar	6/13	9/15	~9%	620
sunflower	Perdovik	6/13	*crop failure due to herbicide carryover from corn*		

These fields were previously in field corn and herbicide residues appear to have caused crop injury; canola stands were thin probably due to low seeding rates and insufficient nutrition provided by 330 lb/A of composted chicken manure fertilizer, which did not meet the fertility needs of the crop.

The poor yields of these trials demonstrate that successful oil seed production requires a relatively high level of soil fertility and management. It should not be attempted on marginal soils, or as a casual enterprise that will need little attention or planning.

Canola trial results - Borderview Farm, Alburg, VT - 2006

Despite challenging weather we were able to harvest a respectable canola crop. Yields ranged from ½ to ¾ ton of canola seed per acre, with highest yields when canola was planted early. The yield standing in the field looked better than in 2005 but after harvest the yields were below last year. We believe this was due to seed loss during harvest.

In 2005 there were 23 canola cultivars trialed in small plots on an experimental scale. These were harvested and threshed by hand. There was little equipment to learn how operate, and very little seed loss. In 2006 canola was grown on a field scale, with three varieties (Croplan KAB36, Oscar and Croplan 610) replicated three times throughout the field. Each replication was 16' x 730' which was basically two passes of a drill down the length of the field.

A commercial combine and operator were hired to do the harvesting. The JD9500 was an impressive machine, however, direct harvesting of the canola resulted in a massive amount of green material in the finished product. As the crop was harvested there was immediate heating of the material in the gravity box. The combine was fine tuned further but still enough green material was present in the seed to pose a threat. Any additional tuning would have resulted in seed loss out of the back of the combine. Without a seed cleaner to immediately remove the foreign material we were sure to loss our crop. At this point we stopped harvesting the plots. If we let the canola plants and weeds dry more we would risk losing seed to pod shattering.

The next step was to try swathing the canola. That involves cutting the crop before combining to allow the whole plant to dry on the ground and avoid shattering of the pods that can occur when direct combining upright plants with fully-dried pods. There are few swathers available to borrow or purchase in the New England area; we borrowed an older swather from Jack Lazor at Butterworks Farm in Westfield, which required some adjustments and involved a learning curve with regard to operating it correctly. There were issues with plugging, difficulty picking up the canola due to lodging, and cutting due to a dull cutter bar. After talking with a few farmers, we learned that a swather with "fingers" should be used due to the lodging issues with canola. When the combine returned to harvest after the swathed canola had dried, there were additional difficulties in picking up the canola. A special head for the combine would have helped. In addition, combining was difficult in areas where the canola was bunched up due to being plugged up earlier in the swather. All in all a lot of seed was lost to the ground, and it is clear that best practices for local production, harvest, and storage still need to be developed.

The final oil yields from the canola seed grown in Alburg were not as high as expected, based on results reported in many other locations, including Maine. As with canola seed from State Line Farm, this appears to be a problem with excess seed moisture which limits the ability of the Tabby oil seed press to fully extract the oil.

Canola Variety Trial - Alburg VT - 2006

Crop	Variety	Plant	Moisture	Seed lb/Acre	gal oil/Acre
canola	601	5/19	13.6%	1750	24.1
canola	KAB	5/19	12.0%	1608	27.9
canola	Oscar	5/19	11.5%	1363	24.7
	Average		12.4%	1573	25.6
canola	601	5/29	13.0%	1200	22.1
canola	KAB	5/29	14.0%	1337	---
canola	Oscar	5/29	12.4%	1000	17.4
	Average		13.0%	1179	19.7

seeds from a canola variety trial

Canola varieties and related issues. The canola varieties grown in these trials included KAB, which was untreated hybrid seed. Varieties 601 and Oscar were untreated and open pollinated, meaning that farmers could save their own seed from these crops. Hyola 401 and Hyola 420 were treated hybrids.

The terms of this project prohibited the use of transgenic (genetically modified, or GMO) seed. That prohibition suits the production preference of many farmers in the region, especially organic farmers and those in transition to organic, such as State Line Farm. However, other farmers will likely want to use transgenic varieties with herbicide tolerance for ease of weed control.

This GMO issue has already been contentious in Vermont, with crops like soybean and corn which are a lot easier to separate that canola, which is easily cross-pollinated over relatively long distances. This raises several concerns should canola become a popular crop here among both organically-minded and conventional farmers. First, it is already difficult if not impossible to find commercial canola seed that is completely free of genetically modified material (although it should be possible to conduct breeding work in isolated areas to get a GMO-free line of canola). Second, even though the organic standards generally accommodate use of seed with a low level of GMO contamination (out of necessity), additional contamination by cross pollination from nearby GMO crops could pose problems with the marketing of organic products, such as organic canola seed meal.

The positive side of these challenges is that if Vermont were able to develop (and protect from contamination) an organic canola seed industry, there would appear to be significant market. The organic crops Extension Specialist from N. Dakota told me that farmers there have trouble finding organic seed and that the market for organic canola is strong.

Sunflower trial results – Kingman Farm – University of New Hampshire - 2006

Variety	Plot	Seed lb/acre	% oil	unfiltered oil gal/acre
378 DMR	plot 1	1,615	26	56
343 DMR	plot 1	1,688	33	74
3080DMR	plot 1	1,343	42	75
308NS	plot 1	744	35	35
305DMR	plot 1	780	37	39
378 DMR	plot 2	762	--	27
343 DMR	plot 2	563	--	25
3080DMR	plot 2	690	--	39
308NS	plot 2	454	--	21
305DMR	plot 2	327	--	16

Field trial at Kingman Farm, UNH

All these seeds were hybrids from Interstate Seeds, with downy mildew resistant (DMR). The variety 305 matured very early (short season variety) which probably limited yield. The 378 was very easy to press, probably due to its low oil content, which kept it from backing up in the feed hopper. This can be avoided with better adjustment. Plot 2 was a shallower, sandy soil that produced plants of similar size but with smaller heads.

This trial highlights the potential effects of soil quality and fertility on oil seed production, as well as the wide range of oil content in the seeds from different sunflower varieties.

Oil from the Kingman Farm trial was processed by Dorn Cox at Tuckaway Farm in Lee, NH (see seed press section). Some of this oil is made into biodiesel for on farm use, and some has been sold to local soap makers. Dorn has submitted a grant proposal to USDA Rural Development value-added program to study the potential to produce oil for human consumption that could be sold to restaurants, then collect the used waste oil for processing into biodiesel, thus getting both food and fuel from an oil seed crop.

Canola trial results - Maine and Vermont – 2005
(from Heather Darby, UVM and Peter Sexton UMaine, funded by NE-SARE)

		Seed Yield lb/Acre		
Company	Variety	Presque Isle ME	Orono ME	Alburg VT
Bayer	INVIGOR 4870	2192	1143	1928
Interstate	Hyola 514	2019	1443	1844
Pioneer	45H21	2012	1438	1916
Interstate	SW Titan	1985	1367	1866
Interstate	Hyola 401	1957	1167	1810
Cropplan	HyClass 905	1936	1627	1787
Bayer	INVIGOR 2663	1919	1039	1906
Cropplan	KAB-36	1914	1448	1777
Pioneer	46H02	1882	1323	1916
Interstate	Hyola 357	1839	1690	1669
Bayer	INVIGOR 5630	1837	1670	1733
Interstate	SW Patriot	1836	1854	1906
Cropplan	Hyclass 712	1832	1263	1786
Interstate	Hyola 420	1822	1412	1704
Cropplan	HyClass 2061	1816	1515	1861
Cropplan	Crosby	1779	1541	1755
Pioneer	46H23	1753	1475	1860
Cropplan	Minot	1747	1326	1637
Interstate	SW Marksman	1740	1758	1781
Pioneer	46A76	1730	1197	1730
Pioneer	43A56	1716	1770	1592
Cropplan	Oscar	1541	1534	1551
Interstate	Hylite 618 CL	1513	1180	1577
Average		1838	1444	1778
LSD (0.05)		NS	377	135

On-Farm Oil Seed Processing. Oil seeds have a relatively low value as a raw commodity, but require no additional work for the farmer beyond growing, with the possible exceptions of drying, storing and/or transporting seed. Processing the seed into oil and meal adds value, for use as fuel directly or as feedstock for biodiesel, and as livestock feed. Processing for direct human consumption adds the most value but also adds food safety, regulatory, and marketing considerations. On-farm processing includes many possible steps, depending on the end-product and markets. Harvesting, cleaning, pressing and processing into biodiesel are some of these steps.

Oil Seed Harvesting. Access to a reliable combine that can handle the acreage planted in a timely fashion when the crop is ready and weather is good is a critical component to an oil seed farming enterprise. For example, in 2006 Cedar Circle Farm in East Thetford VT planted several acres of sunflowers with the hope of producing oil that could be used to run their waste oil greenhouse furnace. The crop grew well and appeared to have a good yield, but it was never harvested. They were relying on a custom harvester, and by the time it arrived the crop had been ruined by soft rot.

Buying a new combine is a very expensive proposition, as new units typically cost over $100,000. Buying a used combine is much more realistic for most farms planning to grow oil seeds on a modest scale. There is greater availability of used combines in western NY and the mid-west, where grains are more commonly gown. Web sites such as www.TractorHouse.com can be used to locate used combines. At this writing, that site listed used combines in working conditions for as little as $2,100 (1979 John Deere) and $5,500 (1981 International) with newer, larger units up to $150,000. Owning an older combine requires mechanical skills or access to someone who has them, and it may be a challenge to obtain parts for repair.

State Line Farm has a 1960's Massey Harris combine that was able to harvest all their oil seed crops. It was purchased used from a neighbor for a $1,000 dollars, and then John Williamson spent many hours and $1,000 on parts refurbishing it to good operating condition. At Borderview Farm, a custom operator was hired to combine the canola crop.

Dorn Cox in NH uses an old John Deere 12A with a 66 inch platform head that is pulled behind the tractor. With this, he can do one row of sunflowers at a time, at a decent speed. It does a good job, and it has a bagger so it is easy to collect seed on a small scale. The fully adjustable fan speed and concave sieves allow it to be used on many kinds of crops, but takes a long time to adjust it properly for different types of seed. Dorn also found it hard to get replacement parts, and in some cases he went to an industrial supply house to get some parts custom-made.

Seed Cleaning. To make high quality oil, enhance seed storage, and to protect the seed presses, seed needs to be cleaned. At State Line Farm and at Borderview Farm, batches of uncleaned seed stored with chaff caused the seed to heat up, reducing quality of the seed meal, and potentially reducing oil quality if there is enough mold.

State Line Farm purchased an Eclipse model 324 seed cleaner for $6,835. Operating speed depends on the seed type and trash level. Canola seems to go fast, sunflower a little slower. However, the proper screens needs to be selected for the seeds you are cleaning; there are hundreds of screen sizes available for different seed. If your combine does a good job, then it is a lot easier to clean the seed. Different screens may be required for the same crop because different fields have different weed seeds that can contaminate seed lots.

The Clipper uses 3 screens at a time. The first screen lets the small grain pass through and by bouncing and shaking to remove, or 'scalp' anything bigger than the seed you are trying to clean. Then there is a series of two sieving screens that remove those (weed) seeds that are smaller than the crop seed. If there is a big variation in the crop seed size, may want to run the batch through a second time to get the smaller crop seeds as well. In general, the bigger the seed, and the higher up off the ground when combined, the easier it is to have clean seed after combining. Sunflowers in both VT and NH trials were clean enough to press directly after combining.

Seed pressing. A Tabby model 70 seed press was purchased for $8,781 by State Line Farm which is about middle range of sizes made by Tabby (www.oilseedpress.com). It is has successfully pressed canola, mustard, soybeans, flax, and sunflowers.

They picked the press up from the distributor, Magic Mill, located in NJ. The capacity is about a ton/day, depending on the condition of the seed and how fast you press it. In general you should be able to get 3-4 gal/hr depending on feedstock. It can be adjusted to extract more less of the total oil, affecting how much remains in the meal (feed). It can run automatically for long periods of time. The seed needs to be thoroughly clean and dry going into it.

Electricity is used to power this mill, but it could be driven by a diesel motor. It has a 2.2 kw 3 hp motor that runs about 8 amps at 3 phase uses about 1500 watts. The unit has a heating collar on the nozzle which helps with seed meal quality, by heating soy to eliminates the tripsin inhibitor (see section on seedmeal). The electronic controls are for variable speed of operation, counting of hours of operation, there's a voltmeter, and an automatic shutoff.

