# An Analysis of On-Farm Feed and Fuel from Dryland Camelina

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## Abstract

*Concern over rising and volatile energy prices, the desire for personal energy independence and the promotion of cleaner energy sources has led many farmers to consider oilseed crops as a source of biodiesel. Analysis of the economics of on-farm biodiesel from dryland camelina (camelina sativa) from both individual and group ownership perspectives shows that camelina meal is the primary product from the process. The cost savings of using meal as livestock feed accounts for most of the value. Combining resources to achieve maximum output results in a more efficient process and allows each producer to have less capital outlay.*

**Key words**: Camelina, oilseed, on-farm biodiesel, multi-owner, scale, economics

## Introduction

Concern over rising and volatile energy prices, the desire for personal energy independence and the promotion of cleaner energy sources has led many farmers to consider oilseed crops as a source of biodiesel with its concomitant feed and fuel components. The former CEO of Shell, John Hofmeister said in an recent interview that he expected U.S. gasoline prices to be around $5.00 per gallon by 2012 (NBR, 2010). They are almost there now. In this environment, it makes sense to revisit the potential for on-farm biodiesel production to understand when and if it can be economically viable for dry land farmers to consider investment in the process. Additionally, previous research has shown that the scale of operations may also be an important factor in profitability.

Camelina (*Camelina sativa*) is not a new crop. Evidence of its cultivation in Europe has been found from 5,000 years ago (Putnam et al, 1993). However, it is a new crop for the western United States where cultivation began in the 1980’s (McVay and Lamb, 2008). More recently, there has been increased interest in camelina as an input for biodiesel production and supplemental feeding of the meal to livestock. This paper investigates the economics of on-farm biodiesel production from the oilseed, camelina (*Camelina sativa*) at two different on-farm scales: the individual producer and at a multiple-ownership or “neighbor” level (three producers in local proximity). We also address some of the issues that arise from an attempt to move to the “community” level and the barriers that exist in moving to a higher scale of production. This paper is an outgrowth of a Western Sustainable Agriculture Research and Education (W-SARE) grant to evaluate camelina as a suitable crop for fallow replacement in a dryland cropping system and to evaluate camelina for feeding and biodiesel applications.

The economics of on-farm biodiesel have been investigated by Sawyer (2007), who found that on-farm biodiesel was uneconomic at current petroleum diesel prices. Kingwell and Plunkett (2006) also addressed on-farm production in Western Australia. They also found that on-farm biodiesel was currently uneconomical to produce. Their work showed that the key driver of potential profitability was having an inexpensive feedstock for production. Bender's (1999), review of 12 feasibility studies showed that production costs for biodiesel were greater than pre-tax diesel prices in the U.S. His paper focused mainly on community and industrial scale production.

Although these papers focus on the economics of biodiesel production, they treat meal production as a by- or "co-product", with transportation costs incurred and without regard to its disposition. If the meal is truly a "co-product," then some thought should be given to the disposition of the meal prior to sizing a biodiesel facility. Previous work by two of the authors (Foulke and Hess, 2010) evaluated camelina for an on-farm biodiesel production system. The authors take the view that producers should consider oil seed (in this case, camelina) meal and biodiesel production as a complete system and size their operation accordingly. This means having the land resource to grow the crop and the animals to consume the meal on-farm. This will minimize meal transportation costs. Indeed, as we will show later, the cost savings of not having to purchase and transport livestock feed accounts for most of the economic value in the production system.

## Methods

The systems approach begins with defining the parameters of the system. The authors use a spreadsheet based “calculator” developed for previous work (Foulke and Hess, 2010) with camelina but refined for a more detailed comparison between different levels of operation. Whereas previously, the authors were only concerned with profitability on an individual basis and with experimentally derived yields; here we use a yield more comparable to the average yield for the state of Montana (NASS, 2010). We also expand the use of the highest cost capital component of the system, i.e. the press, to its maximum sustainable capacity in order to increase efficiency; and share the capital cost among a number of neighbor investors.

