

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

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Abstract

48

Concern over rising and volatile energy prices, the desire for personal energy independence and

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the promotion of cleaner energy sources has led many farmers to consider oilseed crops as a

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source of biodiesel. Analysis of the economics of on-farm biodiesel from dryland camelina

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(camelina sativa) from both individual and group ownership perspectives shows that camelina

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meal is the primary product from the process. The cost savings of using meal as livestock feed

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accounts for most of the value. Combining resources to achieve maximum output results in a

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more efficient process and allows each producer to have less capital outlay.

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

57

58 **Introduction**

59 Concern over rising and volatile energy prices, the desire for personal energy independence and
60 the promotion of cleaner energy sources has led many farmers to consider oilseed crops as a
61 source of biodiesel with its concomitant feed and fuel components. The former CEO of Shell,
62 John Hofmeister said in a recent interview that he expected U.S. gasoline prices to be around
63 \$5.00 per gallon by 2012 (NBR, 2010). They are almost there now. In this environment, it makes
64 sense to revisit the potential for on-farm biodiesel production to understand when and if it can be
65 economically viable for dry land farmers to consider investment in the process. Additionally,
66 previous research has shown that the scale of operations may also be an important factor in
67 profitability.

68

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

79 grant to evaluate camelina as a suitable crop for fallow replacement in a dryland cropping system
80 and to evaluate camelina for feeding and biodiesel applications.

81
82 The economics of on-farm biodiesel have been investigated by Sawyer (2007), who found that
83 on-farm biodiesel was uneconomic at current petroleum diesel prices. Kingwell and Plunkett
84 (2006) also addressed on-farm production in Western Australia. They also found that on-farm
85 biodiesel was currently uneconomical to produce. Their work showed that the key driver of
86 potential profitability was having an inexpensive feedstock for production. Bender's (1999),
87 review of 12 feasibility studies showed that production costs for biodiesel were greater than pre-
88 tax diesel prices in the U.S. His paper focused mainly on community and industrial scale
89 production.

90
91 Although these papers focus on the economics of biodiesel production, they treat meal
92 production as a by- or "co-product", with transportation costs incurred and without regard to its
93 disposition. If the meal is truly a "co-product," then some thought should be given to the
94 disposition of the meal prior to sizing a biodiesel facility. Previous work by two of the authors
95 (Foulke and Hess, 2010) evaluated camelina for an on-farm biodiesel production system. The
96 authors take the view that producers should consider oil seed (in this case, camelina) meal and
97 biodiesel production as a complete system and size their operation accordingly. This means
98 having the land resource to grow the crop and the animals to consume the meal on-farm. This
99 will minimize meal transportation costs. Indeed, as we will show later, the cost savings of not
100 having to purchase and transport livestock feed accounts for most of the economic value in the
101 production system.

102

103 **Methods**

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

112

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

114

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

124

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

129

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

140

141 These estimates are used as an input in the spreadsheet calculator. This model uses economic
142 information and assumptions from the growing and feeding enterprises and combines it with
143 biodiesel production information. The calculator is designed to be adaptable to other types of
144 oilseed crops as well. Production estimates for oil and meal are used in conjunction with prices
145 for other types of comparable meal substitutes to generate a range of alternative feed costs to
146 compare with the costs of growing and feeding camelina. Cost comparisons with camelina are
147 important because the market for this oilseed is not well developed. Comparisons can be made

148 between three different rations: A substitute ration of one-half corn, one-half soybean meal,
149 linseed meal, canola meal and an estimate of growing and pressing costs for camelina. Due to a
150 lack of data, we use an estimate the value of camelina meal based the average of the price of
151 canola meal and linseed meal. Under this assumption, camelina meal is valued at \$0.119/lb. Price
152 data for camelina oil is also not available, so we use an implied price based on the estimated
153 price of the meal and the growing costs for camelina with oil as a residual of the meal production
154 process. Using this method, we estimate the value of the oil to be \$2.49/gal.