The automatic shut off is an important feature to have for non-attended operation. In addition to preventing damage if the screw press gets jammed, the unit also shuts off if there's an interruption in the flow of grain, or if the nozzle becomes too hot. John learned that having a magnet is important to catch any metal that may be in the seeds. He installed one over the stream of seed flowing into the mill after he had a bolt and a nut end from one batch of seed get jammed in the press.

To press well, the seed has to have a moisture content of about 6 to 9% because if it's wet it doesn't flow through the nozzle well and if it's too dry it grinds the seed to dust. When the Tabby press was first set up in the barn it was rigged to expel seed meal into a large wooden box. In some cases seed meal (canola primarily) compacted tightly and prevented it from flowing from the box into a gravity bin, from where it was to go into an outdoor bulk bin. So the grain handling was redesigned to put small batches into poly-tarp totes, which facilitates handling and also will make delivery easier in the future.

Dorn Cox, a farmer in Lee, NH, purchased a Chinese seed press from AGICO (Anyang General International Company Ltd. (http://www.ayimpex.com). The model is # GC80, rated for 200 lbs/hr, with a 7.5 hp, 3-phase motor, that Dorn runs off a 3-phase generator. He bought the unit direct from China for $1100 including broker fees for customs; the total was about $2,000 after buying a frame and the motor.

With this unit, one has to manually adjust the tension on the concentric rings around the screw press in order to accommodate seeds of different oil content, and thus how much is extracted. If the setting is too tight, it backs up the oil into the screw, and the seed meal can pack into the grooves into the screw, then the unit needs to be dissembled. The operator therefore needs to watch carefully and make adjustments, taking into account that it requires about 40 minutes of operation for the unit to warm up fully. If the feedstock varies in oil content then readjustments may be needed, so in order to run the unit without constant monitoring a uniform seed supply is needed. Dorn had challenges pressing batches of sunflower seed from a mix of different varieties. He is considering buying a larger, 10-ton unit, complete with frame and motor, and using direct diesel power. Then he could use the waste heat from the diesel engine to pre-heat the seed.

Roger Rainville, of Borderview Farm researched oil seed pressed that could handle 6 tons a day of canola and other oil seed crops. He found two companies in the U.S. that sell Chinese presses, and then he went and visited Dorn Cox to see the Chinese press he had purchased. Roger decided to order a press from AGICO, too, because the price was so low given the capacity and options. He ordered model #GC-120A with 6 Tons/day, heated or cold press, with oil filters to filter the oil for $2295. He also ordered a vibrating sieve seed cleaner with a rated capacity of 8-15 tons/hr for $2,065. In addition, he purchased spare parts (essentially all moving parts) for $320 for the oil press and $220 for the seed cleaner.

Shipping cost was $920 to Montreal (close to his farm in northern Vermont) plus $30 tax. There is no duty if the equipment is used for agriculture. It is possible to get a broker to help with importing. His equipment will be single phase 220 volt. You can get a 3-phase model, but according to Roger, if the electric motor is less then 10 hp then the cost of the converter does not pay back. You can also get the press with a diesel motor for some additional cost. AGICO presses are also available through some US distributors, like waldermfg.com, but the price is much higher. AGICO will ship individual presses, seed cleaners, and other equipment direct to a U.S. or Canadian port-of-entry.

*Oil Seed Processing Facility***.** State Line Farm started their oil seed enterprise in the old dairy barn. That situation was far from ideal since old barns were not designed for this purpose, and are not suitable to optimizing efficiency, or health and safety. Pressing oil is not compatible with a barn or equipment shop because of dust entering the process, oil spills that inevitably happen, and the need for separation of processing from foot and vehicle traffic patterns.

Therefore, in 2006, State Line Farm constructed a dedicated facility for oil seed handling and processing. Before designing their building John Williamson and Steve Plummer visited other places processing oil and some that were making biodiesel on a small scale, like Green Technologies in Winooski. Building from scratch allowed the facility to incorporate many desirable features to enhance energy efficiency, materials handling and cleanliness. A biodiesel production system able to produce ~400-gallon batches has been designed (see. P 47) and is under construction.

The building at State Line Farm is 30' x 50' with a 16 foot interior clearance. It is built into a small hillside in order to use gravity to as much as possible to feed raw seed into the building. When designing such a building, one needs to consider how the materials can flow through efficiently through all steps of the process, from input of seed to output of vegetable oil and/or biodiesel. At State Line Farm, having the grain storage loaded from atop the hillside bank into a hopper in the upper level of the building avoids the use of an auger to move seed, avoiding the need for power, potential damage to the seed, and noise of operation.

Once the seed is pressed, the oil and meal flow by gravity into separate containers. The building also has large garage doors to allow easy equipment movement, and a dock for ease of deliveries. There is a pitched cement slab floor with a grated drain that can hold 1,000 gallons in the event of a spill. The floor also has radiant heat pipes that will eventually be connected to a boiler. There are windows with southern exposure to provide passive solar heat. When dealing with vegetable oil it is necessary to maintain some minimum winter temperature so the oil does not congeal.

The town was consulted before construction stared, and they considered the building to be an agricultural building and did not throw up any road blocks with regard to permitting. That might not be the case if the facility was not built on a working farm that was producing crops that would be stored and processed in the building.

In NH, Dorn Cox has built a biodiesel processor on a trailer and plans to build an oil seed processing facility on a trailer as well, to allow portability as well as minimizing tax liability with permanent structures. He does plan to build a pole structure to allow operation in inclement weather. The design of this system is included on p. 46.

Northern Maine oil seed experience (information from Dr. Peter Sexton, UMaine Cooperative Extension). Maine has done a little work with sunflower, but their growing season is short so the crop has not been able to mature very well. Soybeans also have trouble drying down in northern Maine, and potatoes don't do well after soybeans so that's a big deterrent to farmer adoption.

Farmers in Aroostook County have grown 3,500 acres of spring canola in each of the last 3-4 years, and potatoes come out pretty clean following canola. A winter canola trial did not survive the winter, and N. Dakota has reported similar problems. Winter canola may have potential in more southern areas.

There is some concern about promoting white mold, which attacks both canola as well as potatoes (and many other crops) but that has not been a problem thus farm and potato yields so far have been better following canola than after small grains. No canola varieties are resistant to white mold, so if there are humid conditions a crop can get a lot of it. Conventional growers can use fungicide sprayed at flowering and get good control. There is a commercially available biological control agent (Contans WP) that has had good efficacy in other crops, and is currently suitable for use on organic farms.

In northern Maine canola is usually planted the first or second week May, then either swathed at the end of August, or combined about the second week of September. Even if canola gets planted in late May or early June it still makes a crop. Farmers that have their own combines tend to direct cut the canola at around 12% moisture then have it hauled to Quebec where it is sold to farmer cooperative. In this case there is a seed drying charge which could be avoided if they waited to harvest until the seed dried down to 10% moisture. However, there are too many risks associated with doing that and because of the weather one can't predict when it will happen.

Farmers without a combine will swath their canola because they don't know when the combine will get there, but the cost of swathing is about $10-15/acre. With swathing you lose a little less seed to pod shattering, but you don't fill out the crop quite as much. Swathing is typically done when about 1/3 of the seed has started to change color. Hyola 420 and Hyola 401 have been the primary cultivars sown, but probably won't be offered by Interstate Seed anymore, so farmers are seeking alternatives.

Canola yields have been about 1,000 lb per acre with low inputs, meaning no added nitrogen or chemical weed control. They run about 1,800 lb per acre when fertilizer and herbicide are used. Farmers pay $12-15/ton for trucking the canola seed, the drying fee if necessary and they get paid a price that is pegged to Winnepeg commodity exchange (http://www.wce.ca/), typically from $300 to $380 Canadian per metric ton. They can buy futures if they want to.

With all the canola production, there was interest in producing biodiesel. One farmer bought a second hand InstaPro press model 1500 that has an extruder and an expeller. It will process about 1 ton of seed per hour. The extruder basically turns canola seed to mush by running it through a disk that busts up the cells and frees the oil, then the expeller mechanically squeezes out the oil. They run the seed through twice to get 80-85% of the total oil; a single pass only yields two-thirds of that. The seed is run through the press at 10-11% moisture, and the seed meal produced after two runs has just 10% fat.

A recent SARE-funded pilot worked with two farms in the Presque Isle area to grow canola for pilot production of biodiesel. The variable cost of production under conventional management (fertilizers and herbicides) was $204 per acre, while under low-input management (no fertilizer or herbicide) it was $147. Due to higher yields with conventional management, the cost per ton of producing canola was $241/ton, while with the low-input system it was $268/ton.

An economic analysis was performed that assumed a plant capacity of 18 tons of canola per day being processed into 1,000 gallons of biodiesel. An estimated total capital of $1,010,000 would be required. The interest expense assumed a loan of $750,000 repaid over an eight year period at an interest rate of 8 percent, with the remainder of the capital ($260,000) being equity. The cost of crushing canola was estimated at $52.67 a ton, and the final cost for biodiesel was estimated to be $3.07 per gallon. For the full report see: http://www.sare.org/reporting/report_viewer.asp?pn=ONE05-048&ry=2006&rf=1

Seed Meal for Livestock Feed. The seed meal of Vermont-grown canola, sunflower, and soybeans were sent to both UVM (below) and Cornell Dairy One Labs (appended, pages 26-28) for analysis. The Dairy One analyses of 2 sunflower variety meals from the UNH trials are also appended (p 29-30). Dr. Matthew Waldon, Dept of Animal Sciences at UVM provided the following advice about using oil seed meals in livestock feed.

“The nutrient profiles provided are comparable to many oilseed feeds that are currently commercially available and fed in the livestock industries. In fact, several forms of soybean, canola, flaxseed, and sunflower meals are currently marketed in North America.

Protein is typically an expensive nutrient in many animal diets, and therefore, feeds containing 30-60% available protein (as these by-products contain) can be valuable commodities. The protein quality of these by-products still needs to be assessed because the amino acid profile and true protein content of these particular by-products have yet to be determined. Protein quality, and the willingness to further process the by-product ingredient could influence the suitability of these ingredients for some animal species.

(canola, soy, and sunflower meal, above)

There also appears to be a significant energy component to these feeds much of which is supplied by fat. This fat can be both positive and negative, in some species (swine, poultry) it might be a welcomed source of energy, in other species we would be more guarded with how much of this fat we feed. The fat contained in these oilseed byproducts would presumably contain significant quantities of unsaturated fatty acids, and these fats can be detrimental to pregastric digestion in ruminants (cows, goats, and sheep).

Typically we might limit these fats to 2-4% of total dietary fat, meaning that these ingredients might need to be limit-fed (ranging from inclusions of about half a pound to several pounds per animal depending on species and type of diet being fed). Furthermore, these plant oils are often more valuable when isolated from the feed ingredient rather than when shipped as part of the oilseed meal. Therefore, it may be of economic interest to investigate other methods (chemical or mechanical) to extract the fat from these by-products such that the fat may be marketed as an individual ingredient to either the human or animal food industries.

Another consideration for these by-products would be the treatment processes by which these ingredients were derived - it is possible that some processes of the primary industry (such as controlled heating of the byproduct) could be beneficial for the feed ingredients. Oilseeds of this nature often contain anti-nutritional factors such as trypsin inhibitors. These compounds cause an inhibition of digestive processes such that the nutrient availability may be limited and animal performance may be impaired. Furthermore, reduced digestibility of nutrients could lead to environmental concerns as these undigested nutrients would pass from the animal into the urine and feces.

Several processing methods can be used to negate these anti-nutritional compounds such as heat-inactivation and enzymatic treatment. These processes neutralize the anti-nutritional factors thereby making the nutrients more digestible. Adequate processing of these by-products might be necessary to maximize the digestibility of these ingredients across species.

One final note regarding these by-products as potential feed ingredients is consistency of the ingredient analyses. Because they are by-products of another primary industry, these type of ingredients (almost by definition) are of secondary importance to the main process (in this case vegetable oil for bio-fuel). Therefore, the feed ingredient analyses are often very inconsistent from one batch to the next. This inconsistency will detract from the value of the by-product to the feed industry and anything that can be done to increase the consistency of analyses will likely increase the value of these byproducts as feed ingredients. However, the costs of increased consistency must be carefully analyzed because the required return on investment may not be attainable.

It is conceivable that 1-3 lbs per day of these potential ingredients could be included in individual production animal diets; however, more information would be needed before we could make any concrete projections on their potential usage."

