Biosolids for Biodiesel

Commercialization Plan

Project Introduction

Biodiesel is an environmentally friendly diesel fuel that is produced using vegetable or meat oils or fats. The oils are mixed with an alcohol and a catalyst. In an esterification reaction, the glycerin in the oil is replaced by the alcohol, transforming the oils into biodiesel. Biodiesel is suitable for use in unmodified diesel engines. It can either be used as mixtures with conventional diesel fuels or as the sole fuel type. Biodiesel is not a new, experimental development. It is a well tested and performance proven alternative to conventional diesel fuel. It is also a fuel that we can grow, a fuel that will help reduce our dependence on fossil fuels and the nations that produce them. Biodiesel is also a much cleaner alternative to conventional diesel. All regulated and non-regulated emissions (excluding NOx compounds) in vehicles run on biodiesel are 40 to 100% lower than those from conventional diesel engines (Table 1). As biodiesel is produced from plant or animal based oils, it also has a minimal effect on global warming.
In Europe, government tax incentives have helped to encourage farmers to produce more high oil crops and have made the price of biodiesel comparable to conventional diesel. Approximately 1.5 million metric tons of biodiesel were produced in Europe in 2003 by about 50 different manufacturers (http://www.degussa-careers.com/karriere/en/home/dynamic_company/our_products/biodiesel.html). The primary reason that all of our diesel fleet isn’t run on biodiesel is cost. On average, biodiesel has generally cost about $1.00 per gallon more than conventional diesel fuels. Despite that fact, private citizens and municipalities are switching over to biodiesel. King County, the most populous county in Washington State, has recently announced that it will integrate biodiesel into its metro bus fleet. The ferry system in King County is currently using biodiesel.

A recent federal tax incentive will help to lower the cost of biodiesel for consumers. As part of the HR 4520, American Jobs Creation Act of 2004, a federal excise tax credit of $0.01 per each % BD in diesel fuel sold will be allowed for blenders of biodiesel (http://waysandmeans.house.gov/Links.asp?section=1559). This incentive will help increase the national demand for biodiesel. Right now, the majority all of the biodiesel used in the US is produced in the Midwest or on the East Coast. This both limits availability and increases price because of high transportation costs. Only when local production facilities are able to process locally available feedstock, will biodiesel become a standard.

The goal of our project was to create a closed-loop production facility for biodiesel in the Pacific Northwest. Our project partnered with farmers and municipalities to use each other’s resources to make cost effective biodiesel. We use nutrient rich waste materials from municipalities (municipal biosolids) as fertilizer to help keep costs down for farmers who grow canola. The canola is crushed in our facility to provide oil for biodiesel and canola meal. We are marketing to local dairies to supply canola meal for their herds. The oil will be processed

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### Table 1. Average biodiesel emissions compared to conventional diesel (National Biodiesel Board).

<table>
<thead>
<tr>
<th>Emission Type</th>
<th>B100</th>
<th>B20</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Regulated</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Unburned Hydrocarbons</td>
<td>-68%</td>
<td>-14%</td>
</tr>
<tr>
<td>Carbon Monoxide</td>
<td>-44%</td>
<td>-9%</td>
</tr>
<tr>
<td>Particulate Matter</td>
<td>-40%</td>
<td>-8%</td>
</tr>
<tr>
<td>NOx</td>
<td>+6%</td>
<td>+1%</td>
</tr>
<tr>
<td><strong>Non-Regulated</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sulfates</td>
<td>-100%</td>
<td>-20%*</td>
</tr>
<tr>
<td>PAH (Polycyclic Aromatic Hydrocarbons)**</td>
<td>-80%</td>
<td>-13%</td>
</tr>
<tr>
<td>nPAH (nitrated PAH’s)**</td>
<td>-90%</td>
<td>-50%***</td>
</tr>
<tr>
<td>Ozone potential of speciated HC</td>
<td>-50%</td>
<td>-10%</td>
</tr>
</tbody>
</table>

* Estimated from B100 result
** Average reduction across all compounds measured
*** 2-nitroflourine results were within test method variability
into biodiesel that can be used by the long-haul trucks that municipalities routinely transport biosolids in and the tractors that the farmers use to plow their fields. By involving all parties in this process we will be able to control costs and provide a service to all involved.

Our company, Emerald Ranches / Natural Selection Farms, Inc. has already begun the process of partnering with municipalities and farmers. We are located in Sunnyside, WA. Sunnyside is an agricultural community in Yakima County, an agricultural county. We farm over 1000 acres including 250 acres of organic fruit. In addition to farming, Natural Selection Farms, Inc. operates a large-scale biosolids application operation and a composting facility. This enterprise has won two awards from US EPA, the King County Golden Globe award: “A tribute to environmentally active individuals and businesses,” and the Washington Organic Recycling Council’s Expanding Vision Award for fulfilling, developing compost markets in agriculture. The biosolids have proven to be an excellent fertilizer for our crops and conditioner for our soils. Beneficial use of biosolids on agricultural lands has helped municipalities find a cost effective home for these waste materials. The success of our operation is a clear demonstration of the benefits to be gained by partnering urban and rural interests.