155
156 The model operates at the capacity of the press. Indeed, the model is built around press capacity,
157 since the press is the most expensive piece of capital equipment in the system (\$12,500). Within
158 the model, total costs can be viewed as those costs that a single producer/investor would face. To
159 try and determine if any economic efficiency could be found, a multiple ownership scenario for
160 the capital equipment (press and biodiesel production equipment) has been built into the model.
161 We refer to this as the “3-neighbor” scenario since it is assumed that these investors would use
162 the same press and biodiesel production facility, but grow their own crop, feed their own animals
163 with the meal and store their own seed, oil, and biodiesel. It is assumed that the neighbors are all
164 located in close proximity to each other to minimize transportation costs. The press can easily be
165 transported between the neighbors for crushing, but the oil would have to be brought to a single
166 point for processing. Therefore, one of the neighbors would need to agree to “host” the facility.
167 Different numbers of investors (neighbors) were tried in the model. In the end, the authors chose
168 three as the optimal number. This is because with three investors, each person’s share would
169 equate to growing approximately 128ac of camelina, and more importantly, feeding about 275
170 head of cattle, which is closer to average herd size in the region than the single investor scenario

171 of 830 head. Of course any arrangement among the neighbors that consumes the meal and oil
172 during the year would be acceptable.

173

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

175

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

184

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

192

193 It is important to note that labor costs are not included in this analysis. Labor for this system is
194 assumed to be all operator labor. No hired labor is required. The amount of labor expended in

195 set-up and production is likely to vary significantly depending on the skills of the operator and
196 any estimate would be purely speculation. Therefore labor is considered to be included in returns
197 to management and capital as in the Montana State University crop budget software used
198 (Montana, 2010). However, the authors realize that set-up and operation labor would be a
199 significant input and if valued, would materially alter the results.

200

201 **Results**

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

208

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

210

211 The summary results for the growing, yield and feeding portions of the model are shown in
212 Table 3. Total output is shown under the “Individual” heading as if an individual producer were
213 operating the system. The “3-Neighbors” heading lists the one-third share that each of three
214 neighbors might encounter as part of the group. As previously stated, growing costs and returns
215 were estimated using a spreadsheet budget developed by Montana State University (Montana,
216 2010). Yield information shows how much meal and oil might be produced from a given
217 acreage. Annual meal usage and oil yield are also shown. Camelina yields in Montana in 2009
218 ranged from 250lbs/ac to over 1,000lbs/ac and averaged 615lbs/ac. The authors chose to model a

219 600lbs/ac yield. Note that the actual percent of oil yielded is different from the amount of oil in
220 the seed. This is because the difference in the percentage of acres harvested over those planted as
221 well as the use of a mechanical press, which leaves some oil in the meal. In this scenario, the
222 breakeven operating yield for growing camelina would be 517lbs/acre.

223

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

225

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

236

237 When evaluating the biodiesel production system, the authors found it helpful to present the
238 costs in two different ways: Total costs, including ownership costs and operating costs, and
239 operating costs alone. Operating costs are analogous to cash costs, which many producers use to
240 evaluate the performance of their operations. However, from an economic perspective,
241 ownership costs must be taken into account since they include depreciation and the opportunity

242 cost of capital. Some sources present only operating costs as a compelling reason to invest in
243 biodiesel. The authors feel that this misrepresents the true costs of the enterprise. By showing
244 these two values side-by-side, producers can make more informed investment decisions.

245
246 Table 4 shows the summary calculator financial results for both the individual and the 3-
247 neighbors scenarios. Avoided costs are the amount of feed and petroleum diesel that the farmer
248 does not have to buy. At current pre-tax diesel fuel prices, \$2.62/gal the investors would *not* have
249 to buy 7,344 gallons of diesel fuel. The larger savings comes from the cost savings for feed.
250 Investors are estimated to save \$36,018 from feeding camelina meal, assuming an alternate 2lbs
251 ration of one-half corn, one-half soybean meal at \$0.24lb. These two values added together result
252 in total estimated savings of \$55,259. The higher value in the process with the current price
253 structure is from the avoided costs of livestock feed. In other words, from a production
254 standpoint it is more accurate think of this system as being centered on feed production with
255 biodiesel as a by-product.