**Figure 1**. Camelina systems approach diagram.

Figure 1 shows a schematic of how the system is structured. Traditional economic analyses of agricultural enterprises often consist of enterprise budgets to analyze the costs and returns from specific activities. Our approach is similar to a “whole farm” approach in that parts of this enterprise are dependent on other enterprises. The system starts with planting camelina, followed by harvesting and crushing the seed. This results in two products, camelina meal and oil.  Since the majority of the output of the process is meal (in terms of weight and volume), meal becomes the primary constituent and should be consumed as close to the point of production as possible to avoid transportation costs. Therefore, having enough animals locally to consume all the meal annually produced is essential and should be an investor’s first concern.

It should be noted that until November 2009, FDA regulations restricted camelina meal supplemental feeding to two percent of a dry matter ration for cattle due to the high level of erucic acid (4 to 5 percent) contained in camelina (Pilgeram et al, 2007). That restriction has now been raised to 10 percent based on further research (FDA, 2009).

Costs and returns of growing camelina are estimated on a model 4,400 acre dry land farm, hypothetically located in the state of Montana (dryland yields in our home state of Wyoming do not support the system). The farm consists mainly of wheat/fallow dryland crop land. Cropping costs and returns are evaluated using a spreadsheet program developed by Montana State University Extension (Montana, 2010) which analyzes tillage types and cropping mix. The price of diesel fuel reflects the four-year average (2007-2010) U.S. pre-tax diesel price of $2.62/gal (EIA, 2010). The camelina yield is set at 600lbs/acre which is slightly above the 2009 Montana average yield of 546lbs/ac (USDA, 2008). Long-term yield information does not exist. The price of camelina is set at the latest reported average Montana camelina price (2007) of $9.18/cwt (USDA, 2008). All other parameters in the spreadsheet remain unaltered.

These estimates are used as an input in the spreadsheet calculator. This model uses economic information and assumptions from the growing and feeding enterprises and combines it with biodiesel production information. The calculator is designed to be adaptable to other types of oilseed crops as well. Production estimates for oil and meal are used in conjunction with prices for other types of comparable meal substitutes to generate a range of alternative feed costs to compare with the costs of growing and feeding camelina. Cost comparisons with camelina are important because the market for this oilseed is not well developed. Comparisons can be made between three different rations: A substitute ration of one-half corn, one-half soybean meal, linseed meal, canola meal and an estimate of growing and pressing costs for camelina. Due to a lack of data, we use an estimate the value of camelina meal based the average of the price of canola meal and linseed meal. Under this assumption, camelina meal is valued at $0.119/lb. Price data for camelina oil is also not available, so we use an implied price based on the estimated price of the meal and the growing costs for camelina with oil as a residual of the meal production process. Using this method, we estimate the value of the oil to be $2.49/gal.

The model operates at the capacity of the press. Indeed, the model is built around press capacity, since the press is the most expensive piece of capital equipment in the system ($12,500). Within the model, total costs can be viewed as those costs that a single producer/investor would face. To try and determine if any economic efficiency could be found, a multiple ownership scenario for the capital equipment (press and biodiesel production equipment) has been built into the model. We refer to this as the “3-neighbor” scenario since it is assumed that these investors would use the same press and biodiesel production facility, but grow their own crop, feed their own animals with the meal and store their own seed, oil, and biodiesel. It is assumed that the neighbors are all located in close proximity to each other to minimize transportation costs.  The press can easily be transported between the neighbors for crushing, but the oil would have to be brought to a single point for processing. Therefore, one of the neighbors would need to agree to “host” the facility. Different numbers of investors (neighbors) were tried in the model. In the end, the authors chose three as the optimal number. This is because with three investors, each person’s share would equate to growing approximately 128ac of camelina, and more importantly, feeding about 275 head of cattle, which is closer to average herd size in the region than the single investor scenario of 830 head. Of course any arrangement among the neighbors that consumes the meal and oil during the year would be acceptable.