**Project and technical objectives**

We began the process by extending the urban rural partnership to building a local biodiesel industry and making this vision into a reality. The first stage of our work was to demonstrate to the cities and the farmers that municipal biosolids was an excellent fertilizer for canola. Two sets of test plots showed that the yield for biosolids fertilized canola was as high as canola grown with conventional fertilizers.

We held open houses for municipal biosolids managers and a range of King County officials to show just how easy it is to ‘grow your own’. We also presented a 1.5 liter bottle of our ‘First Vintage Biosolids Biodiesel’ to King County Executive Ron Sims.
The second stage of the process involved the technical details of turning this vision into an operating enterprise. In the use of municipal biosolids, we were already on target. Natural Selection Farms has 240,000 acres of farmland permitted for biosolids application. We land apply 30,000 wet tons of biosolids and 2.4 million gallons of liquid biosolids per year. The next stage of the process was to use these biosolids to grow feedstock for biodiesel production and to build a facility to extract oil and produce biodiesel. We began by securing letters of commitment from farmers to grow canola, municipalities to purchase the biodiesel and diary farmers to purchase the canola meal. We also started working towards establishing the required crop history in the county so that farmers will be able to qualify for federal crop insurance. We are taking advantage of infrastructure already available in Yakima County to store and clean canola seed, having secured access to seed storage and cleaning facility in Mabton. We identified the appropriate type of oil extraction facility and biodiesel processing facility for a small-scale operation that would be able to meet our needs. We identified available equipment that could be retrofitted to suit our needs for this facility. We identified partners in the event that our business outgrows our planned production capacity, both in terms of municipal biosolids and seed to be processed.

The primary technical objective of our project was to build an oil extraction and diesel processing facility at our farm in Sunnyside so that all of the pieces of this partnership come together and begin production of biodiesel. The goal was to provide municipalities and farmers with a cost effective source of locally made biodiesel, provide new employment opportunities in our county, provide an alternative crop for farmers and create cleaner air at the same time!

Weakness in objective & goal

As stated earlier, the primary obstacle to large scale use of biodiesel is cost. With the current structure, costs at all stages of the process are problematic. The process starts with production of a feedstock. In the Pacific Northwest the best crop for oil production is canola or rapeseed. There is some history of canola production in the state. Canola can be grown here on irrigated lands or on dryland. It can be planted in the spring, but generally has higher yield when wintered over. Canola has not been adopted on a large-scale because revenues from growing canola are generally comparable to or lower than wheat. One of the reasons for low revenues is the fact that
growers are currently required to ship their harvested seed to Canada for processing. In addition, federal crop insurance for growing canola is only available in a few counties in the state.

The high cost of infrastructure in combination with the uncertain economic return for the farmers that one depends on to produce a feedstock make a conventional approach to biodiesel production a very risky business. The prospect of needing to retail the fuel at an unrealistically high price to cover feedstock and infrastructure costs is a very real. This differential is currently being subsidized in the form of a blender’s credit of $1.00 per gallon. This Federal incentive provides a competitive pricing to jump-start this new industry. As facilities and production continues to expand, efficiencies of operational cost will reduce uncertainty of financial risk.

For biodiesel production to be economically feasible, it is essential to maximize revenues from all potential sources. When oil is extracted from the canola seed, the remaining canola meal has value as animal feed. This value can only be maximized if the cattle that will consume the feed are in close proximity to the oil extraction operation.

State and government officials have been very receptive to the concept of starting a new crop commodity, crushing the meal into vegetable oil and meal for local dairy consumption. The fact that we are the first commercial crushing facility in the state has signaled varied levels of concern for non-categorized regulations within the local county. Our crushing / pressing facility has been operating on temporary permits until resolve-resolution is achieved. The production of on farm biodiesel from the vegetable oil remains questionable at this time. We continue to recognize the need to move forward with our primary objective of producing biodiesel from canola seeds grown on soils amended with biosolids. Markets for the canola meal have been developed with local dairies and the transesterfication process of converting the canola oil into biodiesel is being accomplished through a partnership agreement with Imperium Services in Seattle, Washington. The biodiesel is then being utilized by King County for use in their transit system and trucks hauling biosolids to Eastern Washington for soil application.

**Commercial applications and innovative aspects**

Our approach relied on reducing costs and thereby risks at all possible points by taking advantage of existing infrastructure. By using municipal biosolids and livestock manures for fertilizer, we have reduced production costs for farmers. We have also reduced risk for the farmer by contracting to purchase the canola at a fixed price. Our proximity to the large dairy population in Washington State guarantees markets for canola meal at minimal transportation costs. In the future, we can also tap into that dairy-cattle population for an alternative, cost effective fertilizer. The Yakima Valley is also the home of the world’s largest hops production. The decline in the hops industry made available a building that is no longer in use which we retrofitted into a functional facility at a percentage of the cost that a new facility would have been. We were also able to begin production with a smaller facility (<1 million gallons per year) and scale up as economics demand.