256
257 **Table 4.** Camelina calculator summary financial results.
258

259 Total annual costs are estimated by adding growing costs (\$36,267) and biodiesel production
260 costs (\$21,912) for a total cost of \$58,179. Subtracting the avoided costs of fuel and feed
261 (\$55,259) results in the net annual overall savings/cost of the production system (-\$2,920). This
262 number (not including labor) shows that the biodiesel production system from an economic
263 perspective is not economically feasible at the current price of petroleum diesel. However, when
264 evaluated from an “operating costs only” perspective, the total is \$34,034. This is because the
265 ownership costs of growing and processing camelina are not accounted for in this perspective.
266 The 3-neighbors scenario results follow a similar pattern, but are not quite one-third of the

267 individual scenario cost due to the assumption that each of the investors purchase their own
268 storage tanks.

269

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

271

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

280

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

286

287 Glycerol is another by-product of the biodiesel production process. Glycerol is combined with
288 methanol and catalyst as a residual to biodiesel production. The process outlined by Kemp
289 (2006) and used here includes a methanol recovery unit to reclaim and reuse as much methanol
290 as possible. Kemp estimates that three pints per batch can be recovered using this method. Yet

291 even with a methanol recovery unit the glycerol is not “refined” and has very little, if any, value
292 unless the producers are close to a processing facility that can refine this product. Some internet
293 sites promote glycerol from biodiesel production as a livestock feed. But here again the authors
294 caution that even with a methanol recovery unit, the amount of methanol in the glycerol by-
295 product is likely too high for livestock and toxic. In order to be fed, the catalyst (either potassium
296 or sodium hydroxide) must also be neutralized with vinegar and the glycerol left to stand for
297 several days until any residual methanol has evaporated. The authors assign no value to glycerol
298 in the model, instead, to avoid disposal issues, the glycerol is treated as described and fed. This
299 process is estimated to produce 1,322 gallons per year (see Table 3).

300

301 **Discussion**

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

307

308 Economies of scale are achieved when long run average total costs decrease as output increases.
309 As our results show, the assumption that each investor have their own set of tanks leads to
310 marginally *increasing* the unit cost of production in spite of the shared press and production
311 facility. Since we are not increasing production with multiple-ownership, there are no economies
312 of scale. However, what has been achieved is an increase in efficiency for an average sized
313 producer, since the press and production facility are used to near capacity. Additionally, each

314 investor gains through reduced capital outlay. Therefore, the reduced opportunity cost of capital
315 can be considered a gain in efficiency over a single investor setting up the entire facility.

316

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

325

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

331

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

337

338 The capital costs of setting up even a modest biodiesel production system are relatively large.

339 The system designed for our project requires a significant investment of financial resources

340 (\$19,443). Much of this cost is associated with the press. Informal conversations with a rural

341 banker indicate that this type of enterprise would be difficult to finance under traditional terms.

342 Therefore having sufficient financial resources, on hand, would be required.

343

344 To understand economies of scale, the authors wanted to investigate a multiple-press, multiple-

345 ownership scenario with the model. This was intended to be a “community” level model on the

346 order of 9 to 12 investors and three or four presses. However, as work on this model progressed;

347 it became clear that this was a larger undertaking than first thought and represents an order of

348 magnitude higher than multiple-ownership. A number of questions came up that would

349 necessitate a rethinking of the whole model. For instance, a multiple-press model would not be

350 mobile and would require some sort of building (and heat and light). And the quantities of oil

351 and meal produced would require more extensive storage facilities. The biodiesel processing

352 facility would need to be scaled up and would no longer fit with what had been originally

353 designed for on-farm use. With additional investors, some sort of more formal business

354 arrangement seems to be more appropriate than the “neighbor” model proposed here. This could

355 potentially be some sort of cooperative structure. Some provision for liability, insurance and

356 financing would likely be necessary to move to this higher scale. More administration would be

357 required to monitor operations and some hired labor would likely be necessary. Transportation

358 costs would also become more of an issue as farmers would need to transport seed, oil and meal

359 to a central processing facility and haul the products back to the farm. The amount of meal and

360 glycerol produced from a larger facility would be more difficult to dispose of locally unless there
361 is already a robust livestock industry in the region. For these reasons, the authors felt that the
362 number of assumptions about a larger scale facility would make comparison with the work
363 already done problematic and beyond the scope of the current work.