**Table 1**. Biodiesel production facility equipment list and costs.

The model assumes a 20-year life span for the system. Usage of the press was adjusted so that the press would be used the maximum each year in order for its lifespan to be 20 years. Given these assumptions, the press would operate 72 days (24 hours per day) and crush 151,000lbs per year. The biodiesel facility is modeled after Kemp (2006) where 66-gallon water heaters are used to process the oil in 50-gallon batches. A batch must settle overnight, so production capacity is limited to 50 gallons per day. At this rate, oil from an entire crop, 7,344/gal could potentially be processed into biodiesel in 147 batch/days (additional settling tanks could increase capacity, but were not factored in). Table 1 lists the equipment and costs derived from Kemp (2006).

Pressing costs are estimated by using nameplate data from the press. The press used in this project is a Kern Kraft, KK40F with a nameplate throughput capacity of 88lbs per hour and a daily capacity of 2,112/lbs. Current electricity costs are estimated at $0.09 kwh. Daily electricity consumption is estimated to be 38.4 kwh (24hrs X 1.6 kwh). Camelina is assumed to have an average oil content of 34 percent and an average meal content of 66 percent, with an 80 percent extraction rate through the mechanical pressing process. Accounting for 90 percent of planted acres being harvested, this results in an actual oil yield of 27.2 percent.

It is important to note that labor costs are not included in this analysis. Labor for this system is assumed to be all operator labor. No hired labor is required. The amount of labor expended in set-up and production is likely to vary significantly depending on the skills of the operator and any estimate would be purely speculation. Therefore labor is considered to be included in returns to management and capital as in the Montana State University crop budget software used (Montana, 2010). However, the authors realize that set-up and operation labor would be a significant input and if valued, would materially alter the results.

## Results

Table 2 summarizes the estimated start-up costs investors would face to produce biodiesel. This includes the production equipment listed in Table 1, the press, storage tanks and testing and safety equipment. The production of biodiesel involves the use of some hazardous and explosive chemicals (caustic soda and methanol). Quality control of the product is also essential for personal safety and to safeguard equipment. Therefore testing and first aid equipment costs are built into the model.

**Table 2**. Start-up capital summary.

The summary results for the growing, yield and feeding portions of the model are shown in Table 3. Total output is shown under the “Individual” heading as if an individual producer were operating the system. The “3-Neighbors” heading lists the one-third share that each of three neighbors might encounter as part of the group. As previously stated, growing costs and returns were estimated using a spreadsheet budget developed by Montana State University (Montana, 2010). Yield information shows how much meal and oil might be produced from a given acreage. Annual meal usage and oil yield are also shown. Camelina yields in Montana in 2009 ranged from 250lbs/ac to over 1,000lbs/ac and averaged 615lbs/ac. The authors chose to model a

600lbs/ac yield. Note that the actual percent of oil yielded is different from the amount of oil in the seed. This is because the difference in the percentage of acres harvested over those planted as well as the use of a mechanical press, which leaves some oil in the meal. In this scenario, the breakeven operating yield for growing camelina would be 517lbs/acre.

**Table 3**. Camelina calculator annual growing, yield and feeding results.

The model assumes camelina meal is fed to cattle at a rate of 2lbs per day for 90 days (winter feeding). In order for all the meal produced in a given year to be consumed, 830 cattle would need to be fed this ration. Many producers in the region do not have this many cattle, which lends support to the neighbor model used here. The 3-neighbor scenario, assumes each neighbor has a third the number of cattle and land area in camelina as in the individual scenario. As seen in Table 3, the amount of meal produced is quite large. When considering a biodiesel production system, it is important to determine an outlet for meal production, whether among the neighbor investors or others in the region before investing. The authors feel that due to the quantity produced, meal dispensation should be the primary consideration in the decision to invest in this system.