Perhaps the most innovative part of our plan was the creation of a built in market for our product. The municipalities who supply us with biosolids need diesel to operate their long-haul vehicles and transient systems. The farmers that grow the canola and raise livestock need diesel to operate their farm equipment. By supplying the people that supply us, we can create a closed
loop system whereby everyone stands to profit. We met with transit managers from two of the larger municipalities which provide biosolids about the potential to formulate contracts that include both biosolids management and diesel supply. Through work we did with King County Executive Ron Simms, we were able to put together a cooperative effort. King County’s Metro Transit System will use biodiesel blended and transported by Associated Petroleum Producers, transesterficated by Imperium Services, who in turn will use expelled canola oil from us that was grown on ground fertilized with King County’s biosolid. We started this process with establishing a contract with Imperium Services based upon the canola seed pricing index set by Cambra Foods of Lethbridge, Canada. This is the only market farmers in our area have had for marketing canola seeds. The cost of shipping from the Yakima Valley to Lethbridge is approximately forty dollars per ton. The freight cost to our facility is significantly less, providing increased savings for the farmers while receiving the same price per pound of seed as if it were shipped to Canada. There are approximately 250,000 dairy cows in the Yakima Valley. These cows consume on an annual basis $25 million dollars of canola meal brought in from Canada. The potential benefit of keeping in state revenue through locally produced canola generates a significant financial impact to local rural communities particularly as this industry grows. The usage of our canola meal production is generating demand. Our canola meal has been commanding 25% increase value over Canadian meal. In addition to our own production, we have enlisted growers with desire to grow canola and become part of this operation. M & E Feeds and Seed, Inc. is a licensed and bonded broker who works directly with the farmers to contract seed purchases in addition to maintaining the grain storage capacities.

Table 2 below details what we project to produce. This level of production is profiled to increase as we work with farmers from outside of the county and work with animal manure in addition to municipal biosolids. This table illustrates that a small scale biodiesel industry in Yakima County has the potential to be beneficial for the farmers, municipalities, and diaries in the Yakima County and in Washington State. This business model promotes ties to continue to develop between municipalities, farmers and cattle ranchers committed to building a local, cost effective biodiesel industry in Yakima County.

Table 2. Projected near-term increase in canola seed and biodiesel production.

<table>
<thead>
<tr>
<th>Year</th>
<th>Land in Production (ac)</th>
<th>Biosolids Applied (wet tons)</th>
<th>Seed Harvested (lbs)</th>
<th>Oil Extracted (lbs)</th>
<th>Meal Produced (tons)</th>
<th>Biodiesel Production (gal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>1</td>
<td>15</td>
<td>4500</td>
<td>1395</td>
<td>1.55</td>
<td>182</td>
</tr>
<tr>
<td>2006</td>
<td>500</td>
<td>7500</td>
<td>2250000</td>
<td>697500</td>
<td>776</td>
<td>90767</td>
</tr>
<tr>
<td>2007</td>
<td>1000</td>
<td>15000</td>
<td>4500000</td>
<td>1395000</td>
<td>1553</td>
<td>181534</td>
</tr>
<tr>
<td>2008</td>
<td>2100</td>
<td>31500</td>
<td>9450000</td>
<td>2929500</td>
<td>3260</td>
<td>381220</td>
</tr>
</tbody>
</table>

Having completed the 2006 season we are pleased to announce that our goals have exceeded projections. Projection for the 2007 year is predicted at this time to exceed the goals set for
2008. As mentioned earlier, due to the difficulty in gaining regulation acceptance in Yakima County for the tranesterification process of vegetable oil into biodiesel, all the tranesterification processing will be accomplished in King County. We are still accomplishing our goal for on farm biodiesel usage. Biodiesel will be back hauled with the same trucks hauling the vegetable oil to Imperium Services in Seattle. This is unfortunate for Yakima County in that much of the revenue benefits from biodiesel production once projected for our local communities will be realized in King County.

**On going research**

Continued research is extremely valuable to heighten knowledge about growing canola in Eastern Washington. Work that Drs. Hal Collins and Ann Hang from WSU Research Center in Prosser has provided a significant framework of nutrient requirements of canola. Knowledge that canola responds well to high levels of nitrogen, phosphorus and sulfur provides the basis for understanding the response gained when biosolids and livestock manures provide the nutrient base. Other arenas for significant research will need focus on varieties, plant population and water consumption.

Starting in the spring of 2005, we seeded 100 acres of spring canola using five different varieties depicted in table 3.

**Table 3. 2004 Spring canola varieties commercial test plots**
Information gained from the spring varietals test displayed two significant issues of concern. The first that winter canola, being fall planted commences blooming in April and through mid May. Spring canola typically blooms a month later, being May and June. When the heat units exceed 34 degrees Celsius the plant stops flowering (seed pod development) which in the above test plot correlated to approximately half the yield when compared to fall planted, winter canola. The other issue was learned from the grain drill on the Cracker Jack variety was adjusted to increase the poundage per acre for seeding from 8 pounds to 15 pound. Plant population became excessively dense creating competition for sunlight. The resulting plants were very tall, slender with pods forming only on the top one foot level of the plant. On lesser seeding rate of 5 pounds per acre, plant competition is reduced and a production of seed band results in an area of 2.5 to 3 feet on the plants.