Informal conversations suggest that currently, conventionally-grown oil seed meals have a value of about $200/ton in the Northeast, and organically-grown seed meals are worth about twice that amount. At this writing, Whitman's Feed in N. Bennington reports buying conventional, hexane-extracted canola meal for $170/ton delivered by rail car; Green Mountain Feeds in Bethel says they cannot get enough organic canola or sunflower meal on a consistent basis to use it in their organic rations; it would probably be worth $400-$450/ton if they did.

Forage Analysis Results of oil seed meals from State Line Farm.
Wet Chemistry, UVM Ag Testing Lab, October 2006

--------------------------dry matter basis------------------------

Crop	% Dry Matter	% Crude Protein	% Available Protein	% ADF	% NDF	% Fat	% Ash	% TDN
Canola	90.5	39.0	37.5	25.3	36.3	23.6	5.9	105.3
Flax	90.8	41.5	41.5	18.3	32.7	22.7	5.4	106.1
Mustard	89.0	44.7	44.2	15.4	23.5	23.4	6.3	108.3
Soybean	87.0	54.4	54.4	10.0	12.0	13.0	5.7	97.8
Sunflower	90.9	33.8	33.8	36.5	52.3	17.1	5.3	92.6

One interesting alternative use for these seed meals, especially if they are not of sufficient quality to use in feed, is as a biomass fuel in furnaces or boilers designed for corn and/or biomass pellets. One such unit, manufactured by LDG, Inc of Pella, Iowa (www.cornheat.com) was recently installed in a greenhouse at Walker Farm in Dummerston, VT with funding from UVM Extension. We plan to test-burn oil seeds and seed meals this year. If successful, this type of heating system may be installed at State Line Farm's oil seed processing facility, where it could run on wood pellets, corn, or oil seeds/seed meal.

Sugar Crop and Ethanol Production. The idea behind growing sugar-containing crops is to be able to process them to produce ethanol for biodiesel production in conjunction with on-farm vegetable oil. John Williamson has a decade of experience growing sweet sorghum, which he has grown to make sorghum syrup in his maple syrup evaporator. Sugar beets also have potential for our region due to their adaptation to colder climates and ability to produce high yields.

Sweet sorghum stalks contain fermentable sugars in the sap equal to 200-400 gallons of ethanol or more per acre, depending on crop yield and variety. That's about twice the ethanol that's obtained from corn grain, but sweet sorghum is not as popular as corn as a source of ethanol due to the high cost of constructing and operating a central processing plant for a relatively perishable crop. While the starch in corn can be stored for long periods of time prior to processing, the simple sugars in sweet sorghum have to be fermented immediately.

In northern climates, it is best to use varieties adapted to southern U.S. that are late to mature, so they do not form a mature seed head, which uses up energy (sugars). These varieties can grow up to 10-12 feet tall, and some are prone to lodging, which can make harvest difficult. Fresh weight yields can be 40 tons/acre, of which 78% water, so processing must take place nearby to minimize transportation expense.

In addition to the heavy weight of fresh sorghum per acre, there is another obstacle to large, centralized processing of sweet sorghum for ethanol: the sugars in the stalk began to "sour" very soon after harvest. Treating the chopped crop with materials such as sulfuric acid and specialized yeasts may be effective for preserving the crop prior to processing.

Sweet sorghum production (from Purdue Univ.) Sorghums are generally sown between May 20 and June 5. However, research at the University of Minnesota found that early planting resulted in excellent yields when temperatures were above normal and rainfall was below normal. The top four inches of the soil should be warm (65 to 70°F at planting. This gives quick germination and promotes early growth. Rapid early growth is essential since weeds may severely compete with small sorghum plants if growth is slowed by cool weather.

The seeding rate and method depend on the use for the crop and the equipment available. Minnesota research shows little response to planting rates of 20,000 to 80,000 plants/acre for sugar yield. Sorghum for syrup can be planted with a corn planter or with a grain drill at a rate of 10 to 15 lb/acre. Seeding depth should be 1 in. in medium or heavy soil or 1 1/2 in. in sandy soil.

Soil fertility needs are similar to corn, although sorghums are more efficient in their use of soil P and K. Balanced fertilization is essential to get high yields. A 5 to 7 ton/acre sorghum crop will remove about 100 lb N, 40 lb P_2O_5 and 180 lb K_2O /acre. Soil test to determine P and K requirements. Minnesota research indicates no response to N on soils with 5 to 6% organic matter with corn treated with 50 lb N/acre as the previous crop. On sandy soils apply about 20% of the N at planting (not seed placed) and the rest within 30 days after emergence. Where the sorghum is planted in rows, N may be sidedressed when the crop is 8 to 16 in. tall. Sorghum seed is sensitive to fertilizer. Therefore, for row planting place fertilizer 2 in. to the side and at or slightly below seed depth. For broadcast stands, work fertilizer well into the soil before sowing. A soil pH of 6.0 or higher is ideal.

Sweet Sorghum varieties for Vermont. With help from a previous Northeast SARE grant, Mr. Williamson grew 30 cultivars of sorghum at 3 locations around Bennington. Soil texture and fertility, competition from weeds, and management practices differed among the sites. He evaluated each variety for its rate of maturation at each site, and the sap of each for sugar content and taste. When harvesting sorghum for syrup it is not necessary to wait for the grain to mature; in fact, peak sugar content occurs at the soft dough stage.

Early maturing sorghum varieties are preferable in Vermont's short growing season, so that one can collect the seed of these somewhat hard-to-come-by varieties. Uniformity of maturation is also preferable, as this facilitates harvesting. A sap sugar content of 13% or greater, as determined by a Brix reading, is necessary to make harvest worthwhile, and this level was found in early October in the varieties Moes Miller, Smith, Della, Orange, Simon, Ames Amber, and Waconia Orange cultivars. John currently grows Della, Sugar Drip and Umbrella, which have grown well in Vermont, and their seed is generally available from southern growers. John has found that only in about one in five years does seed have time to mature in Vermont, usually the crop gets frosted before the seed reaches the 'nut' stage.

Processing sweet sorghum on the farm. In 2005 a renewable permit was obtained from the Bureau of Alcohol, Tobaccos and Firearms to produce ethanol on the farm. A small still was constructed (to buy blueprints for $30 see: http://running_on_alcohol.tripod.com/id3.html). It can be used to distill the fermented juice of high-sugar crops like sweet sorghum (19% brix in 2006) or sugar beets (about 21% slightly dehydrated). Yeast is added to start the fermentation, then after 72 hrs the mash is about 10-12% alcohol; the resulting 95% ethanol can be run through a zeolite molecular sieve to remove most remaining moisture.

Fresh sorghum will yield about 50% of its weight in juice with the mechanical mill at State Line farm, which is roughly 100 years old. Typically, State Line Farm has produced 750-1,000 gallons of sorghum juice per acre. With a more efficient dewatering screw press press it's possible to get about 80% of the juice out. This piece of equipment is made by in Florida by the Vincent Corporation, which primarily serves the pulp/paper and citrus industries. One can rent units of various sizes, seewww.vincentcorp.com.

On average the sugar content of the sorghum juice produced at State Line farm is about 15%, but it has ranged from as little as 10% to as high as 20%. It is estimated that one could produce perhaps 1600 gallons of sweet sorghum juice with good yields and a modern press, yielding about 200 gallons of ethanol per acre with proper equipment to ferment and distill the juice.

Sugarbeets as an ethanol crop. Sugar beets are widely grown for commercial sugar production in some north-central states. Test plots of sugar beet (variety 5310) were planted at Borderview and State Line farms in mid-May. The plots at the latter farm failed due to wet weather in May, but the small plots in Alburg did well, yielding an impressive 57.8 T/acre. The roots were very large, and high in sugar.

During commercial processing, sugar beets are cut into slices and soaked in water to remove the sugar before processing. In a simple on-farm test, the roots were simply pressed and the juice extracted, yielding a 9% brix solution. Sugar beets appear to have potential for on-farm ethanol production in Vermont if suitable processing equipment is available, such as modern screw-type press.

Regulatory Issues. There are many rules, regulations, and taxes at both the state and federal level that apply to the production and sale of fossil fuels and in some cases local health, safety and zoning ordinances may be applicable. The extent to which these regulatory issues might affect the on-farm production and use of vegetable oil and/or biodiesel made from vegetable oil is an important consideration that needs clarification before farmers and others move forward to develop new bio-based fuel enterprises. I asked two students at Vermont Law School, Laura Furey and Mark Seltzer, to look into some of these issues, and memos with their findings are appended.

The first memo (p. 29) provides an overview of 'On-site Oil Seed Processing and the Law" including permits and taxation. The second memo (p.33) addresses whether bio-fuels must be dyed for agricultural use. The third document (p. 37) is a description of how California Biofuels User Groups system came into being, allowing the use of B-100 outside of the normal fuel regulations. This could be a model for forming a similar user group in Vermont, perhaps comprised of farmers. In short, in 2004 the California Division of Measurement Standards and Office of Administrative Law signed off on state regulations that allow the legal purchase of B100 as a 'developmental fuel' providing certain regulatory exemptions. This was based on the Code of Federal Regulations provisions which provide an exception for registration of fuels that are in a developmental or research phase:

40 C.F.R. § 79.4 Requirement of registration.
(a) Fuels.
(3) Any designated fuel that is (i) in a research, development, or test status; (ii) sold to automobile, engine, or component manufacturers for research, development, or test purposes; or (iii) sold to automobile manufacturers for factory fill, and is not in any case offered for commercial sale to the public, shall be exempt from registration.

Economic Analysis. Enterprise budgets are available for oil seed and sugar crops in traditional growing regions (see references), but the reality will vary across farms and regions, depending on the value of farm labor, the cost of using equipment, and the market price. A full economic picture must also consider value-added products, their markets, and all the crops in the rotation. Here is an initial attempt at doing that:

Canola enterprise budgets for conventional spring production suggest operating costs between $100 and $200/acre. Specifically, $107 (north-central N. Dakota, 2007); $121/acre (Oklahoma 2005), $136/acre (High Plains 2006), $142 (Maine 2003), and $206 (Ontario 2007). Given that many Vermont farms will be less specialized and have small fields, costs can be assume to be somewhat higher. Organic production may add some costs, too, depending on whether organic fertilizers or insecticides are required; but costs may also be lower if manure is available for fertility and good crop rotations reduce the need for weed cultivation. A range of $150-$250/A in production costs for Vermont is a reasonable assumption, including modest fixed costs.

Sunflower enterprise budgets for conventional oil-seed production range from $92 (north-central N. Dakota, 2007); $107 (Nebraska 2006); to $234 (Kansas, 2006). Here again, assuming a range of total production costs from $150 to $250 per acre for VT seems reasonable, and the enterprise budget at State Line Farm is about in the middle of that.

2006 Oil Seed Crop Production Costs at State Line Farm (per acre)

	canola	sunflower
1 soil test ($10+postage, labor 1 hr (for 10A)	$ 4	$ 4
15 T farm manure (@ $5/T value)	---	$ 75
1/2 ton 4-3-3 organic fertilizer	$100	---
seed (6 lb @ $4; 4 lb@ $4)	$ 24	$ 16
spread manure (1 hr) or fert. (1/2 hr)	$ 15	$ 30
plow, disk (1/2 hr.)	$ 15	$ 15
cultivate weeds 2x	---	$ 30
harvest, incl. empty combine into bins	$ 30	$ 45
winter cover crop with rye (disk, seed,etc.)	$ 40	---
Total per acre variable costs..	*$228*	*$215*

Production costs will vary from farm to farm and from year to year, as will yields and prices for oil and seed meal. The following chart is one attempt to look at a range of possible net returns per acre from canola.

seed yield	oil produced	seed meal	..…….returns/acre*……......			
(lb / acre)	(gallons)	(pounds)	low	med	high	future?
1,500	69	840	$201	$291	$402	$554
2,000	92	1180	$334	$476	$668	$1052

* low = $2/gal oil, $150/ton meal   med = $3/gal oil, $200/ton meal
high = $4 gal/oil, $300/ ton meal   future? = $6 gal/oil, $500/ton meal

Variable and fixed production costs must be subtracted from gross returns. Costs could be lowered by using on-farm biodiesel, and a sustainable cropping system to provide ‘free’ nitrogen and pest suppression.

Estimated costs and returns for on-farm oil seed production and processing.

