Growing Camelina for Bio-Diesel in Arkansas Delta

Business Feasibility Study

For

Arkansas Green Energy Network

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Executive Summary

As part of the Wealth Creation in Rural Communities – Building Sustainable Livelihoods Initiative[1], Arkansas Green Energy Network (AGEN) is exploring the possibility of developing value chains to help Arkansas Delta communities create wealth by becoming more energy sustainable. The introduction of a bioenergy crop, Camelina, could provide business opportunities along a value chain for:

- Small farmers who grow seed
- Farmers who grow Camelina as an alternative winter crop for profit
- Commercial harvesters who harvest the crop for small farmers without equipment
- Seed processors to extract oil and meal
- Micro bio-refineries to process Camelina oil into bio-diesel and other products.
- Transportation haulers of seed, oil and meal
- Feed processors to mix Camelina meal with other ingredients for feed rations.

Research and seed variety testing is ongoing in the Northwest United States by Montana State University, Oregon State University, private companies and others. These studies have shown that Camelina can be grown in cool climates on marginal soil with little fertilizer inputs and little water. Some research has been done in the Arkansas Delta by researchers at Arkansas State University and University of Arkansas – Phillips County Community College in Dewitt. Because of limited experience growing the crop, the yields from the first round of planting have been low and more research is needed to see if the crop can be successfully grown in the Arkansas Delta.

Camelina has a very short maturity cycle (100 days or less with some varieties 85 or less) and could be an alternative winter crop to replace winter wheat or be utilized as a second income crop for cotton and soybean farmers. For soybean farmers, yields drop five bushels per acre

[1] Within The Ford Foundation, this work is part of the Expanding Livelihood Opportunities for Poor Households Initiative.

when winter wheat is grown and soybeans are planted later in the year. A winter crop of Camelina will allow soybeans to be planted on time without loss in yields. Camelina yields of 1,500 pounds or more per acre will make Camelina financially more lucrative than winter wheat.

Camelina is not a traded commodity tracked by the United States Department of Agriculture (USDA) and is not eligible for crop insurance or subsidies. Current farmers are lobbying the USDA to change Camelina to a commodity. The addition of a southern lobby will help move the process along. Currently, farmers grow Camelina under a contract with private seed companies and the entire crop is sold back to the seed company at the contracted price. A partnership with an existing seed company will need to be executed or a new local Mid-South seed Company will need to be started to build an infrastructure for the Camelina market.

Camelina is an attractive oilseed crop because of the high oil content (30-40%). Meal extracted from the seed is high in Omega-3 and Vitamin E. However, the Federal Drug Administration (FDA) has not approved Camelina for human consumption. Recently, the FDA has approved feed rations with up to 10% Camelina meal for cattle. Camelina can be used in limited amounts in swine rations and FDA has issued a "letter of no objection to 10% use in broiler feed. Research has shown that feeding Camelina meal to layers increases the Omega-3 in eggs.

Camelina oil is squeezed from the seed using crushers. The oil can be used as a feedstock for bio-diesel, lubricants and other uses. Cost of Camelina oil is estimated to be $4.75 per gallon. Using income from the meal to offset the cost of the oil, the cost drops to $2.88 per gallon. Camelina oil is still too expensive to be used as a feedstock for bio-diesel at the present time without incentives. Increases in the price of oil could make Camelina and other oilseeds more attractive in the future. Movement by airlines and the military to use bio-fuels will increase demand for bio jet fuel in the next 10 years increasing demand for Camelina oil.

The process of oil and meal extraction is similar to current soybean, cottonseed and other oilseed. Large crushing operations are available in the Arkansas Delta with plenty of excess capacity. Proven production processes are available to produce biodiesel in batch or continuous flow. Micro-crushers and refineries could use small amounts of oil until market demands increase.

Study Conclusions

According to a study by BioMass Advisors, research in growing Camelina has accelerated due to demand and possible contracts for aviation biofuels by private airlines and the military. Most of this research has been concentrated in the Northwest and Northern Plains in the U.S and Western Provinces of Canada. Local farmers in these areas have contracted with local companies such as Sustainable Oils and Great Plains Oil to grow Camelina. Total acreage planted in Montana fell in 2009 and yields have not been as high as expected. Camelina grows best in cool, arid climates and is being tested as a replacement for Spring Wheat in those areas. The crop grows on marginal land with very little input costs for seed, fertilizer and herbicides. Yields have varied up to 2,500 pounds per acre in research trials.