Knowledge gained from the 2003/2004 research test plots correlated water management to yield. Excessive irrigation will have a converse effect on yield and we felt that we would replicate the information gained in the 2003 research on a commercial level. Working with Don Jamison, agronomist with Agrimanagement from Yakima, we established three comparable fields with the same Casino variety, planting dates within two days of each other, consistent tillage and pre-irrigation practices. These three plots were identified as Normal Irrigation, Mild Deficit Irrigation and Heavy Deficit Irrigation. The irrigation practice was typical sprinkler irrigation from wheel lines. Normal Irrigation received two passes with the wheel line producing 2.8” inches of water per pass. The Mild Deficit Irrigation received one pass of 2.8” inches of water. The Heavy Deficit received no supplemental irrigation. In a letter dated January 16, 2007, Mr. Jamison states: “It seems fairly safe to guess that in this one-year study of three different field of fairly deep soil and medium charged soil profile to begin with (see 3/24/2006 data – table 4 below) that this crop can function with more or less than 15” of available water from the profile, from irrigation or from accumulated rain fall.” He went on to say that, “We can see that the soil moisture data was greatly depleted by the time of our early July samplings. This data from East of Pears shows that the soil moisture was fully depleted in a 5’ deep root zone.
### 2006 Canola Water Use Study

#### Field: West 5 acre

<table>
<thead>
<tr>
<th>Date</th>
<th>Days since last sample</th>
<th>Crop Stage</th>
<th>Height (cm)</th>
<th>Canopy</th>
<th>ERD</th>
<th>In. to refill (ETo)</th>
<th>In. to refill (ETo)</th>
<th>In. low-baseline water in ETo</th>
<th>Rain Gauge reading</th>
<th>Estimated Calc weekly Use (DCU)</th>
<th>Calc weekly Use (DCU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/14/2005</td>
<td>0</td>
<td>5-6</td>
<td>50-100</td>
<td>1.0</td>
<td>NAW</td>
<td>58</td>
<td>65</td>
<td>75</td>
<td>84</td>
<td>91</td>
<td>3.22</td>
</tr>
<tr>
<td>4/20/2005</td>
<td>17</td>
<td>Pre-bloom</td>
<td>23-30</td>
<td>50-100</td>
<td>1.5</td>
<td>NAW</td>
<td>61</td>
<td>72</td>
<td>85</td>
<td>91</td>
<td>4.61</td>
</tr>
<tr>
<td>5/4/2005</td>
<td>14</td>
<td>pod form</td>
<td>37-58</td>
<td>80-100</td>
<td>1.5</td>
<td>NAW</td>
<td>39</td>
<td>57</td>
<td>65</td>
<td>70</td>
<td>1.62</td>
</tr>
<tr>
<td>5/19/2005</td>
<td>14</td>
<td>pod devel.</td>
<td>54-66</td>
<td>50-100</td>
<td>3.0</td>
<td>NAW</td>
<td>25</td>
<td>37</td>
<td>55</td>
<td>64</td>
<td>2.22</td>
</tr>
<tr>
<td>6/1/2005</td>
<td>14</td>
<td>seed devel.</td>
<td>42-63</td>
<td>75-100</td>
<td>3.0</td>
<td>NAW</td>
<td>31</td>
<td>47</td>
<td>57</td>
<td>65</td>
<td>6.94</td>
</tr>
<tr>
<td>7/7/2005</td>
<td>15</td>
<td>seed devel.</td>
<td>46-63</td>
<td>50-100</td>
<td>3.5</td>
<td>NAW</td>
<td>1</td>
<td>2</td>
<td>12</td>
<td>17</td>
<td>9.25</td>
</tr>
</tbody>
</table>

#### Management Strategy: Normal Irrigation

- Total Use: 112.28
- AVG Calc inches/day: 0.11

#### Note:
- Actual rain gauge readings (irrigation plus rainfall) would likely be ~15% higher due to evaporation.
- Actual total usage is given for the days sampled starting 3/24 and does not include any usage before that date (including early spring or the previous fall).

### Harvested: 7/14

#### 2006 Canola Water Use Study

#### Field: Big North

<table>
<thead>
<tr>
<th>Date</th>
<th>Days since last sample</th>
<th>Crop Stage</th>
<th>Height (cm)</th>
<th>Canopy</th>
<th>ERD</th>
<th>In. to refill (ETo)</th>
<th>In. to refill (ETo)</th>
<th>In. low-baseline water in ETo</th>
<th>Rain Gauge reading</th>
<th>Estimated Calc weekly Use (DCU)</th>
<th>Calc weekly Use (DCU)</th>
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<tbody>
<tr>
<td>3/24/2006</td>
<td>0</td>
<td>5-6</td>
<td>50-100</td>
<td>1.0</td>
<td>NAW</td>
<td>58</td>
<td>65</td>
<td>75</td>
<td>84</td>
<td>91</td>
<td>3.22</td>
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<tr>
<td>4/20/2005</td>
<td>17</td>
<td>Pre-bloom</td>
<td>23-30</td>
<td>50-100</td>
<td>1.5</td>
<td>NAW</td>
<td>61</td>
<td>72</td>
<td>85</td>
<td>91</td>
<td>4.61</td>
</tr>
<tr>
<td>5/4/2005</td>
<td>14</td>
<td>pod form</td>
<td>37-58</td>
<td>80-100</td>
<td>1.5</td>
<td>NAW</td>
<td>39</td>
<td>57</td>
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<tr>
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<td>pod devel.</td>
<td>54-66</td>
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<td>25</td>
<td>37</td>
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<td>64</td>
<td>2.22</td>
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<tr>
<td>6/1/2005</td>
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<td>42-63</td>
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<td>31</td>
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<td>65</td>
<td>6.94</td>
</tr>
<tr>
<td>7/7/2005</td>
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<td>seed devel.</td>
<td>46-63</td>
<td>50-100</td>
<td>3.5</td>
<td>NAW</td>
<td>1</td>
<td>2</td>
<td>12</td>
<td>17</td>
<td>9.25</td>
</tr>
</tbody>
</table>