Crop production

	Low*	High*
Variable Production costs (labor, equipment, inputs/acre)	$150	$250
Fixed production costs (land, taxes, etc/acre)	$ 25	$ 50
Average oil production/acre	50 gal	100 gal
Average seed meal production/acre	1000 lb	2000 lb
Value of virgin (for fuel, soapmaking, etc. not food)	$2 gal	$4 gal
Value of seed meals for animal feed	$200/ton	$500/ton

* estimated range of costs for canola or sunflower crops, farms, growing systems

Net returns/acre range from (-$100) to $700

Taking an rough average of $200 total production costs and yield of 75 gallons of oil @ $2.50/gal plus 1500 lb of seed meal @ $350/ton, then average net return would be estimated to be $450/acre without making biodiesel (under good growing conditions).

On-Farm Oil Seed Processing

On-Farm Oil Production Equipment	
Oil Seed Press and accessories	$10,000
Oil tanks, seed meal totes,	$ 2,000
Seed storage bin and drying bin	$10,000
Seed cleaner and accessories	$ 7,000
Misc.	$ 1,000
Total	$30,000

On-Farm Biodiesel Production Equipment	
Biodiesel tanks	$12,000
Pumps, pipes, valves, fittings	$ 8,000
Boiler system	$ 5,000
Condensor, alcohol recovery	$ 2,000
Misc. supplies and equipment	$ 3,000
Fuel storage, fire suppression, etc.	$ 5,000
Total	$35,000

Total oil seed and biodiesel processing facility equipment $65,000
(not including building or ethanol production equipment)

Annual Biodiesel Production Costs

$65,000 invested in processing equipment (annual cost over 10 years including interest and maintenance)	$ 7,000
Half-time labor to run the system (wages, benefits, etc.)	$25,000
Permits, insurance, ASTM tests, repairs	$ 3,000
Total annual fuel processing cost	$35,000

Assuming production of 25,000 gallons of fuel/year (or ~500 gal/week):

Production cost/gallon = $1.40 before ingredients.
Add .2 gal methanol @ $3/gal (=$.60/gal) plus paying $2/gal for virgin oil.
Total cost would be $4/gallon to produce on-farm biodiesel.
Minus $1/gal federal incentive then *total cost = $3/gallon.*

Assuming 50,000 gallons of fuel/year (or ~1000 gal/week):

(requires an additional $15,000 for oil press and bins, tanks, and 3/4 time labor, thus increasing the annual processing costs to ~$50,000), so production cost/gallon = $1.00.
Add $.60/gal for methanol plus $2/gal for virgin oil, total cost is $3.60/gal.
Minus $1/gal federal incentive = *total cost is $2.60/gallon.*

Assuming 100,000 gallons of fuel/year (or ~2,000 gal/week = five 400 gallon batches):

(This requires an additional $25,000 for oil press and bins, and full-time labor, thus increasing The annual processing costs to ~ $88,000, so production cost/gallon = $.88.
Add $.60/gal for methanol plus $2/gal for virgin oil, total cost is $3.48/gal.
Minus $1/gal federal incentive = *total cost is $2.48/gallon.*

Land required for community-scale on-farm biodiesel production.

Assuming that a sustainable crop rotation plan to produce oil seed crops (canola, soy, sunflower) requires at least half the land to be in legumes for nitrogen for fertility, as well as silage corn and/or sweet sorghum to break pest cycles, then the following amount of land would be needed to produce on-farm biodiesel:

	Annual production of biodiesel		
	25,000 gal	50,000 gal	100,000 gal
At 50 gal oil/acre:	1,000 acres	2,000 acres	4,000 acres
At 75 gal oil/acre:	667 acres	1,333 acres	2,666 acres
At 100 gal oil/acre:	500 acres	1,000 acres	2,000 acres

Sustainable cropping system gross returns - one scenario of yields, costs, and prices:

4 year 'community' crop rotation for producing 25,000 gallons of on-farm biodiesel

	Gross	Net*
250 acres canola @ 1500 lb/acre		
69 gal oil/acre (Maine data) x $3/gallon = $52,000	$ 73,000	$22,000
840 lb meal/acre x $200/ton = $21,000		
250 acres soybean @ 30 bu/acre with 18% oil		
42 gal oil/acre x $3/gal = $31,500	$ 69,000	$39,000
1500 lb meal x $200/ton = $37,500		
200 acres silage corn @ 20 tons/acre x $25/ton	$100,000	$35,000
50 acres sorghum@10 ton/acre=200 gal ethanol x $3/gal	$ 30,000	$16,000
250 acres clover/alfalfa (also replaces 100 lb/acre N fertilizer)		
2 cuts legume hay = 3 ton/acre x $125 / ton	$ 94,000	$48,000
Total gross/net returns for 1,000 acre crop rotation system:	$ 366,000	$160,000

*Variable costs: canola $204/A (Maine), soybean $119/A, corn $326/A, alfalfa $182/A, sorghum $287/A (Penn State: http://agguide.agronomy.psu.edu/cm/sec12/sec12toc.cfm)

Additional references and useful links.

Canola Fact Sheets – Ontario
http://www.omafra.gov.on.ca/english/crops/field/canola.html

Canola Production – N. Dakota
http://www.ag.ndsu.edu/pubs/plantsci/crops/a686w.htm

Canola Production and Management – Manitoba
http://www.gov.mb.ca/agriculture/crops/oilseeds/bga01s01.html

Canola Production Guidelines – Maryland
http://www.agnr.umd.edu/MCE/Publications/PDFs/FS635.pdf

2006 Canola Variety Trials – 3 year mean - Ontario
http://www.ontariocanolagrowers.ca/Publications/2006%20Canola%20Performance%20Data.pdf

Spring Canola – Maine
http://www.umext.maine.edu/onlinepubs/htmpubs/2438.htm

Sunflower Production – N. Dakota
http://www.ag.ndsu.edu/pubs/plantsci/rowcrops/eb25w-2.htm

High Plains Sunflower Production Handbook – Kansas
http://www.oznet.ksu.edu/library/crpsl2/MF2384.pdf

Sunflower Production and Management – Manitoba
http://www.gov.mb.ca/agriculture/crops/oilseeds/bgd01s01.html

Sunflower Production – Purdue Univ.
http://www.hort.purdue.edu/newcrop/afcm/sunflower.html

Production of Sweet Sorghum for Syrup in Kentucky
http://www.ca.uky.edu/agc/pubs/agr/agr122/agr122.htm

Sources of Sweet Sorghum Seed
http://www.ca.uky.edu/nssppa/production.html#seed

Sorghum – for Syrup (and ethanol info) Purdue Univ.
http://www.hort.purdue.edu/newcrop/afcm/syrup.html

Soybean yield Vermont - UVM
www.uvm.edu/pss/vtcrops/research/SoybeanTrialBoyden.pdf

Biomass Production and Ethanol Potential from Sweet Sorghum
http://www.leopold.iastate.edu/research/grants/1995/1991-46_Sweet_Sorghum_for_Ethanol_%5B_Energy_%5D.pdf

Biomass Oil Analysis – National Renewable Energy Lab
http://www.nrel.gov/docs/fy04osti/34796.pdf

Comprehensive biofuels site
www.journeytoforever.org

Clipper grain cleaners, Dickey John moisture tester
www.seedburo.com

Poly dome grain bins
www.americanroyal.net/page/page/3244987.htm

Dairy One

FORAGE TESTING LABORATORY
DAIRY ONE, INC.
730 WARREN ROAD
ITHACA, NEW YORK 14850
607-257-1272 (fax 607-257-1350)

Sample Description	Farm	Code	Sample
CANOLA MEAL, Dry		615	10776030

Sampled	Recvd	Printed	ST	CO
	01/08/07	01/11/07		

MECHANICAL PRESS CANOLA MEAL
VERN GRUBINGER
UNIV OF VERMONT
11 UNIVERSITY WAY
BRATTLEBORO, VT 05301

ENERGY TABLE - NRC 2001
BW = 1350 Fat% = 3.7 Tprot% = 3.1

Milk, Lb	NEL Mcal/Lb	NEL Mcal/Kg	Milk, Kg
Dry	1.37	3.03	Dry
40	1.32	2.92	18
60	1.28	2.82	27
80	1.23	2.70	36
100	1.16	2.56	45
120+	1.09	2.41	54+

NEM3X	1.22	2.68	
NEG3X	0.87	1.91	
ME1X	1.98	4.37	
DE1X	2.11	4.65	
TDN1X,%	100		

COMMENTS:

1. THIS SAMPLE WAS TESTED TWICE FOR CRUDE PROTEIN TO CONFIRM THE VALUE LISTED.
2. NRC ENERGIES - SMALL BREEDS - DO NOT USE ENERGIES BEYOND 80 LBS. MILK. LARGE BREEDS - USE 120 LB. ENERGY WITH EXTREME CAUTION.

Analysis Results

Components	As Fed	DM
% Moisture	11.0	
% Dry Matter	89.0	
% Crude Protein	30.9	34.7
% Available Protein	29.5	33.2
% ADICP	1.3	1.5
% Adjusted Crude Protein	30.4	34.2
Soluble Protein % CP		73
% NDICP	4.0	4.5
% Acid Detergent Fiber	26.0	29.2
% Neutral Detergent Fiber	31.0	34.9
% Lignin	7.4	8.3
% NFC	1.2	1.4
% NSC	8.2	9.2
% Starch	.7	.8
% Sugar	7.5	8.4
% Crude Fat	25.4	28.5
% Ash	4.57	5.13
% TDN	89	100
NEL, Mcal/Lb	1.08	1.21
NEM, Mcal/Lb	1.17	1.31
NEG, Mcal/Lb	.84	.94
% Calcium	.62	.70
% Phosphorus	.84	.95
% Magnesium	.30	.34
% Potassium	.94	1.06
% Sodium	.005	.005
PPM Iron	51	58
PPM Zinc	39	43
PPM Copper	2	2
PPM Manganese	44	49
PPM Molybdenum	.8	.9
% Sulfur	.39	.44
% Chloride Ion	.12	.13
Horse TDN, %	50	56
Horse DE, Mcal/lb	1.00	1.12

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FORAGE TESTING LABORATORY
DAIRY ONE, INC.
730 WARREN ROAD
ITHACA, NEW YORK 14850
607-257-1272 (fax 607-257-1350)

Sample Description	Farm	Code	Sample
SUNFLOWER MEAL, Dry		688	10776040

Sampled	Recvd	Printed	ST	CO
	01/08/07	01/11/07		

MECHANICAL PRESS SUNFLOWER MEAL
VERN GRUBINGER
UNIV OF VERMONT
11 UNIVERSITY WAY
BRATTLEBORO, VT 05301

ENERGY TABLE - NRC 2001
BW = 1350 Fat% = 3.7 Tprot% = 3.1

Milk, Lb	NEL Mcal/Lb	NEL Mcal/Kg	Milk, Kg
Dry	1.12	2.48	Dry
40	1.08	2.39	18
60	1.04	2.30	27
80	1.00	2.20	36
100	0.95	2.09	45
120+	0.89	1.95	54+
NEM3X	1.01	2.23	
NEG3X	0.70	1.54	
ME1X	1.65	3.64	
DE1X	1.79	3.95	
TDN1X,%	87		

COMMENTS:

1. THIS SAMPLE WAS TESTED TWICE FOR CRUDE PROTEIN TO CONFIRM THE VALUE LISTED.
2. NRC ENERGIES - SMALL BREEDS - DO NOT USE ENERGIES BEYOND 80 LBS. MILK. LARGE BREEDS - USE 120 LB. ENERGY WITH EXTREME CAUTION.