Limited research has been done on the crop in the Mid-South Delta region on very small acres of land. Research for this study has found:

- Camelina can be grown as a cool weather crop to replace winter wheat or as a rotational winter crop behind soybeans, corn or cotton. Additional research is needed to:
    - See the effects of growing Camelina behind these crops.
    - Determine the effect of residual carryover of herbicides and pesticides on Camelina
    - Determine the effects of residual Camelina in cotton, corn or soybeans fields.
- Source of Camelina seed is limited and would have to be ordered from current sources located in the Western U.S.
    - Until a local source of seed is developed, the price of seed used for planting will be slightly higher for Mid-South farmers because of freight costs to ship the seed to the Mid-South.
    - A node on the value chain could be developed using small farmers to grow Camelina for seed under strict conditions that adhere to regulations of the Arkansas Plant Board.

- Plant breeding and development of seed varieties to grow in the Delta will be an important next step in expanding Camelina acreage.
  - Large seed companies have the resources to develop different varieties of Camelina and use test farms in South America to speed the time for development.
  - Possible partnerships with large seed companies can help reduce costs and time to market for Camelina seed varieties for the Arkansas Delta.
- No established market for Camelina exists today because of lack of USDA commodity status.
  - Camelina crop is not eligible for crop insurance or farm subsidies due to the restrictions. Mid-South farmers can join with farmers from other parts of the country to lobby for commodity status.
  - A local organization can be established to contract with local farmers to grow adaptive varieties for the Delta.
  - A local Mid-South Company can process the seed into Camelina meal and help negotiate the sale of meal to feed processors.
  - An alternative may be to contract with existing companies in the Northwest to grow Camelina for them if economically feasible.
- Crushing capabilities are available for the extraction of oil and meal in the Mid-South area.
  - Additional tests are needed to see if current facilities can handle the small seed and extract oil at economical rates.
  - Small crushers can be purchased to handle the expected crop until available volume is substantial enough for contracting with larger oilseed crushers.
- The market for Camelina meal is limited due to FDA restrictions that require 10% or less of Camelina meal in livestock rations.

- A huge potential market for the meal exists in the Arkansas poultry industry if the restrictions are lifted or the percentage of meal allowed in rations is increased. Because of the close proximity to the poultry growers, Delta growers will have a price advantage because of lower freight costs.

- Because of the high commodity prices, the cost of all oilseeds used as feedstock for bio-fuels is too high at the present time. Most refineries are processing used cooking oil and animal tallow. Both are much less expensive and allow a more competitive cost of biofuel production. The cost of Camelina oil can be reduced by offsetting the sale of meal.
    - Small locally owned bio-refineries selling both meal and oil could be developed to process the oil into bio-diesel to be used locally.

Conclusion: Growing Camelina and processing the seed into oil, meal and other by-products shows huge future potential in the Mid-South area. For Camelina to be an economically viable crop, local companies will need to invest in:

- Conducting field trials on various varieties of Camelina in various types of soil and other conditions in the Delta.
- Plant breeding and testing for adaptable varieties to these conditions.
- Lobbying with Camelina growers in other parts of the United States for FDA approval for human consumption of Camelina oil and higher percentage of Camelina meal used in livestock rations.
- Using revenue from the sale of meal to offset the cost of producing Camelina oil for it to be cost competitive in producing bio-fuels.

Study Definition

Research from studies and personal interviews will be used to evaluate Camelina crops. The adaptability of Camelina in the Arkansas Delta will be explored using studies from Montana State University, Oregon State University and Penn State University in field trials conducted on Camelina crops in those states. Additional data from field trials at Arkansas State University, BioDimensions in Memphis, UA Phillips County Community College in Stuttgart and other regional studies will be evaluated. These studies will be used to determine:

- Best types of soil for maximum Camelina yields.
- Amount of moisture needed.
- Inputs of fertilizer, herbicides and other chemicals.
- Expected yields of Camelina crop.
- Breakeven analysis of cost of inputs versus yields and value of revenue generated.

In the second phase of the process, a model will be developed for locally owned companies to develop the value chain if economically feasible. The model can be used by a cooperative, company or other organizations to follow as the Camelina is grown and processed into bio-diesel or bio-jet fuel. Nodes on the value chain include:

- Seed production.
- Education and promotion of Camelina crop.
- Planting, growing and harvesting Camelina.
- Transportation of seed to processing location.
- Seed crushing and oil extraction.
- Meal production.
- Sale of Camelina meal to area livestock feed processors to mix into livestock rations while meeting the 10% requirements.
- Processing of oil into bio-diesel or jet fuel.