364

365 The question remains, under what conditions would on-farm biodiesel become economically
366 viable? The authors support Kingwell and Plunkett (2006) in their contention that there is no one
367 “trigger price” for economic viability. Rather, different producers will face different scenarios
368 based on their production practices and prices that they face. Some preliminary work with our
369 calculator model shows that when holding all costs static except pre-tax petroleum diesel of
370 \$2.62, on-farm biodiesel would break even at \$3.38/gal. However, it is not unreasonable to think
371 that if petroleum diesel prices were to rise than other input prices would follow suite, thereby
372 shifting the production price structure upwards. Achieving a breakeven price for on-farm
373 biodiesel likely converges at some point, but beyond what the authors found reasonable to
374 model.

375

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

382

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

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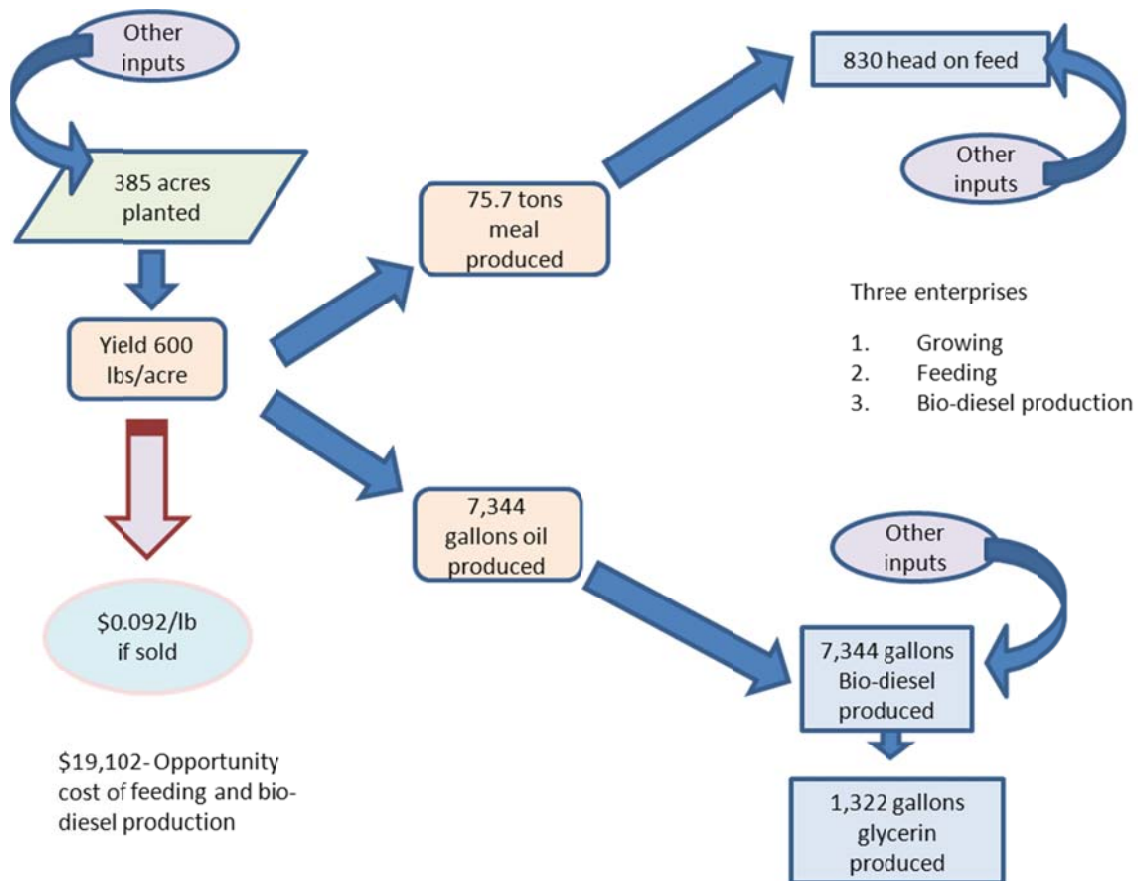
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455 **Figure 1.** Camelina systems approach diagram.

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

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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

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461 **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

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

	Individual	3-Neighbors⁴⁶⁵
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

466 **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

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

	Total costs		Operating costs only	
	Per gallon	Per batch*	Per gallon	Per batch*
A. Individual scenario				
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			
<i>*1 batch equals 50 gallons</i>				