Analysis Results

Components	As Fed	DM
% Moisture	4.2	
% Dry Matter	95.8	
% Crude Protein	22.2	23.2
% Available Protein	21.2	22.2
% ADICP	1.0	1.1
% Adjusted Crude Protein	22.2	23.2
Soluble Protein % CP		42
% NDICP	1.2	1.3
% Acid Detergent Fiber	29.0	30.3
% Neutral Detergent Fiber	48.8	50.9
% Lignin	9.7	10.1
% NFC	N/A	N/A
% NSC	7.0	7.3
% Starch	1.2	1.3
% Sugar	5.7	6.0
% Crude Fat	23.0	24.0
% Ash	5.05	5.27
% TDN	83	87
NEL, Mcal/Lb	1.00	1.05
NEM, Mcal/Lb	1.04	1.09
NEG, Mcal/Lb	.73	.76
% Calcium	.35	.37
% Phosphorus	.92	.96
% Magnesium	.44	.46
% Potassium	1.37	1.43
% Sodium	.003	.003
PPM Iron	78	81
PPM Zinc	77	80
PPM Copper	27	29
PPM Manganese	32	33
PPM Molybdenum	.5	.5
% Sulfur	.28	.29
% Chloride Ion	.09	.09
Horse TDN, %	52	55
Horse DE, Mcal/lb	1.05	1.09

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FORAGE TESTING LABORATORY
DAIRY ONE, INC.
730 WARREN ROAD
ITHACA, NEW YORK 14850
607-257-1272 (fax 607-257-1350)

Sample Description	Farm	Code	Sample
SOYBEAN MEAL, Dry		681	10776020

Sampled	Recvd	Printed	ST	CO
	01/08/07	01/11/07		

MECHANICAL PRESS SOYBEAN MEAL
VERN GRUBINGER
UNIV OF VERMONT
11 UNIVERSITY WAY
BRATTLEBORO, VT 05301

ENERGY TABLE - NRC 2001
BW = 1350 Fat% = 3.7 Tprot% = 3.1

Milk, Lb	NEL Mcal/Lb	NEL Mcal/Kg	Milk, Kg
Dry	1.23	2.70	Dry
40	1.18	2.60	18
60	1.14	2.51	27
80	1.09	2.40	36
100	1.03	2.27	45
120+	0.96	2.13	54+
NEM3X	1.14	2.52	
NEG3X	0.81	1.78	
ME1X	1.83	4.04	
DE1X	2.00	4.40	
TDN1X,%	92		

COMMENTS:

1. THIS SAMPLE WAS TESTED TWICE FOR CRUDE PROTEIN TO CONFIRM THE VALUE LISTED.
2. NRC ENERGIES - SMALL BREEDS - DO NOT USE ENERGIES BEYOND 80 LBS. MILK. LARGE BREEDS - USE 120 LB. ENERGY WITH EXTREME CAUTION.

Analysis Results

Components	As Fed	DM
% Moisture	6.9	
% Dry Matter	93.1	
% Crude Protein	37.3	40.0
% Available Protein	36.2	38.9
% ADICP	1.1	1.1
% Adjusted Crude Protein	37.3	40.0
Soluble Protein % CP		38
% NDICP	3.5	3.7
% Acid Detergent Fiber	10.7	11.5
% Neutral Detergent Fiber	16.9	18.1
% Lignin	2.1	2.2
% NFC	24.8	26.7
% NSC	18.5	19.9
% Starch	2.4	2.5
% Sugar	16.2	17.4
% Crude Fat	12.0	12.9
% Ash	5.61	6.03
% TDN	86	92
NEL, Mcal/Lb	.97	1.04
NEM, Mcal/Lb	1.03	1.11
NEG, Mcal/Lb	.73	.78
% Calcium	.16	.17
% Phosphorus	.84	.90
% Magnesium	.26	.28
% Potassium	2.34	2.52
% Sodium	<.001	.001
PPM Iron	131	141
PPM Zinc	56	61
PPM Copper	23	25
PPM Manganese	23	24
PPM Molybdenum	1.7	1.8
% Sulfur	.31	.33
% Chloride Ion	.08	.09
Horse TDN, %	73	78
Horse DE, Mcal/lb	1.46	1.56

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Dairy One

FORAGE TESTING LABORATORY
DAIRY ONE, INC.
730 WARREN ROAD
ITHACA, NEW YORK 14850
607-257-1272 (fax 607-257-1350)

Sampled	Recvd	Printed	ST	CO
	04/17/07	04/26/07		

SUNFLOWER 305 DMR
DORN COX
11 RANDALL RD
DURHAM, NH 03824

ENERGY TABLE - NRC 2001

BW = 1350 Fat% = 3.7 Tprot% = 3.1

Milk, Lb	NEL Mcal/Lb	NEL Mcal/Kg	Milk, Kg
Dry	1.22	2.69	Dry
40	1.17	2.59	18
60	1.13	2.50	27
80	1.08	2.39	36
100	1.03	2.26	45
120+	0.96	2.12	54+

NEM3X	1.10	2.43
NEG3X	0.78	1.71
ME1X	1.79	3.95
DE1X	1.93	4.26
TDN1X,%	93	

COMMENTS:

1. THIS SAMPLE WAS TESTED TWICE FOR CRUDE PROTEIN, LIGNIN, ACID DETERGENT FIBER, NEUTRAL DETERGENT FIBER AND CRUDE FAT TO CONFIRM THE VALUES LISTED.
2. NRC ENERGIES - SMALL BREEDS - DO NOT USE ENERGIES BEYOND 80 LBS. MILK. LARGE BREEDS - USE 120 LB. ENERGY WITH EXTREME

Sample Description	Farm	Code	Sample
SUNFLOWER MEAL, Dry		688	11025390

Analysis Results

Components	As Fed	DM
% Moisture	7.6	
% Dry Matter	92.4	
% Crude Protein	24.8	26.8
% Available Protein	24.2	26.2
% ADICP	.6	.7
% Adjusted Crude Protein	24.8	26.8
Soluble Protein % CP		52
% NDICP	1.6	1.7
% Acid Detergent Fiber	20.2	21.8
% Neutral Detergent Fiber	27.7	30.0
% Lignin	6.2	6.7
% NFC	15.2	16.4
% Starch	.7	.8
% ESC (Simple Sugars)	5.0	5.4
% Crude Fat	20.4	22.1
% Ash	5.87	6.36
% TDN	86	93
NEL, Mcal/Lb	1.02	1.10
NEM, Mcal/Lb	1.10	1.19
NEG, Mcal/Lb	.78	.84
% Calcium	.35	.38
% Phosphorus	1.02	1.11
% Magnesium	.54	.58
% Potassium	1.44	1.56
% Sodium	.002	.002
PPM Iron	151	163
PPM Zinc	61	66
PPM Copper	20	22
PPM Manganese	30	33
PPM Molybdenum	.5	.5
% Sulfur	.30	.32
% Chloride Ion	.11	.12
Horse TDN, %	60	65
Horse DE, Mcal/lb	1.20	1.30

MORE ->

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Dairy One

FORAGE TESTING LABORATORY
DAIRY ONE, INC.
730 WARREN ROAD
ITHACA, NEW YORK 14850
607-257-1272 (fax 607-257-1350)

Sample Description	Farm	Code	Sample
SUNFLOWER MEAL, Dry		688	11025400

Sampled	Recvd	Printed	ST	CO
	04/17/07	04/26/07		

SUNFLOWER 343 DMR
DORN COX
11 RANDALL RD
DURHAM, NH 03824

ENERGY TABLE - NRC 2001
BW = 1350 Fat% = 3.7 Tprot% = 3.1

Milk, Lb	NEL Mcal/Lb	NEL Mcal/Kg	Milk, Kg
Dry	1.29	2.84	Dry
40	1.24	2.74	18
60	1.20	2.64	27
80	1.15	2.53	36
100	1.09	2.40	45
120+	1.02	2.25	54+
NEM3X	1.15	2.53	
NEG3X	0.81	1.79	
ME1X	1.87	4.12	
DE1X	2.01	4.42	
TDN1X,%	98		

COMMENTS:

1. THIS SAMPLE WAS TESTED TWICE FOR CRUDE PROTEIN, LIGNIN, ACID DETERGENT FIBER, NEUTRAL DETERGENT FIBER AND CRUDE FAT TO CONFIRM THE VALUES LISTED.
2. NRC ENERGIES - SMALL BREEDS - DO NOT USE ENERGIES BEYOND 80 LBS. MILK. LARGE BREEDS - USE 120 LB. ENERGY WITH EXTREME

Analysis Results

Components	As Fed	DM
% Moisture	5.8	
% Dry Matter	94.2	
% Crude Protein	21.6	23.0
% Available Protein	21.3	22.6
% ADICP	.3	.3
% Adjusted Crude Protein	21.6	23.0
Soluble Protein % CP		53
% NDICP	1.8	1.9
% Acid Detergent Fiber	24.8	26.3
% Neutral Detergent Fiber	30.5	32.3
% Lignin	7.2	7.6
% NFC	14.0	14.9
% Starch	.9	.9
% ESC (Simple Sugars)	5.1	5.4
% Crude Fat	25.0	26.5
% Ash	4.93	5.23
% TDN	92	98
NEL, Mcal/Lb	1.11	1.18
NEM, Mcal/Lb	1.20	1.28
NEG, Mcal/Lb	.86	.92
% Calcium	.30	.32
% Phosphorus	.94	1.00
% Magnesium	.50	.53
% Potassium	1.22	1.30
% Sodium	.002	.002
PPM Iron	184	196
PPM Zinc	61	64
PPM Copper	20	21
PPM Manganese	28	29
PPM Molybdenum	.6	.7
% Sulfur	.26	.28
% Chloride Ion	.10	.11
Horse TDN, %	56	60
Horse DE, Mcal/lb	1.12	1.19
MORE ->		

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Memorandum - On-site Oil Seed Processing and the Law

To: Vern Grubinger
From: Mark Seltzer and Laura Furrey
CC: Michael Dworkin
Date: May 17, 2007
Re: On-site Oil Seed Processing and the Law

Disclaimer

This memorandum is a student research product, based upon factual assumptions that you provided to us, and is intended to assist and expedite a professional assessment of this matter. It does not purport to be, and is not the equivalent of, the work of a licensed professional with expertise in this area. Before making significant decisions on this matter, it would be appropriate to consider consultation with a licensed professional with expertise in this field.

Introduction

The use of alternative fuels is becoming more of a viable energy source for many consumers that traditionally have relied on fossil fuels. This is especially true when applied to farms and farming communities where alternative energy resources are produced and processed on-site. In the context of alternative fuel production, issues around meeting federal fuel standards and paying certain taxes (or receiving certain tax credits) may be minimized or avoided, if the fuel is used in privately-owned farm equipment and not sold or otherwise introduced into commerce. There are a variety of factors to consider in determining whether on-site alternative fuel production is a feasible option for a particular farm.

Tax Implications

Form 637 is the Application for Registration for certain excise tax activities. On-site oil seed processing could fall into a few different listed categories on the form, depending on the operation. Activity "AB" is for producers and importers of agri-biodiesel[1], "AF" is for producers and importers of alcohol, "NB" is for producers and importers of biodiesel, other than agri-biodiesel, and renewable biodiesel. The required information asks for the annual volume of agri-biodiesel, alcohol, or biodiesel being bought, sold, traded, transferred, or exchanged. Additionally, activity "AL" is applicable to an alternative fueler that sells for use or uses alternative fuel as a fuel in a motor vehicle or motorboat.[2] This could be applicable if the biodiesel is being used in vehicles that will be traveling on the public highway.[3]

Permits and Regulations

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[1] The definition of agri-biodiesel is biodiesel produced from virgin vegetable oils derived from corn, soybeans, sunflower seeds, canola, cottonseeds, crambe, rapeseeds, safflowers, flaxseeds, rice bran, and mustard seeds, as well as from animal fats. http://www.irs.gov/irb/2005-35_IRB/ar18.html#d0e2849

[2] IRS Form 637 (Rev. 10-2006). Available at http://www.irs.gov/pub/irs-pdf/f637.pdf

[3] In Vermont, a "motor vehicle" is defined as " any self-propelled vehicle using fuel on the public highways and registered or required to be registered for operation thereon." 23 V.S.A. § 3002(5).

Depending on the operation, a variety of permits could be required. Most permits are based on local regulations and requirements. It would be advisable to seek the assistance of the town clerk, the zoning administrator, the planning commission, or public works prior to beginning any projects or when making substantial changes to existing operations.

Local Building Codes and Zoning requirements, if any, must be complied with. Construction Permits can be obtained from the Vermont Department of Public Safety. All construction permits, and a change in use of an existing building, require approval from the Commissioner and/or staff members of the Division of Fire Safety.[4]

According to the Vermont Fire and Safety Code, the installation of any boiler or pressure vessel shall be reported to the "Authority Having Jurisdiction" which is the Commissioner and staff members of the Division of Fire Safety. The report should include the location, type, capacity, age and date of installation of any boiler or pressure vessel.[5] Additionally, the boiler or pressure vessel needs to be inspected by a commissioned inspector and found to be in compliance with the Vermont Fire and Safety Code.[6] The Department of Public Safety should also be contacted regarding the safe storage and use of methanol. Often the level of regulatory concern is directly related to how much of the process chemicals and the oil or biodiesel are stored on site, as well as the producer's storage and operating practices.[7]

There is also the possibility that a number of environmental permits may be needed, again, depending on the process.

Although no fossil fuels are being burned and the facility cannot be characterized as a pollutant source subject to the Clean Air Act emission standards, methanol is listed as a hazardous air pollutant under the Clean Air Act.[8] There could be permitting involved if excessive quantities of methanol are being vented from the biodiesel process.