When evaluating the biodiesel production system, the authors found it helpful to present the costs in two different ways: Total costs, including ownership costs and operating costs, and operating costs alone. Operating costs are analogous to cash costs, which many producers use to evaluate the performance of their operations. However, from an economic perspective, ownership costs must be taken into account since they include depreciation and the opportunity cost of capital. Some sources present only operating costs as a compelling reason to invest in biodiesel. The authors feel that this misrepresents the true costs of the enterprise. By showing these two values side-by-side, producers can make more informed investment decisions.

Table 4 shows the summary calculator financial results for both the individual and the 3-neighbors scenarios. Avoided costs are the amount of feed and petroleum diesel that the farmer does not have to buy. At current pre-tax diesel fuel prices, \$2.62/gal the investors would *not* have to buy 7,344 gallons of diesel fuel. The larger savings comes from the cost savings for feed. Investors are estimated to save \$36,018 from feeding camelina meal, assuming an alternate 2lbs ration of one-half corn, one-half soybean meal at \$0.24lb. These two values added together result in total estimated savings of \$55,259. The higher value in the process with the current price structure is from the avoided costs of livestock feed. In other words, from a production standpoint it is more accurate think of this system as being centered on feed production with biodiesel as a by-product.

**Table 4**. Camelina calculator summary financial results.

Total annual costs are estimated by adding growing costs (\$36,267) and biodiesel production costs (\$21,912) for a total cost of \$58,179. Subtracting the avoided costs of fuel and feed (\$55,259) results in the net annual overall savings/cost of the production system (-\$2,920). This number (not including labor) shows that the biodiesel production system from an economic perspective is not economically feasible at the current price of petroleum diesel. However, when evaluated from an “operating costs only” perspective, the total is \$34,034. This is because the ownership costs of growing and processing camelina are not accounted for in this perspective. The 3-neighbors scenario results follow a similar pattern, but are not quite one-third of the individual scenario cost due to the assumption that each of the investors purchase their own storage tanks.

**Table 5**. Camelina biodiesel unit costs of production.

Unit production costs are shown in Table 5. Camelina oil feedstock is the primary constituent, followed by chemicals. Depreciation and annual maintenance are both estimated at five percent of start-up costs (see Table 2). The ‘operating costs only’ columns differ from the ‘total costs’ columns in that camelina oil costs do not include the ownership costs associated with growing the crop, nor is depreciation included. The cost of producing on-farm biodiesel from camelina is estimated to be $2.98/gal. Note again that labor is in the form of returns to management and capital. From the 3-neighbors scenario the cost is a bit higher, $3.04/gal due to the assumption that each investor would have their own set of storage and blending tanks.

Subsidy values required to breakeven and breakeven per unit prices were also calculated from the total cost columns for each scenario. In the individual scenario, a per-gallon subsidy of $0.40 would be required to break even, and equate to a $3.38/gal price of fuel. In the 3-neighbors scenario, these prices rise to $0.45/gal and $3.49/gal respectively. Remember that these values are based on a pre-tax petroleum diesel price of $2.62/gal.

Glycerol is another by-product of the biodiesel production process. Glycerol is combined with methanol and catalyst as a residual to biodiesel production. The process outlined by Kemp (2006) and used here includes a methanol recovery unit to reclaim and reuse as much methanol as possible. Kemp estimates that three pints per batch can be recovered using this method. Yet even with a methanol recovery unit the glycerol is not “refined” and has very little, if any, value unless the producers are close to a processing facility that can refine this product. Some internet sites promote glycerol from biodiesel production as a livestock feed. But here again the authors caution that even with a methanol recovery unit, the amount of methanol in the glycerol by-product is likely too high for livestock and toxic. In order to be fed, the catalyst (either potassium or sodium hydroxide) must also be neutralized with vinegar and the glycerol left to stand for several days until any residual methanol has evaporated. The authors assign no value to glycerol in the model, instead, to avoid disposal issues, the glycerol is treated as described and fed. This process is estimated to produce 1,322 gallons per year (see Table 3).