#### Management Strategy: Mild deficit irrigation

- Total Use: 7.43
- AVG Calc inches/day: 0.11

#### Note:
- Actual rain gauge readings (irrigation plus rainfall) would likely be ~15% higher due to evaporation.
- Actual total usage is given for the days sampled starting 3/24 and does not include any usage before that date (including early spring or the previous fall).

### Harvested: 7/14

#### Big North West

<table>
<thead>
<tr>
<th>Date</th>
<th>Days since last sample</th>
<th>Crop Stage</th>
<th>Height (cm)</th>
<th>Canopy</th>
<th>ERD</th>
<th>In. to refill (ETo)</th>
<th>In. to refill (ETo)</th>
<th>In. low-baseline water in ETo</th>
<th>Rain Gauge reading</th>
<th>Estimated Calc weekly Use (DCU)</th>
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<tr>
<td>6/1/2005</td>
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<td>50-64</td>
<td>46-63</td>
<td>3.5</td>
<td>NAW</td>
<td>23</td>
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<td>63</td>
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<tr>
<td>6/19/2005</td>
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<td>50-100</td>
<td>3.5</td>
<td>NAW</td>
<td>33</td>
<td>57</td>
<td>65</td>
<td>70</td>
<td>7.74</td>
</tr>
</tbody>
</table>

#### Total Use: 0.34
- AVG Calc inches/day: 0.10

#### Note:
- Actual rain gauge readings (irrigation plus rainfall) would likely be ~15% higher due to evaporation.
- Actual total usage is given for the days sampled starting 3/24 and does not include any usage before that date (including early spring or the previous fall).

### Harvested: 7/14

#### Field: E of Peace

<table>
<thead>
<tr>
<th>Date</th>
<th>Days since last sample</th>
<th>Crop Stage</th>
<th>Height (cm)</th>
<th>Canopy</th>
<th>ERD</th>
<th>In. to refill (ETo)</th>
<th>In. to refill (ETo)</th>
<th>In. low-baseline water in ETo</th>
<th>Rain Gauge reading</th>
<th>Estimated Calc weekly Use (DCU)</th>
<th>Calc weekly Use (DCU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/24/2006</td>
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<td>6-9</td>
<td>80-100</td>
<td>1.5</td>
<td>NAW</td>
<td>55</td>
<td>65</td>
<td>75</td>
<td>85</td>
<td>91</td>
<td>3.23</td>
</tr>
<tr>
<td>4/20/2005</td>
<td>17</td>
<td>Pre-bloom</td>
<td>23-30</td>
<td>50-100</td>
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<td>NAW</td>
<td>61</td>
<td>72</td>
<td>85</td>
<td>91</td>
<td>4.61</td>
</tr>
<tr>
<td>5/4/2005</td>
<td>14</td>
<td>pod form</td>
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<td>33</td>
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<td>7.74</td>
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</table>

#### Management Strategy: Heavy deficit irrigation

- Total Use: 10.38
- AVG Calc inches/day: 0.10

#### Note:
- Actual rain gauge readings (irrigation plus rainfall) would likely be ~15% higher due to evaporation.
- Actual total usage is given for the days sampled starting 3/24 and does not include any usage before that date (including early spring or the previous fall).

### Harvested: 7/14

#### 2006 Canola Water Use Study

**Note:** Actual rain gauge readings (irrigation plus rainfall) would likely be ~10-15% higher due to evaporation.
This also indicates, that this crop while quite capable of rooting and extracting water deeply would also be quite capable of recovering deep or leached nitrates that may follow a more shallow rooted crop such as sweet corn, mint, or potatoes. Hence, there are some "environmental" values to bring such a crop into periodic rotation after a crop that has a fairly high nitrogen use and rater inefficient uptake; onions would be another rotational crop that could be added to the list above.”

Dairies through out the Yakima Valley face Department of Ecology compliance issues regarding nitrogen and phosphate through their manure management programs. Many grow corn to extract these elements from the ground where manure has been applied, to recycle the nutrients through feeding programs. The benefit of knowledge gained with Mr. Jamison’s research reinforces the benefits of canola as an alternative crop toward gaining sustainability within our valley rich in dairies producing soil fertilizer as a by product of milk production. Particularly, with the canola meal providing another nutrient source for protein in the process.