There are also waste disposal considerations when processing biodiesel. With wastewater, it is important to consider any wash that is being used and discarded. The biggest concern could be the presence of methanol. If methanol is present in the wastewater, it could be classified as a spent solvent which is categorized under the Resource Conservation and Recovery Act (RCRA) as a hazardous waste from a nonspecific source (F003) and must be managed according to State and/or Federal regulations.[9] Depending on the method of wastewater discharge which could be to the municipal sanitary sewer, to a septic system, or directly into a nearby body of water, different standards and regulations apply.

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[4] Vermont Fire and Safety Code 2005, Section 4. Available at www.vermontfuel.com; See http://www.dps.state.vt.us/fire/fireprevention.htm for permit applications.
[5] Vermont Fire and Safety Code 2005, Section 3(c). Available at www.vermontfuel.com
[6] Vermont Fire and Safety Code 2005, Section 3(d). Available at www.vermontfuel.com
[7] Alovert, Maria, Small Scale Commercial Production: Local B100 and Why "Niche Markets" Matter: A US Bioidiesel Industry Primer. Available at http://www.localb100.com/industry.html.
[8] Clean Air Act §112(b), 42 U.S.C. §7412(b) (1990).
[9] See 40 C.F.R. 261.31 (2006).

Additionally, any solid wastes resulting from the process could be regulated under RCRA if they exhibit one of four hazardous characteristics (Ignitability, Corrosivity, Reactivity, Toxicity) or if the waste is specifically listed as hazardous waste in Environmental Protection Agency's (EPA) regulations.[10] Municipal solid waste disposal facilities should be consulted regarding disposal of any solid waste. Certain RCRA regulations could be avoided if a closed-loop system is in place, the solid waste was recycled into a useful product, or if it is not stored on-site for more than 90 days.

It is advisable to check with a Natural Resource Permit Specialist regarding any environmental permits that may be necessary as a result of biodiesel production. These permits should be obtained prior to the commencement of construction of any projects. A local permit specialist can be located at the Vermont Agency of Natural Resources website.[11]

Currently, there does not appear to be a fuel dealer's license applicable to the distribution of biodiesel in Vermont. A diesel fuel dealer's license in Vermont is only necessary if you are a dealer[12] or distributor[13] of diesel fuel[14] which is being used in motor vehicles. However, the term motor vehicle applies only to vehicles that are used on the public highway.[15] If the biodiesel is being sold to others for use in motor vehicles which will be used on the public highway, then a diesel fuel dealer's license may be needed and an application should be filed with the Commissioner of Motor Vehicles at the Department of Motor Vehicles.[16]

There is some indication that small scale commercial production of biodiesel falls under the same set of regulations as other small oleo-chemical operations, such as soap or detergent manufacturing, rather than those regulations governing petroleum refining, which in general should not apply to the processes utilized in biodiesel manufacturing. Creating a working relationship with your local zoning board and the appropriate regulatory agencies is important to ensuring that your operation not be regulated like a petroleum refinery or petroleum distribution business.[17]

Unresolved Issues

[10] See 40 C.F.R. 261.30 (2006).

[11] http://www.anr.state.vt.us/dec/ead/pa/index.htm (We have sent an email requesting information to the permit specialist for Shaftsbury, Vermont, Rick Oberkirch, although we have been unable to contact him by phone.)

[12] 23 V.S.A. §3002(2) "Dealer" means any person who sells or delivers fuel into the fuel supply tanks of motor vehicles owned or operated by others.

[13] 23 V.S.A §3002(3) "Distributor" means (any person who sells or delivers fuel into bulk storage tanks of a dealer or user.

[14] 23 V.S.A. §3002(4) "Fuel" means clear diesel fuel that has not been dyed….and any blend of undyed diesel and other fuel used or suitable for use fuel for the generation of power to propel motor vehicles.

[15] 23 V.S.A. §3002(5): "Motor vehicle" means any self-propelled motor vehicle using fuel on the public highways and registered or required to be registered for operation thereon.

[16] Dealer's and distributor's licenses; application; issuance 23 V.S.A. §3005 (1985).

[17] Alovert, Maria, Small Scale Commercial Production: Local B100 and Why "Niche Markets" Matter: A US Bioidiesel Industry Primer. Available at http://www.localb100.com/industry.html.

All producers of biodiesel are required to register with the EPA as a fuel manufacturer if their product will be introduced into commerce in the United States. One requirement of this registration is access to health affects testing data on the fuel being registered. However, the EPA allows this access to be given from a "group" who has completed this testing previously and has such data on file with the EPA. The NBB completed this testing in 1997 and grants access to this date to all of its Biodiesel Processor and Small Producer members free of charge.[18] A non-voting, small producer member manufactures less than 250,000 gallons of biodiesel annually. Additionally, to become a member of the NBB the producer must verify that "it will process only biodiesel that is registered with the EPA pursuant to the Clean Air Act regulations found at 40 C.F.R. Part 79."[19]

These regulations, under 40 C.F.R. §79.2(c), define "fuel" as "any material which is capable of releasing energy or power by combustion or other chemical or physical reaction."[20] Under 40 C.F.R. §79.2(d), a "fuel manufacturer" is defined as "any person who, for sale or introduction into commerce, produces, manufactures, or imports a fuel or causes or directs the alteration of the chemical composition of a bulk fuel, or the mixture of chemical compounds in a bulk fuel, by adding to it an additive…"[21] These definitions, in addition to the requirement of registration in 40 C.F.R. §79.4[22], are an indication that if the fuel is not being offered for sale, introduced into commerce (through trade or barter, for example), or is in a development or test status, it might be exempt from registration.

It is unclear whether any registration is required if the biodiesel is not ASTM certified, does not meet EPA requirements, and is not being sold, traded, or otherwise "introduced into commerce in the United States." It is also unclear what is a "designated fuel" under 40 C.F.R. §79.4. We currently have an email with unresolved questions being reviewed by a staff member of the National Biodiesel Board (NBB). Also, many of the tax implications and credits depend on whether the final B100 product from on-site oil processing can legally be titled "biodiesel," which requires ASTM D6751 certification and registration with the EPA.

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[18] http://www.biodiesel.org/members/info/add_prod.shtm
[19] http://biodiesel.org/members/membershippacket/NBBMembershipPacket.pdf
[20] 40 C.F.R. §79.2(c)
[21] 40 C.F.R. §79.2(d)
[22] 40 C.F.R. § 79.4 Requirement of registration.
(a) Fuels:
(1) No manufacturer of any fuel designated under this part shall, after the date prescribed for such fuel in this part, sell, offer for sale, or introduce into commerce such fuel unless the Administrator has registered such fuel.
(3) Any designated fuel that is (i) in a research, development, or test status; (ii) sold to automobile, engine, or component manufacturers for research, development, or test purposes; or (iii) sold to automobile manufacturers for factory fill, and is not in any case offered for commercial sale to the public, shall be exempt from registration.

Memorandum – Fuel dye and tax requirements

To: Vern Grubinger
From: Mark Seltzer
CC: Michael Dworkin
Date: May 17, 2007
Re: Fuel dye and tax requirements.

Disclaimer:
This memorandum is a student research product, based upon factual assumptions that you provided to us, and is intended to assist and expedite a professional assessment of this matter. It does not purport to be, and is not the equivalent of, the work of a licensed professional with expertise in this area. Before making significant decisions on this matter, it would be appropriate to consider consultation with a licensed professional with expertise in this field.

Purpose of Memo:

Determine whether bio-fuels must be dyed for off road, non-taxable use.

Answer:

Fuels such as kerosene and diesel fuels which are not subject to taxes are traditionally required to be dyed with "Solvent Red 164"[23] to distinguish these fuels from fuels which are taxed.

Unlike kerosene and diesel fuel, 100% bio-fuel "liquid"[24] does not need to be dyed for off-road untaxed use according to state and federal legislation. If the fuel is blended with off-road diesel untaxed or kerosene, dyeing requirement should be followed. For example: 20% biodiesel mixed with 80% off-road diesel should be appropriately dyed.[25]

Reference Material:

- **Vermont Statutes: Diesel Fuel Tax 23 V.S.A. §3002:**
  - "…(4) "Fuel" means clear *diesel fuel* that has not been dyed in accordance with 26 U.S.C. § 4082 or section 211(I) of the Clean Air Act and any blend of undyed diesel and other fuel used or suitable for use for the generation of power to propel *motor vehicles.[emphasis added]"*
    - The term "motor vehicles" has been defined under paragraph (5) of this statute as a: "vehicle using fuel on the *public highways [emphasis added]* and registered or required to be registered for operation thereon…"
    - The term "use" has been defined under paragraph (9) to mean "..the consumption of fuel by a user to propel motor vehicles on the highways of the state….."

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[23] *See* 26 CFR 48.4082-1(b)(1)
[24] *See* 26 USC 4041(b)(1)(a)
[25] http://www.biodiesel.org/news/taxincentive/Biodiesel%20Tax%20Credit%20NBB%20Issue%20Breif.pdf (last visited 3/6/2007)

- **US Code:** Exemptions for diesel fuel and kerosene **26 U.S.C. § 4082(a)(1)**
  "which the Secretary determines is destined for a nontaxable use, (2) which is indelibly dyed by mechanical injection in accordance with regulations which the Secretary shall prescribe, and (3) which meets such marking requirements (if any) as may be prescribed by the Secretary in regulations. Such regulations shall allow an individual choice of dye color approved by the Secretary or chosen from any list of approved dye colors that the Secretary may publish."

- **Clean Air Act:** Regulation of fuels **42 U.S.C. § 7545(i) -**Specifically deals with sulfur content in diesel fuel.
  - (i)(2) "…The Administrator *may require manufacturers and importers of diesel fuel [emphasis added]* not intended for use in motor vehicles to dye such fuel in a particular manner in order to segregate it from motor vehicle diesel fuel. The Administrator may establish an equivalent alternative aromatic level to the cetane index specification in paragraph(1)."

- **Regulation:** Diesel fuel and kerosene; exemption for dyed fuel- **26 CFR 48.4082-1**
  - "…(b) Dyeing requirements. Diesel fuel or kerosene satisfies the dyeing requirement of this paragraph (b) only if the diesel fuel or kerosene contains (1) The dye Solvent Red 164 (and no other dye) at a concentration spectrally equivalent to at least 3.9 pounds of the solid dye standard Solvent Red 26 per thousand barrels of diesel fuel or kerosene; or
    (2) Any dye of a type and in a concentration that has been approved by the Commissioner…"

- **US Code:** Tax Requirements: Special Fuels **26 USC 4041:** Alternative fuels.
  - "… (b) Exemption for off-highway business use. (1)(A) **"**In general. No tax shall be imposed by subsection (a) on liquids sold for use or used in an *off-highway business use [emphasis added]*…"
    - **Defined: Off-highway business use: 26 USC § 6421**(e)(2)(A) "In general. The term "off-highway business use" means any use by a person in a trade or business of such person or in an activity of such person described in section 26 USCS § 212 (relating to production of income) otherwise than as a fuel in a highway vehicle…"
  - **"(f) Exemption for farm use.—**
    - **(1) Exemption.**--Under regulations prescribed by the Secretary, no tax shall be imposed under this section on any liquid sold for use or used on a farm for farming purposes.
    - **(2) Use on a farm for farming purposes.**--For purposes of paragraph (1) of this subsection, use on a farm for farming purposes shall be determined in accordance with paragraphs (1), (2), and (3) of section 6420(c)….**"**
      - **26 USC 6420(2) defines: "**…The term "farm" includes stock, dairy, poultry, fruit, fur-bearing animal, and truck farms,

plantations, ranches, nurseries, ranges, greenhouses or other similar structures used primarily for the raising of agricultural or horticultural commodities, and orchards."

- **(a)(2)(A) Special Motor Fuels In general.—"**There is hereby imposed a tax on any liquid (other than gas oil, fuel oil, or any product taxable under section 4081)
  - **(i)** sold by any person to an owner, lessee, or other operator of a motor vehicle or motorboat for use as a fuel in *such motor vehicle_[emphasis added]*. **(ii)** used by any person as a fuel in a motor vehicle or motorboat unless there was a taxable sale of such liquid under clause (i).
  - **(B) Rate of tax.**--The rate of the tax imposed by this paragraph shall be-- **(i)** except as otherwise provided in this subparagraph, the rate of tax specified in section 4081(a)(2)(A)(i) which is in effect at the time
  - of such sale or use, and …"

Table 1: Summary of Fuel Uses

The below table is set out a comparison of different variables farmers may wish to combine. The table lists tax, dye requirements for each of these fuels. Additional requirements may exist such as Clean Air Act registration requirements. These registration requirements go beyond the scope of this research.