## Discussion

This paper investigates the costs and returns of a biodiesel production system from camelina in a western United States, dryland crop setting. Important insight has been gained in several areas. The original intent was to investigate economies of scale of moving from the individual scale to a three local investor, “neighbors,” multi-ownership model and to address the issues of moving to the community scale.

Economies of scale are achieved when long run average total costs decrease as output increases. As our results show, the assumption that each investor have their own set of tanks leads to marginally *increasing* the unit cost of production in spite of the shared press and production facility. Since we are not increasing production with multiple-ownership, there are no economies of scale. However, what has been achieved is an increase in efficiency for an average sized producer, since the press and production facility are used to near capacity. Additionally, each investor gains through reduced capital outlay. Therefore, the reduced opportunity cost of capital can be considered a gain in efficiency over a single investor setting up the entire facility.

The per gallon (operating only) cost of $0.40/gal could lead some to think that biodiesel production is profitable given today's diesel price. However, when ownership costs are included, the resulting $3.04/gal production cost shows the enterprise is not profitable. Producers who normally only consider cash costs in production decisions would be wise to take a closer look at the ownership costs involved. Additionally, we assigned labor costs to returns to management and capital. A significant amount of operator time would likely be required to produce the amount of fuel estimated here and these costs would likely add a considerable amount to per unit production costs if factored in.

Perhaps the greatest challenge to biodiesel profitability is the opportunity cost of putting land into camelina when prices for other crops (especially wheat in our region) are so high. It makes it hard to justify growing a marginal crop like camelina when profitability of more mainstream crops is so great. Of course crop prices do fluctuate, and there may come a time when this difference is not so great.

Since the current market for camelina is thin (low trading volumes and few trading hubs), it is important to have sufficient livestock resources (or access to them) to dispose of the meal, although this could change if the market matures. Our calculations show that at current meal and diesel fuel prices, camelina meal, and the role it plays in the capital flows of the system plays a more central role than that of the oil.

The capital costs of setting up even a modest biodiesel production system are relatively large. The system designed for our project requires a significant investment of financial resources ($19,443). Much of this cost is associated with the press. Informal conversations with a rural banker indicate that this type of enterprise would be difficult to finance under traditional terms. Therefore having sufficient financial resources, on hand, would be required.

To understand economies of scale, the authors wanted to investigate a multiple-press, multiple-ownership scenario with the model. This was intended to be a “community” level model on the order of 9 to 12 investors and three or four presses. However, as work on this model progressed; it became clear that this was a larger undertaking than first thought and represents an order of magnitude higher than multiple-ownership. A number of questions came up that would necessitate a rethinking of the whole model. For instance, a multiple-press model would not be mobile and would require some sort of building (and heat and light). And the quantities of oil and meal produced would require more extensive storage facilities. The biodiesel processing facility would need to be scaled up and would no longer fit with what had been originally designed for on-farm use. With additional investors, some sort of more formal business arrangement seems to be more appropriate than the “neighbor” model proposed here. This could potentially be some sort of cooperative structure. Some provision for liability, insurance and financing would likely be necessary to move to this higher scale. More administration would be required to monitor operations and some hired labor would likely be necessary. Transportation costs would also become more of an issue as farmers would need to transport seed, oil and meal to a central processing facility and haul the products back to the farm. The amount of meal and glycerol produced from a larger facility would be more difficult to dispose of locally unless there is already a robust livestock industry in the region. For these reasons, the authors felt that the number of assumptions about a larger scale facility would make comparison with the work already done problematic and beyond the scope of the current work.