Another attempt to provide innovation to the production of canola is second cropping within the same growing season. Fall planted winter canola is typically harvested in early to mid July in Eastern Washington. Areas blessed with sufficient irrigation water can re-hydrate the soil profile and with minimum tillage plant short season forage for livestock fodder. This would typically be a crop such as triticale, corn or sudan grass. Another approach that we used was to irrigate the stand, canola stocks immediately after harvest. The remaining stubble unlike wheat has residual vegetation that produced additional leaves, in addition to the seed from combine tailings germinating providing fall and winter pasture. The canola pasture was test for nutrients, analyzed by Cumberland Valley Analytical Services, Inc. and found to provide as a dry matter basis; 30.38% Crude Protein, 25.10 Acid Detergent Fiber, 28.15 Neutral Detergent Fiber, 16.10% Ash, Total Desirable Nutrients of 69.74% (calculated using Robinson et al. University of California Davis 2004) and a Relative Feed Value of 229.165. With a minimal amount of mineral supplements and additional canola meal from the pressing facility, bred cows have pastured the past 3 months thus providing dual cropping income from the same acreage.
Construction and implementation

Recognizing that the pressing and extruding equipment would be the most important facet for our success, we elected to work with a U.S. company providing ease for replacement parts, service and knowledge. Insta-Pro from Des Moines, Iowa provided technical knowledge on nutritional values gained through their patented extrusion technology, which has been extremely essential to our marketing success of the canola meal to local dairies. The balance of the equipment; tanks, augers, motors, pumps and elevator legs are all common to the grain handling industry. Therefore, we opted to purchase new pressing and extruding equipment (the heartbeat of our operation) and search out good pricing on used equipment for the balance. This allowed us to accomplish a higher capacity operation. Our capital expenditures for equipment was less than anticipated, however, the labor for refurbishing used equipment and installation was higher than originally anticipated. Refurbishing of equipment began in November of 2005. An order for the pressing equipment was placed with Insta-Pro at the same time. Delivery of the presses and extruders occurred in the early summer of 2006.

The following pictures display the construction stages of equipment into the facility.
Installation of used grain storage tanks prior to painting

Tom Dolan fabricating stands for outside overhead grain bin tanks.
Devin Newhouse fabricating stairwells & hand railings

Lifting of refurbished elevator leg and tanks onto fabricated stand
Completed & painted outside grain receiving area

Delivery and setting of the presses
Finishing touches on construction

Finished and functional operational crushing facility
The canola crushing facility is located at 5170 Emerald Road. Two domestic wells service this area, in addition to two power companies, Benton Rural Electric Association and Pacific Power and Light. Additional external amenities include an adjacent farm shop, restrooms, storage buildings and a private park which is secured by a cyclone fence.

The presssing facility is contained in a 4,800 square foot metal building with 25 foot eves. The building has metal sheeting on the outside, insulation and metal sheeting interior. It has two walk thru doors and a 15’ x 18’ roll up door. Inside the building is a 14’ x 24’ structure which houses an office / lunch room area and electrical / parts and tool storage area. The facility is well lit with ten indoor sodium vapor lights. The electrical service for this facility is an 800 amp, 480 volt, three-phase service provided by Benton REA.

Located outside is an 8’ x 12’ lean-to building which houses a rotary air compressor for the facility’s diaphragm pumps. There is also a concrete truck unloading ramp serviced by an 18” auger in the unloading pit. After the seed is unloaded, it is then augured into a 12” cross auger to the 55’ elevator leg. This provides the capacity to unload a ton of seed per minute. Above the truck unloading ramp, two 25 ton meal storage tanks are mounted on a steel structure stand. On top of the meal storage tanks there is a 5 hp. air lift and an eight foot cyclone.

The seed leaves the elevator leg through a distributor head to one of the two 25 ton seed storage tanks inside the building. Located between these two tanks is a seed cleaner. The cleaner removes undersize and oversize foreign particles prior to being conveyed thru a 23’
elevator leg to a third 25 ton storage tank. This tank provides clean grain storage for the pressing facility. In the case of soybean processing, a portable destoner is attached under this tank, for use prior to the seed being transferred to elevator leg. The seed is then lifted by a 24 elevator leg into an even flow bin prior before entering the first press. This bin also houses a large magnet for removal of any metallic objects. As the seed flows from this bin into the first press it is regulated by a Betts butterfly valve at the rate of 5.5 pounds per second. The first press is the initial crushing of the seed, removing approximately 34% of the oil from the seed. The vegetable oil gravity flows to a diaphragm pump below the press, which pumps the raw vegetable oil up and over into an oil screening tank. The meal that flows from the first press is conveyed to the second press by means of a Redler drag elevator. The second press removes approximately 24% of the oil which is also pumped to the screening tank.

The meal then is conveyed by auger to the even-flow hopper which feeds the extruder. This hopper also has a large magnet for precautionary measures for metal object removal. The meal at this point is approximately 120 degrees Fahrenheit. Through Insta-Pro’s extrusion technology, the temperature will reach 270 Fahrenheit. This process sterilizes the meal, removing enzymes that could be detrimental to livestock feed. This process causes cell wall degradation which facilitates oil separation from the meal. The meal is then conveyed through another auger to a third press where approximately 35% of the oil is removed and once again conveyed by a diaphragm pump to the screening tank. The meal that comes from this press falls into a cut and fold auger which blends the product prior to the hammer mill. This meal has approximately 7.5% oil remaining which creates excellent bi-pass protein for the local dairy cows. The hammer mill shatters the meal into a powder which is then vacuumed outside the building by an air lift into the overhead meal storage tanks, awaiting truck delivery to local dairies.