Use	Tax?	Dye?
Off-road vehicles used on a farm for farming purposes. (B100)	No[26]	No[27]
Off-road SVO	No[4]	No[5]
Off-road WVO	No[4]	No[5]
Off-road BioDiesel/Diesel Mix (ie: B20)	No[28]	Yes[5]
Agricultural plate vehicles.[29].(B100)	No State[8] *Federal?*	No[5]
Agricultural plate vehicles (B20)	No State[30] *Federal?*	Yes[5]
Customer Highway vehicles (B100)	Yes[31]	No[2]

[26] **26 U.S.C. §4041:** Alternative fuels. (b) Exemption for off-highway business use. (b)(1)(A) In general. No tax shall be imposed by subsection (a) on liquids sold for use or used in an off-highway business use.

[27] **26 C.F.R. § 48.4082-1** Dyeing requirements. Diesel fuel or kerosene (1) The dye Solvent Red 164 (and no other dye) at a concentration spectrally equivalent to at least 3.9 pounds of the solid dye standard Solvent Red 26 per thousand barrels of diesel fuel or kerosene…

[28] **26 U.S.C. 6420 (f)(1)** Exemption.--Under regulations prescribed by the Secretary, no tax shall be imposed under this section on any liquid sold for use or used on a farm for farming purposes.
23 V.SA.§ 3003 No tax (d)(1)(B) uses for agricultural purposes not conducted on the highways of the state

[29] **23 V.S.A. §368**. Misuse of farm registration (a) A person shall not operate or move upon a highway a motor truck, registered as a farm truck: (1) with a gross weight, including load and vehicle, exceeding the weight for which it is registered under section 367 of this title; or (2) for any purpose other than the transportation of agricultural products produced on, or materials to be used in connection with the operation of, a farm.(b) Any truck operated or moved in violation of this statute shall be required to be registered as a commercial truck and any person in violation of this section shall be fined not more than $175.00 for each offense. **23 V.S.A § 367(f)-** Addresses farm trucks.

[30] **23 V.S.A. § 3003** (d)(1) For users, the following uses shall be exempt from taxation under this chapter and be entitled to a credit for any tax paid for such uses under section 3020 of this title (F) uses by any vehicle registered as a farm truck under section 367(f) of this title.

[31] **26 U.S.C. 4041** (a)(2)(A) Special Motor Fuels In general. There is hereby imposed a tax on any liquid (other than gas oil, fuel oil, or any product taxable under section 4081) **(i)** sold by any person to an owner, lessee, or other operator of a motor vehicle or motorboat for use as a fuel in such motor vehicle. **(ii)** used by any person as a fuel in a motor vehicle or motorboat unless there was a taxable sale of such liquid under clause (i).

LEGAL AND ORGANIZATION STRUCTURE
OF BIODIESEL USER GROUPS IN CALIFORNIA

The following explains what is required to obtain a variance to the regulations in order to sell biodiesel in blends above B20 in California, which created the need for Biodiesel User Groups (B.U.G.s)

The California Department of Food and Agriculture's Division of Measurement Standards is the state agency which is responsible for regulating products sold to consumers by weight or measure. One of the prime missions of the DMS is to protect consumers by providing specifications for products sold.

To provide for the legal sale of biodiesel (B100) and high biodiesel blends (B21+) in the state, the Division of Measurement Standards (DMS) and the National Biodiesel Board (NBB) in 2003 worked together to develop regulations, and began the process of public review. B20 and below does not require a variance from the state.

At that time, if a consumer pulled up to a pump that was labeled "Biodiesel", it wasn't totally clear that the product being pumped was ASTM D6751 (B100) Biodiesel. Perhaps the pump owner heard that filtered post consumer oils were "Biodiesel", because he saw something about it on the TV news, or learned how to make biodiesel from a book. A pump could have claimed to be selling B100, but the fuel was really B20. Until the DMS provided regulations that stipulate what biodiesel is and what makes up Biodiesel Blends, consumers could not be sure of what they where putting in their vehicles.

After the first round of public review, Chevron/Texaco, the Western States Petroleum Association, the Engine Manufacturers Association, and Alliance of Automobile Manufacturers made enough negative comments that the proposed regulations went through drastic changes.

In the original proposal the DMS stipulated that Biodiesel is B100 meeting ASTM D6751 and that Biodiesel Blends must specify what the blend is (BXX) and that the biodiesel blend must be made from biodiesel D6751 and the petro must be D975.

The negative comments correctly pointed out that since the Biodiesel ASTM standards D6751 did not identify biodiesel as a fuel, but instead identified Biodiesel D6751 as "Standard Specification for Biodiesel Fuel (B100) Blend Stock for Distillate Fuels D 6751".

Note the word " Blend Stock ", that's the one that is very problematic, because it defines the standard as pertaining to biodiesel meant for blends.

Therefore forcing the DMS to regulate the sale of B100 and blends above B20 as a non-standardized fuel, because according to the existing law only diesel fuels meeting D975 could be sold in the state.

Therefore, the regulations were revised to remove B100 and non D975 compliant biodiesel blends from the authorized product list.

The proposed regulations authorizing the sale of Biodiesel Blend fuels in the state where as follows -

4147. Specifications – Biodiesel Blending Stock and Biodiesel Fuel Blends. Biodiesel Blending Stock and Biodiesel Fuel Blends shall meet the following specifications:

(1) The diesel fuel used for blending shall meet the specifications set forth by ASTM International in the latest version of "Standard Specification for Diesel Fuel Oils D 975", contained in the ASTM publication entitled: Annual Book of ASTM Standards, Section 5, Volume 05:01.

(2) Biodiesel blending stock shall meet the specifications set forth by ASTM International in the latest version of "Standard Specification for Biodiesel Fuel (B100) Blend Stock for Distillate Fuels D 6751", contained in the ASTM publication entitled: Annual Book of ASTM Standards, Section 5, Volume 05:04.

(3) Any finished biodiesel blend shall meet the specifications set forth by ASTM International in the latest version of "Standard Specification for Diesel Fuel Oils D 975", contained in the ASTM publication entitled: Annual Book of ASTM Standards, Section 5, Volume 05:01.

NOTE: Authority cited: Sections 12027 and 13450, Business and Professions Code. Reference: Sections 13401(j) and 13450, Business and Professions Code.

Another set of regulations came to pass (although at a much reduced warning level) which requires labeling on all biodiesel blend dispensers, advertising signs and storage tanks.

4148. Labeling and Price Advertising Sign Requirements for Biodiesel.

(a) Biodiesel blends shall have the words "Biodiesel fuel (BXX)", where XX represents the volume percent biodiesel in the fuel, used to describe the name of the product on all dispensers, advertising signs, and storage tank labels as required in Section 13480 and 13532 of the Business and Professions Code.

(b) Every Biodiesel blend dispenser dispensing blends greater than 5 volume percent (B5) of Biodiesel shall display on each customer side, as required by Section 13484 of the Business and Professions Code, a sign clearly visible which reads as follows:
"THIS FUEL CONTAINS BIODIESEL. CHECK THE OWNER'S MANUAL OR WITH YOUR ENGINE MANUFACTURER BEFORE USING"

NOTE: Authority cited: Sections 12027 and 13450, Business and Professions Code. Reference: Sections 13480, 13484 and 13532, Business and Professions Code.

Something to note: The above regulations did not appear to effect Biodiesel (B100), which is sold as a developmental fuel, as it is correctly, not a "Biodiesel blend".

The above regulations allowed for the sale of Biodiesel Blends in the state which topped out at around the B15 level. This is the upper end of the scale at which a blend of D975 and D6751 fuels will still be in compliance with the distillation criteria for 975.

HOWEVER, WITH MUCH INPUT FROM THE B100 COMMUNITY THE DMS IMPLEMENTED A PREEXISTING VARIANCE TO THE REGULATIONS, THAT ALLOWED FOR THE LEGAL PURCHASE OF B100 AND HIGH BIODIESEL BLENDS IN CALIFORNIA AS A DEVELOPMENTAL FUEL.

Division of Measurement Standards (DMS) Variance Info for Distributors/ Vendors

On July 19th, 2004 the Office of Administrative Law (OAL) signed off on the biodiesel regulation package. The regulations took effect on August 19, 2004. The final language reads:

Biodiesel (B100) and Biodiesel Blends (non D975) will be sold in California as "Developmental Fuels". As such, vendors who sell biodiesel/blends will need to apply for a variance outlining their compliance with the following code.

(q) "Developmental engine fuel" means any experimental automotive spark-ignition engine fuel or compression- ignition fuel which does not meet current standards established by this chapter but has characteristics which may lead to an improved fuel standard or the development of an alternative fuel standard.

13405. (a) The Department of Food and Agriculture may grant a variance from the specifications of this chapter for developmental engine fuels if all of the following conditions apply:

(1) Variances may only be granted to provide for the development of information under controlled test conditions to assist in the creation of chemical and performance standards for engine fuels.

(2) Developmental engine fuel shall only be distributed or sold to fleet-type centrally fueled vehicle and equipment users.

(3) The applicant shall warn all parties in writing of any potential risk associated with the use of the developmental engine fuel.

(4) The applicant shall report information when and as the department may prescribe in order for the department to monitor the progress of the developmental engine fuel technology evaluation.

(b) The applicant for a variance shall comply with all other requirements, terms, and conditions that are contained in regulations adopted by the department to further the purposes and administration of this section.

(c) (1) In granting a variance, the department expresses no opinion as to whether an applicant's developmental engine fuel will perform as represented by the applicant nor any opinion to the extent, if at all, that the developmental engine fuel may be safely and effectively used as a substitute for other spark-ignition or compression- ignition engine fuels without incident.

(2) Damages caused by the sale, delivery, storage, handling, and usage of the developmental engine fuel shall be addressed in accordance with contractual provisions negotiated and agreed upon by the applicant and the user.

(d) The department may withdraw a variance if the applicant does not adhere to the conditions required to obtain the variance or if the department recognizes a high probability of equipment harm with the continued use of the developmental engine fuel or to protect public safety.

This meant that consumers would be able to access and buy biodiesel and biodiesel blends which do not meet D975 through vendors which have filed for and had been granted a variance.

The variance normally allows for the development fuels to be sold to centrally fueled fleets. However, in the case of individual consumers, fuel sales will also be allowed through co-op purchase organizations and to members of “Biodiesel Users Groups”.

The Biodiesel Users Group is the mechanism vendors use to allows for the sale of the developmental fuel to individual users.

Below is a basic template of the form each new user fills out before we sell them fuel. (we have vendor reciprocity, so users only need to fill out the form once, they are given a card to show other vendors) We also have to report the anonymous quantitative data we collect on the type of vehicles, engine makes, models running on biodiesel in California quarterly to the DMS.

Even though it seams like an inconvenience many of us feel it gives us an authoritative voice when dealing with policy makers and original engine manufacturers. ..because we can give real world data on the vehicles successfully running on B100 /high blends. It also provides excellent customer service by insuring each new biodiesel user is given all the information necessary to have a successful transition to utilizing biodiesel. Which I believe creates more biodiesel advocates.

BIODIESEL USERS GROUP - Variance User Agreement Template

This agreement applies only to the below mentioned parties. This form represents a non-binding contract between (Your business name) Biodiesel Users Group. ("us") and "you."

Name: ____________ _________ _________ ___ User #: __________

Full Mailing Address:____ _________ _________ _________ _________ _______

City: ____________ _______State: ____Zip code:_______ __

Phone: ____________ ____email: ____________ _________ ____

Biodiesel Use: B20 _____B100___ ____Other (Specify) _________

Estimated Annual Use: B20 _______B100 ______Other _________

Vehicles, Vessel or Equipment using Biodiesel or Biodiesel Blends:

Make: ____________ ____Model ____________ __ Year_______

Biodiesel: Quality of the fuel is very important to all of us. Purchase only 100% biodiesel manufactured to ASTM D 6751 standards.

I. User Responsibility and Disclosure: It is the user's responsibility to provide their fuel vendors with any requested information regarding the performance of biodiesel or any issues that the user observes while using the fuel. This information is critical to allow the fuel vendor to complete the required quarterly reports to the CA Department of Measurement Standards.