The question remains, under what conditions would on-farm biodiesel become economically viable? The authors support Kingwell and Plunkett (2006) in their contention that there is no one “trigger price” for economic viability. Rather, different producers will face different scenarios based on their production practices and prices that they face. Some preliminary work with our calculator model shows that when holding all costs static except pre-tax petroleum diesel of $2.62, on-farm biodiesel would break even at $3.38/gal. However, it is not unreasonable to think that if petroleum diesel prices were to rise than other input prices would follow suite, thereby shifting the production price structure upwards. Achieving a breakeven price for on-farm biodiesel likely converges at some point, but beyond what the authors found reasonable to model.

The authors’ model also supports Kingwell and Plunkett in their contention that the key driver in the system is the price of the feedstock. The amount of meal produced makes it the primary component of the system. Lower price (cost) feedstocks increase the attractiveness of on-farm production. But opportunity costs of capital and depreciation in the production system, in most cases, would keep these costs from going low enough to support economically viable on-farm biodiesel production.

From a purely economic perspective, on-farm biodiesel production from camelina is not economically feasible. This research serves to illustrate the premium producers would need to achieve their goals. However, the authors understand that economics is only one variable (albeit quite important) in the decision-making process. Those farmers concerned about access to fuel, volatile fuel prices and the impact of petroleum diesel on the environment do have a choice. Biodiesel may have a place in farmer’s production system, but it will not come without a price.

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**Figure 1**. Camelina systems approach diagram.