Growing Camelina

Camelina is an ideal crop for the cool summer climate in the Northern U.S. and Canada. Camelina grows best in areas with cold winters, cool spring weather and little rainfall. Field trials have proven that Camelina is:

- A low input and hardy crop.
- Low fertilizer requirements.
- Strong yields with limited rainfall and soil moisture.
- Seedlings can withstand hard frost.
- Short growing season. 100 – 110 days with varieties being tested at 85 days.
- Weed and pest resistant.
- Competitive oil yields compared to other oilseed crops.
- Cannot be used directly in food which helps prevent the current food versus fuel argument.

Based on available research, Camelina could only be grown during Delta winters as a replacement for winter wheat or other winter crops. Florida farmers have successfully double cropped Camelina by planting in October and harvesting in December and replanting in January and harvesting in March. It is doubtful that this practice could be done in the Arkansas Delta because of the earlier frost dates and colder winter temperatures.
Because of the short growing season, studies are being done to test Camelina as a double crop behind cotton or soybeans. Camelina would be planted in October or November after the cotton or soybean crop is harvested. Camelina would be harvested in April before cotton is planted in May or around the same time as a normal soybean crop is planted. Total 2011 estimated Arkansas cotton acreage is 650,000. If economically feasible, Arkansas cotton farmers could generate additional income on their land by growing Camelina.

Camelina is a cool weather crop that matures in 85 to 100 days. Sustainable Oils is currently field testing certain varieties that mature in 80 days or less. According to research in Montana and other Northern states, the crop germinates at low temperatures and the seedlings are very frost tolerant. According to Arkansas State University field trials the crop goes dormant during colder weather and begins growing as temperatures become warm again. This is similar to existing winter wheat grown in the Arkansas Delta area.

An analysis of climate conditions in the Arkansas Delta is shown in Table One.

Table 1				
	Average Precipitation		**Temperature**	
Month	**Rain**	**Snow**	**Maximum**	**Minimum**
January	4.60	2.3	50	33
February	3.89	1.4	54	35
March	4.66	.5	62.7	43.2
April	5.10	None	72.5	52.6
May	5.02	None	79.9	60.4
June	3.71	None	87.8	68.5
July	3.41	None	91.0	71.8
August	3.32	None	90.3	70.7
September	3.40	None	84.4	64
October	2.91	None	74.4	52.9
November	4.15	.5	61.6	42.1
December	4.13	.8	52.4	35.2

No seedling damage has been seen at temperatures as low as 12°F. Camelina should tolerate Arkansas temperature patterns during a winter growing season (October through April) with maximum highs 50-74.4 and minimum lows 33-52.9. However, it will be important to harvest the crop no later than early May because temperatures above 85° can cause damage to the pods and decrease production.

Of particular concern is the higher precipitation in Arkansas. In northern field trials, Camelina seemed to do best in areas with 8 -15 inches of annual precipitation. Average Arkansas rainfall from October to April is 24.34 inches with additional precipitation from snowfall. During the wet Spring of 2011, researchers in Dewitt recorded some drown outs due to excess rainfall. In studies completed in Montana and Colorado, Camelina had an advantage over other oilseeds at moisture levels up to 15 inches. Other oilseeds such as canola, soybean, safflower and sunflower have higher yields per acre when rainfall exceeds 15 inches.

Camelina can be grown on marginal land. However, Camelina needs certain levels of nitrogen, sulfur and phosphorus fertilizer for adequate yields. According to research, Camelina needs 40-60 pounds of nitrogen per acre; 60 pounds of phosphorous per acre and 15-20 pounds of sulfur per acre to grow well. Nitrogen above 60 pounds per acre will have a marginal effect on yield but the increase will not offset the increased cost of the fertilizer. Additional sulfur may only be needed in low sulfur soils. Application of sulfur increases oil content but does not increase seed yield. Studies will need to be conducted in the Arkansas Delta to determine the most economical amount of fertilizer used with the higher moisture levels available. Camelina seems to grow best in coarse texture or well drained soils.