II. Precautions and disclaimers: The following are facts concerning biodiesel and its usage. You as a user must be aware of and responsible for these qualities of biodiesel fuel:

1. Solvent Properties: Biodiesel, in addition to being fuel, is an effective solvent, and will act accordingly. This means that:

a. Biodiesel will dissolve existing solids—created through usage of petroleum diesel—in your vehicle's fuel system. These solids will clog your vehicle's fuel filter. When this happens depends on many factors, but can be recognized by the following symptoms: power loss, engine sputtering, difficulty starting, and poor fuel mileage. When you notice these symptoms, you will have to replace your vehicle's fuel filter (possibly more than once, depending on the amount of petroleum solids in the fuel system). (Your business name) recommends keeping at least one spare fuel filter on hand at all times. Clogging of fuel filters also occurs with old fuel storage containers that contained petroleum diesel.

When dealing with such large fuel tanks, fuel filters may have to be changed many times, and cleaning of the tank prior to biodiesel usage may be a more suitable alternative.

b. Biodiesel will, over time, dissolve most types of paint. For this reason, (your business name) recommends keeping a clean, soft, dry rag on hand when fueling, to gently wipe off any spillage. When the rag becomes soaked with biodiesel, put it in a dark, closed storage container to await proper disposal. Do not leave fuel-soaked rags crumpled up in the sun. Under such conditions, the rags are prone to spontaneous combustion due to oxidation and the heat generated during that process.

c. Biodiesel will degrade rubber components in older vehicles' fuel systems faster than petroleum diesel. These components include some hoses, seals, and o-rings. Most diesel vehicles made after 1993 use synthetic components, eliminating this problem. Please contact the manufacturer for answers on specific parts. Should your rubber components need replacement, we recommend viton substitutes. Call us for more information.

2. Cold Weather Properties: Depending on its feedstock, biodiesel can gel at temperatures as high as 40 degrees Fahrenheit or higher without added anti-gel. During the winter months, if operating in cold environments the only way to be 100% certain your fuel will not gel is to maintain a percentage of petroleum diesel in your fuel supply (exact quantity varies with climate). This is especially recommended for vehicles with electronically-controlled, highly-sensitive fuel injection systems, such as those found in Volkswagen TDIs and Chevrolet/GMC Duramaxes. Feel free to ask us about other possibilities for cold weather fuel storage, including heating elements and insulation.

3. Vehicle Emissions and Performance: Because every engine is different, (your business name) makes no claims about the emissions or performance when burning biodiesel fuel. Biodiesel will not have the same effects on every vehicle. Because the BTU value of biodiesel is slightly less than that of petroleum diesel no. 2, a small loss of power and fuel economy is to be expected, although this is mitigated by biodiesel's higher lubricity and cetane number.

4. Biodiesel Storage Etiquette: Biodiesel should not be stored more than 6 months without topping off or cycling. Biodiesel can oxidize when exposed to air and light for extended periods, resulting in a "rancid" fuel that can have negative effects on your vehicle's performance. Biodiesel needs to be stored properly, in a dark container, away from air and water. Use a filter with a water separator. Like diesel, biodiesel can attract bugs and biological contamination. The potential for contamination should be taken very seriously, and guarding against it is the member's responsibility. Large fuel containers must be vented properly. Regarding rust and age issues of storage containers, see section IV. 1(a), above.

5. Fuel Additives: Biodiesel, in this document, is defined as 100% biodiesel (B100) and biodiesel blends are identified by the blend concentration. For example B20 contains 20% biodiesel and 80% petroleum diesel. If you would like to use an additive in your fuel, for whatever reason, we recommend you contact us so we can share with you the

benefits of our experience. If you plan on blending biodiesel with petroleum diesel, remember: the better quality the diesel, the better the blend.

Reference Resources:

Biodiesel Handling and Use Guidelines http://www.eere. energy.gov/ biomass/pdfs/ biodiesel_ handling. pdf
Generic Biodiesel MSDS

http://www.nbb. org/pdf_files/ MSDS.PDF
Biodiesel FAQ's http://www.nbb. org/pdf_files/ RegulatedFleet_ QA.pdf

Engine Warrantee Information http://www.nbb. org/resources/ fuelfactsheets/ standards_ and_warranties. shtm

All information contained in this User Agreement is believed to be accurate at the time of printing. In addition to the above precautions and disclaimers, (your business name) reminds you that many mechanics have not heard of biodiesel, nor worked on vehicles using it as fuel.

I have read, understand and agree to the terms of this User Agreement.

Signed: Date:

This information was posted to local-b100-biz@ yahoogroups.com on 3/16/2007 by:

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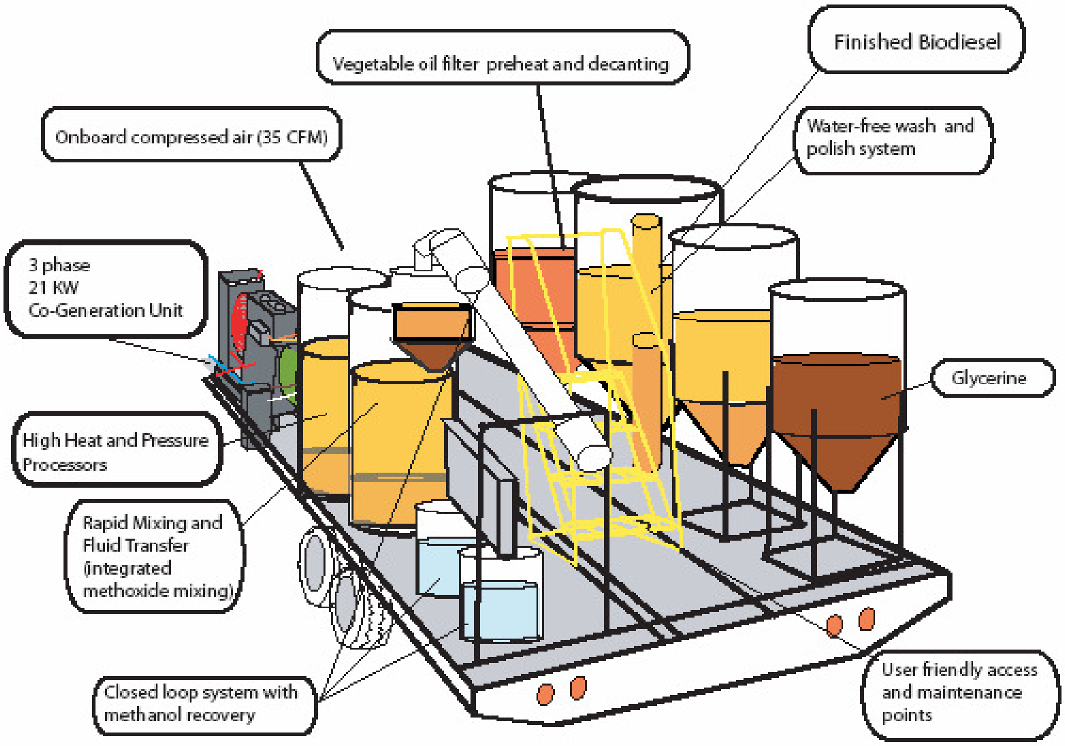
Sunflower Power
Farm Based Energy Systems

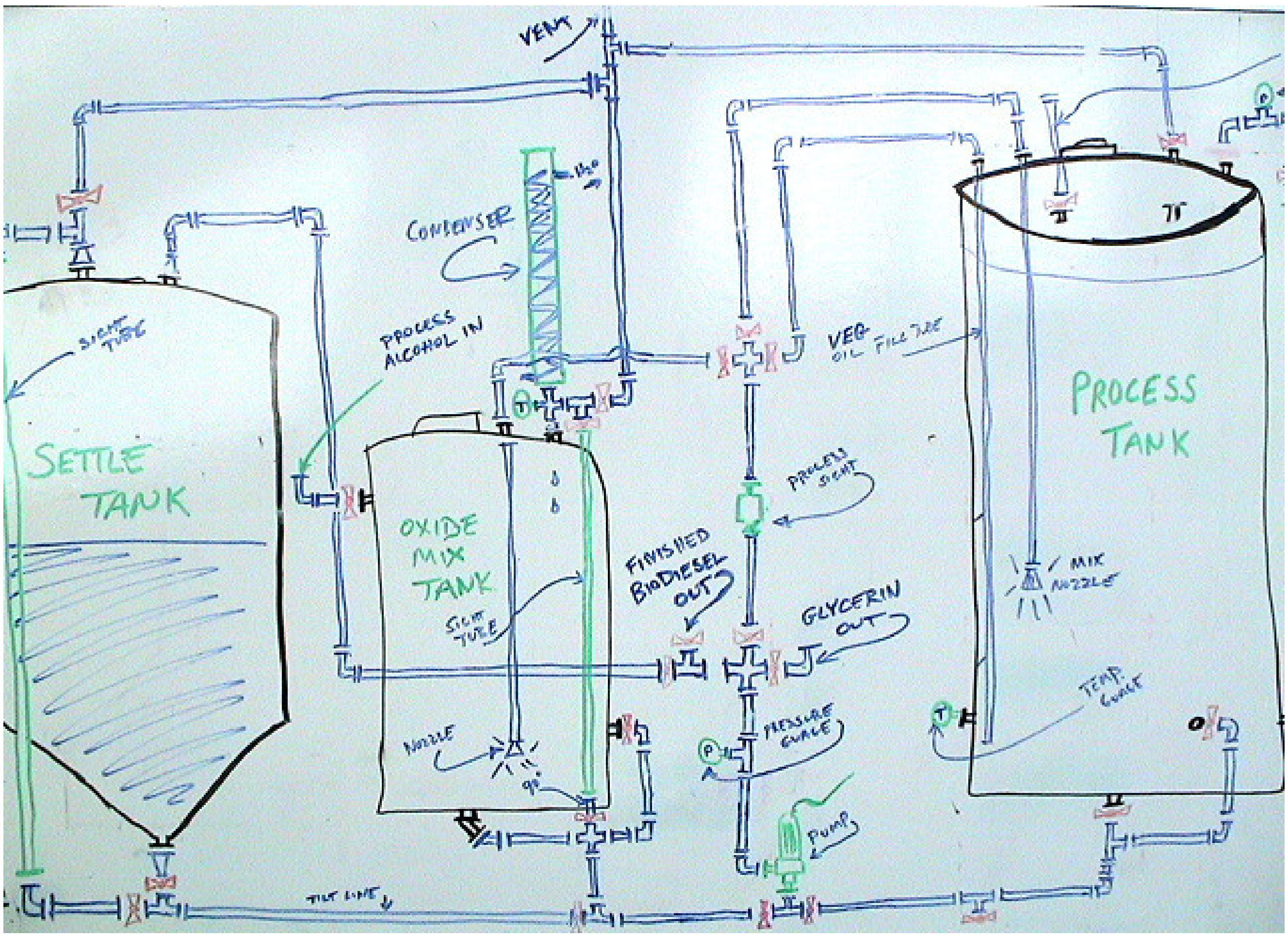
Self Contained Educational Biodiesel Processor

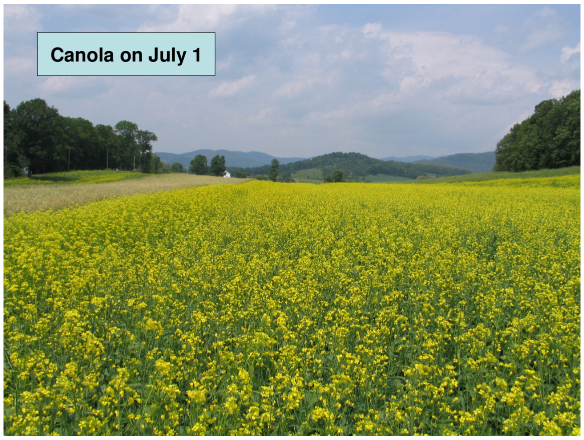


Features:
Mobile unit -can be deployed to multiple locations
Operates inside included portable shelter
Compact design fits inside 20' or 40' container for long distance transport
Requires no outside utilities (power or water)
Provides auxiliary 3 phase power, air and heat
Uses 55 gallon drums for feed stocks and finished products
All equipment anti-vibration mounted
Easy access to all components for maintenance & cleanup
Closed system with air operated fluid transfer
Can scale from 60 gal/hr + (heat transfer limited)
Fuel consumption from 1.5 gal/hr
Single person operation

contact: Dorn AW Cox
e-mail: dornawcox@comcast.net
phone:603.781.6030

Biodiesel System Design at State Line Farm (by Steve Plummer)




Canola on July 1


Sunflowers on July 1


Canola on August 1


Sunflowers on August 1


Canola on August 18


Sunflowers on October 2

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