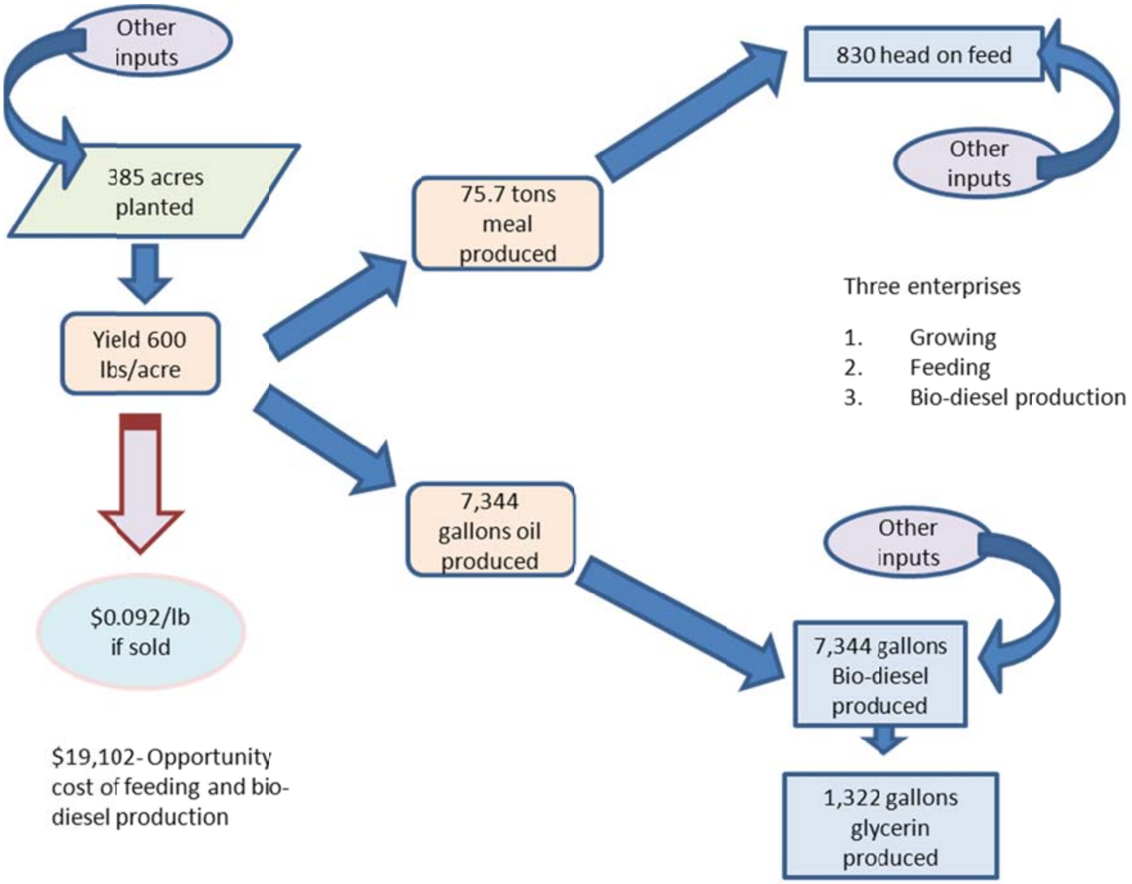

**Table 1**. Biodiesel production facility equipment list and costs.

| **Qty** | **Item** | **price/ea** | **Cost** |
|---|---|---|---|
| 3 | 66 gallon electric hot water heaters (@ $467 ea) | $467.65 | $1,402.95 |
| 1 | 30 gallon mixing tank and stand (conical base) | $149.00 | $149.00 |
| 1 | 60 gallon wash tank and stand (conical base) | $175.00 | $175.00 |
| 1 | 300 gallon raw oil storage tank | $249.00 | $249.00 |
| 1 | 300 gallon biodiesel storage tank | $249.00 | $249.00 |
| 1 | 40 gallon treated water storage tank | $70.00 | $70.00 |
| 4 | liquid pumps, 1/2 hp @600gpm | $40.00 | $160.00 |
| 1 | reverse osmosis water purifying system (GE Merlin) | $390.00 | $390.00 |
| 1 | air/liquid condenser unit (estimated) | $200.00 | $200.00 |
| 1 | ventilator fan (Broan 701 cfm fan) | $159.00 | $159.00 |
| 1 | chemical mixer (Talboys laboratory stirrer explosion proof) | $231.00 | $231.00 |
| 1 | water tank heater (1,000 watt) | $19.80 | $19.80 |
| 1 | Small compressor (airbrush compressor like below) | $80.00 | $80.00 |
| 1 | air blower (airbrush compressor with variable speed) | $80.00 | $80.00 |
| 1 | chemical hand pump (barrel fuel type pump) | $24.99 | $24.99 |
| 2 | 2 inline oil filters (estimate) | $30.00 | $60.00 |
| 1 | 1 inline air filter | $7.99 | $7.99 |
| 16 | 3/4" ball valves | $12.73 | $203.68 |
| 1 | 3/4" re-enforced nylon tubing (per 50 foot box) | $49.49 | $49.49 |
| 20 | 3/4" black mild steel pipe (per foot) | $2.50 | $50.00 |
| 1 | 14 gauge electrical wire -Romex (per 250' roll) | $43.90 | $43.90 |
| 1 | Electrical load center, 100 amp | $49.00 | $49.00 |
| 1 | assorted fasteners and couplings | $100.00 | $100.00 |
| 1 | digital probe thermometer | $42.95 | $42.95 |
|  |  |  | **$4,246.75** |

**Table 2**. Start-up capital summary.

| **Total estimated** | **Individual** | **3-neighbor (Per investor)** |
|---|---:|---:|
| Biodiesel production equipment | $4,671 | $1,557 |
| Press cost | $12,500 | $4,167 |
| Storage tanks | $1,959 | $1,959 |
| Testing and Safety equipment | $313 | $104 |
| Total estimated start-up costs | **$19,443** | **$7,787** |