The vegetable oil that flows into the screening tank from the three presses is allowed to settle in the first compartment which separates out large particulates, then, as it flow through the screens more particulates are removed. An auger conveys this sediment back to the extruder for reprocessing. The oil is then pumped by an explosion proof centrifugal pump from the screening tank to a Shriver filter press that uses diatomaceous earth. The mixing requires a 500 gallon tank prior to the oil being pumped into the filter press. The oil is then once again filtered through a one micron sock filter prior to pumping into the 34,500 gallon tank that is inside the building. Two additional 10,000 gallons tanks are located outside the building for bulk storage of vegetable oil. A portable diesel pump is utilized to convey the oil when necessary to or from these tanks. Additional auxiliary equipment essential to the operation are a Gene man lift with a 60’ boom, spare parts inventory and necessary tools and welders for on going fabrication. All access stairways and overhead walkways are constructed of expanded metal steps for reduced slippage complete with handrails, toe kick guards and mid rails to meet or exceed OSHA, WISHA and the WA. State Department of Labor and Industries mandated worker protection requirements. A lockout / tag out padlock system are implemented on the electrical controls. All signage is in place for worker protection including emergency escape routes, fire extinguishers, as well as, a firewall on the west side of the building, electronic smoke/heat sensing units have been installed and are monitored by Moon Security. All outside equipment has been painted white, the inside equipment is painted Insta-Pro green with safety yellow on all machinery guards.

Additional equipment on site, awaiting installation; a 10,000 gallon Super Vault dual walled, concrete lined, 4 hour fire protection tank, a 2,000 gallon stainless steel tank with internal mixer
and a 2,800 gallon jacketed, thermal heated stainless steel tank and a filter press. This additional equipment is for the tranesterification process of converting vegetable oil into biodiesel when the permitting process has been accomplished with Yakima County.

**Commercialization in operation**

In October Insta-Pro sent their representative, Oz Grimm, to assist in start up of the pressing equipment. His function was to educate the operators on techniques to be utilized to operate the equipment to maximum potential. One of the most value aspects of the equipment is displayed in the following photograph of the extruder. The Insta-Pro extruder utilizes heat and pressure in conjunction with moisture to achieve cooking, deactivation of anti-nutritional factors, protein dewatering and starch gelatinization, which lead to increased protein, amino acids and energy digestibility. Zang et al (1993). This is accomplished by a series of screws and cones picture below. Additional benefit of this process on the meal is increased shelf life. (Favor Parker-Lancaster School Agriculture). Deactivation of anti-nutritional factors through rupturing oil cell releases the natural antioxidant enzyme myrosinase responsible for the degradation of goitrogenic glucosinolates which can cause growth depression through reduced iodine uptake by the thyroid gland. Fenwick et al (1986)

![Jim Sebring, Tom Durfey & Oz Grim discuss the workings of the Insta-Pro Extruder](image)

Some alterations within the facility were accomplished to electrical and mechanical movement of product and oil prior to being fully operational in November, 2006. The facility currently operates 24 hours per day, 5 days per week. Quality improvements to product flow handling and increased oil filtering have been accomplished. Inspections have been performed by Washington State Labor and Industries, Yakima County Building Department, Yakima County Clean Air Authority and the Yakima County Fire Department, District 5 to assure compliance is being maintained. Operational charts are maintained for product inflow, outflow and temperature monitoring. Current seed pressing rate is 1850 pounds per hour with oil output at 75 gallons per hour and 1147 pounds of meal per hour.

After pressing all of our owned seed, purchasing agreements between M&E Seed and Feeds, Inc, of Prosser WA and McKay Seeds, Inc. of Moses Lake have provided additional canola seed to continue our pressing operation. Meal sales are being marketed through M&E
Seed and Feed, who is licensed and bonded. Canola meal is sold to; Newhouse Dairy, Kevin Den Hoed Dairy, Hang 4 Dairy, Van de Muller Dairy and Williams Dairy. They have consumed all of the meal produced to date. Samples are being taken daily to monitor oil content in the meal. Analysis performed by Warren Analytical Laboratories, have shown crude fat (residual oil content) to range from 4.8% to 10.41% depending upon the press settings. Moisture in the meal average 5% and protein 35.87% to 38.11%. We have been working with feed nutritionalist to establish dairy cow feed ratios and have accomplished a 43% increased value over the hexane extracted meal dairies purchased from Lethbridge, Canada.

Oil sales are increasing with the recent signing of the Imperium Renewable’s agreement. Other oil purchasers are Central Washington Biodiesel, Wi Bio-Fuel and Roger Wolf-RNS Farms. We have received letters of interest from other facilities that are in the building process and will not be tranesterficating until spring of this year. These facilities include Gen-X from Burbank, Washington and Whole Energy from Bellingham Washington. Our oil has been tested for multiple elements prior to and after the production of biodiesel. In all cases, the process performed by Imperium Services and Whole Energy have found the oil capable of producing biodiesel well within specification for ASTM standards for biodiesel production. Please see attached letter of interest to contract for canola oil.
December 13, 2006

To:    Ted Durfee, Natural Selection Farms
From:  Orion Polinsky, Whole Energy Fuels Corp

Re: Test Results on Sunnyside Farms Crude Canola Sample

Dear Ted,

WEF has analyzed the sample of Crude Canola Oil that you provided us and processed it into biodiesel. The Canola oil contained 2.7% FFA, which is normal for fresh pressed oil. The viscosity of the crude canola oil is higher than what we have experienced with degummed canola, but upon processing into biodiesel the viscosity was brought to within specification. The Canola was processed using KOH and methanol. The resulting biodiesel color/clarity and other important specifications are similar to biodiesel that we have both made and sold that is made from canola.