**Table 3**. Camelina calculator annual growing, yield and feeding results.

| | **Individual** | **3-Neighbors** |
|---|---|---|
| **Growing costs** ($/ac) | | |
| Gross revenue (@ $0.0918lbs/ac) | $55.08 | $55.08 |
| Total operating costs | -$47.47 | -$47.47 |
| Total ownership costs | -$46.73 | -$46.73 |
| Total growing costs | -$94.20 | -$94.20 |
| Returns over operating costs | $7.61 | $7.61 |
| Returns over total costs | -$39.12 | -$39.12 |
| **Yield** | | |
| Area of camelina planted | 385 | 128 |
| Area harvested (90%) | 367 | 122 |
| Yield | 600lbs/ac | 600lbs/ac |
| Total harvest | | |
| Percent oil | 34 | 34 |
| Percent meal | 66 | 66 |
| Percent of oil extracted | 80 | 80 |
| Actual percent oil yield | 27.2 | 27.2 |
| Total weight of oil | 56,549lbs | 18,850lbs |
| Total weight of meal | 151,351lbs | 50,450lbs |
| Total volume of oil (@7.7lbs/gal) | 7,344gal | 2,443gal |
| Total weight of meal | 75.6 tons | 25.2 tons |
| Total glycerol production | 1,322gal | 441gal |
| **Feeding** | | |
| Feeding rate | 2lbs/day | 2lbs/day |
| Number of days on feed | 90 | 90 |
| Number of head on feed | 830 | 277 |
| Total consumption of meal | 149,400lbs | 49,800 |
| Residual meal | 1,951lbs | 650lbs |

**Table 4**. Camelina calculator summary financial results

| | **Individual*** | | **3-neighbors*** | |
|---|---|---|---|---|
| | Total costs | Operating costs only | Total costs | Operating costs only |
| Fuel costs avoided | $19,241 | $19,241 | $6,414 | $6,414 |
| Feed costs avoided | $36,018 | $36,018 | $12,006 | $12,006 |
| | $55,259 | $55,259 | $18,420 | $18,420 |
| Growing costs | $36,267 | $18,276 | $12,089 | $6,092 |
| Biodiesel production costs | $21,912 | $2,949 | $7,435 | $1,048 |
| | $58,179 | $21,225 | $19,524 | $7,140 |
| Total est. cost or savings | **-$2,920** | **$34,034** | **-$1,104** | **$11,279** |

**Assumes labor is included in returns to management and capital*

**Table 5**. Camelina biodiesel unit costs of production.

**A. Individual scenario**

| | Total costs | | Operating costs only | |
|---|---|---|---|---|
| | Per gallon | Per batch* | Per gallon | Per batch* |
| Camelina oil | $2.49 | $124.35 | $0.04 | $1.87 |
| Chemicals | $0.20 | $9.91 | $0.20 | $9.91 |
| Annual operating cost | $0.03 | $1.69 | $0.03 | $1.69 |
| Capital depreciation (5% of startup) | $0.13 | $6.62 | $0.00 | $0.00 |
| Annual maintenance costs (5% of startup) | $0.13 | $6.62 | $0.13 | $6.62 |
| Total | **$2.98** | **$149.18** | **$0.40** | **$20.08** |
| Per gallon subsidy required to breakeven | **$0.40** | | | |
| Per gallon breakeven price | **$3.38** | | | |

**B. 3-neighbor scenario**

| | Total costs | | Operating costs only | |
|---|---|---|---|---|
| | Per gallon | Per batch* | Per gallon | Per batch* |
| Camelina oil | $2.49 | $124.35 | $0.04 | $1.87 |
| Chemicals | $0.20 | $9.91 | $0.20 | $9.91 |
| Annual operating cost | $0.03 | $1.69 | $0.03 | $1.69 |
| Capital depreciation (5% of startup) | $0.16 | $7.95 | $0.00 | $0.00 |
| Annual maintenance costs (5% of startup) | $0.16 | $7.95 | $0.16 | $7.95 |
| Total | **$3.04** | **$151.85** | **$0.43** | **$21.41** |
| Per gallon subsidy required to breakeven | **$0.45** | | | |
| Per gallon breakeven | **$3.49** | | | |

**1 batch equals 50 gallons*