We look forward to discussing further with you and providing you a sample of biodiesel made from your oil. Although more basic biodiesel plants now in operation are not able to integrate FFA above 1% with acceptable yield, our plant will have no problem processing oil you produce based on this sample. We believe, however, that it will be beneficial to receive regular samples from you so that we can quantify seasonal and other variations. These variations have the potential to negatively impact product quality unless we work in advance to address them.

I have shared these results with Atul and he has expressed an interest in meeting with you in the near future to discuss a potential supply contract for our biodiesel production in 2007.

Sincerely,

Orion Polinsky
360-815-6507
Company information

Emerald Ranches/Natural Selection Farms, Inc.

Natural Selection Farms is owned and operated by Ted and Pamela Durfeys. The Durfeys also own and operate Lighthouse Ranches, the farming entity and Emerald Ranches the organic farming division. These companies are situated in Sunnyside, WA and include 1150 acres of farmland as well as a municipal biosolids storage facility and compost facility. The farmland is all irrigated and includes about 250 acres of organic fruit (grapes, cherries and pears). The remainder is currently used for a range of agronomic crops. The compost site as well as their biosolids application sites and storage sites are all permitted though the Washington State Department of Ecology and Yakima County Health Department. The sites are also considered a Washington State registered Beneficial Reuse Facility with the Washington State Department of Ecology. The company is one of the few in central Washington to have completed such a wide array of certification and registration processes. Our composting and biosolids operation (under Natural Selection Farms) employs seven full time personnel and has an annual gross income of approximately $900,000. Our tree fruit operation (which we are currently leasing) has traditionally employed 150 people at peak season and had sales of $1.4 million in 2004. Our commitment to environmental stewardship is evident from the awards that we have received.

- King County Department of Natural Resources Golden Globe Award – 2001.
  ‘A tribute to environmentally active individuals and businesses.’
- Sunnyside Chamber of Commerce Outstanding Agri-business person – 1998
- US EPA- National Award for advocacy of environmental stewardship through biosolids recycling 1994 & 1996
- Washington Organic Recycling Council - Expanding Vision Award - Fulfilling, developing compost markets in agriculture

Emerald Ranches has been a family operated farm for over 60 years and Natural Selection Farms has operated for over 18 years. We started to diversity our operation to include organic farming, composting and biosolids management in the mid 1980s. We did this for several reasons; conventional farming practices were taking their toll on our soil as we were beginning to witness decreased yields due to salt build up and a range of other factors. In addition, as farmers, we had experienced the ups and downs of prices for our crops and realized that diversification was essential to a successful farming operation. Finally, by producing composts from our own and other crop waste materials and using biosolids instead of synthetic fertilizers, we can maintain our soils and keep our environment healthy for our kids.

Intellectual property

We expect to be able to maintain our closed loop operation and therefore our advantage over other potential producers in the area by integrating residuals management contracts with biodiesel purchasing agreements. The degree of specialization that we will be able to offer municipalities, to both manage their biosolids and produce their biodiesel, should keep us competitive. There is also opportunity to expand our operation as manure management regulations become more stringently enforced. The Environmental Protection Agency passed new confined animal feeding operations (CAFO) rules in February, 2003. These rules are more restrictive and place a greater importance on appropriate nutrient management for land application of manures and liquid wastes (http://www.epa.gov/npdes/caforule/). As land
application of animal manures becomes increasingly regulated, owners of CAFOs would be expected to contract with companies like Natural Selection Farms to spread their manures in an environmentally sound manner. These operations also have a need for canola meal and diesel fuel suggesting that similar types of contracts can created with dairies and CAFOs in Yakima County.

There is also opportunity to integrate additional research to value add to the existing production of the vegetable oil into biodiesel. Many food processors are currently using food grade lubricating oils that potentially could be supplied with the lubricity accomplished with the glycerin bi-product of biodiesel production. Dairy usage of an utter wash product primarily consists of glycerin and iodine. Another potential for study is meal, having extremely low moisture content, to be bagged and utilized as an absorbent for chemical and oil spills. All of these concepts generate additional revenue over and above, providing for additional vertical integration and expansions of the existing facility. Once again this promotes rural agriculture, providing environmentally friendly solutions that are economically viable.

Thank-you!

Pam and I would like to personally thank everyone involved with the USDA CREES Program. Your logo has been an icon on the many presentations we have presented across Washington and Oregon. Without your help, this success story of renewable energy for a sustainable rural economy would not exist. The time and effort by all the members of your staff, Washington State legislator, Governor Gregoire, Community Trade & Economic Development, and Port of Sunnyside are to be included into our personal thank-you.