Camelina seed varieties are limited. In France, Group Limigrain has a winter variety "Epona" and a spring variety "Celine" that has been in field trials in Northwest U.S.[2] Other Camelina seed varieties are available from Montana State University. In addition, Sustainable Oils is continuing to develop additional varieties. Camelina can be seeded using a broadcast method or shallow drilling. Montana studies indicate seeding rates at 3 to 5 pounds per acre should be adequate but higher rates may be needed in areas where plant establishment may be difficult Camelina can be used in no-till situations but tests have shown reduction in yields.

Camelina has been grown successfully without herbicides. Early germination and tight seeding tends to inhibit weed growth. Only one herbicide, Poast®, is currently registered as a post-emergence grass control product for use on Camelina. Herbicide carryover from previous crops my inhibit Camelina production and can be a concern. Experiments with various crop rotations will help determine the effects of herbicide carryover.

[2] *Camelina.* D.T. Ehrensing and S.O. Guy. Oregon State University Extension Service. Page 4-5

Relationship to Other Crops

Winter Wheat

Arkansas Winter Wheat Crop 2009 – 2011			
	2009	**2010**	**2011**
Acres Harvested	390,000	150,000	520,000
Yield per Acre (Bushels)	44	54	61
Total Production (Bushels)	17,160,000	8,100,000	31,700,000
Price per Bushel	$4,86	$5.20	N/A
Total Crop Value	$83,398,000	$42,120,000	N/A

Winter wheat is grown as a rotational crop after typical crops of soybeans are harvested. Even though the yields of "late beans" are lower, double cropping with winter wheat provides additional income to Arkansas Delta farmers.

According to USDA July reports, Arkansas **winter wheat** production for 2011 was forecasted at 31.7 million bushels, up a significant 23.6 million bushels from last year. Yields averaged 61 bushel per acre, seven bushels per acre more than last year's yield. At an estimated cost of $6.00 per bushel, wheat would generate $366 in gross revenue per acre. Because of rising wheat prices, farmers increased acreage planted in 2011. Total acres harvested are approximately 520,000 acres; an increase of 370,000 acres from 2010. Any replacement winter crop such as Camelina will have to provide the same economic benefit for Delta farmers.

Soybeans

Soybeans are a competitive oil and meal crop to Camelina. Total Arkansas soybean acreage harvested was 3.15 million acres in 2010 with an average yield of 35 bushels

Arkansas Soybean Crop 2008 – 2010			
	2008	**2009**	**2010**
Acres Harvested	3,250,000	3,270,000	3,150,000
Yield per Acre (Bushels)	38	37.5	35
Total Production (Bushels)	123,500,000	122,625,000	110,250,000

per acre. In 2010, Arkansas ranked 8th in the nation in total soybean production and is a major supplier of soybean meal and oil. According to the Arkansas Soybean Promotion Board, soybeans are grown in 50 of Arkansas' 75 counties[3] including all of the counties in the Arkansas Delta area. Arkansas soybean yields in 2010 averaged 35 bushels per acre compared to 37.5 bushels per acre in 2009. As outlined above, soybeans can be planted behind the winter wheat harvest allowing income from two crops on the same land in one year. Optimum planting dates for soybeans are May 5th through July 5th.

Double Crop Soybeans

Single Crop/Double Crop Yields				
	2007	**Yield (Bushels)**	**2008**	**Yield (Bushels)**
Single Crop Soybeans	2,210,000	37	2,520,000	39
Double Crop Soybeans	610,000	33	730,000	34

Source: USDA Crop Yield Reports 2007-2008

Estimated double crop soybean acreage was 610,000 and 730,000 acres in 2008 and 2007 respectively. In 2009, the USDA stopped estimating double crop acreage so no numbers are available for 2009-2010. Double crop soybeans are estimated to yield 34 bushels per acre in 2008 and 33 bushels per acre in 2008 and tend to be 4-5 bushels per acre lower when planted late after the wheat crop is harvested. Winter Camelina production would allow harvest of the crop and planting of soybeans at normal times with no decrease in yield.

[3] Arkansas Soybean Promotion Board. *Arkansas Ag Statistics, page 1*.

According to the August 11, 2011, USDA crop forecast, soybean prices for 2011/12 are higher than previously forecasted. The U.S. season-average soybean price is projected at $12.50 to $14.50 per bushel, up 50 cents on both ends of the range. Soybean meal prices are projected at $355 to $385 per short ton, up $10.00 on both ends of the range. Soybean oil prices are projected at $.545 to $.585 cents per pound, up 0.5 cents on both ends of the range. By planting soybeans later after wheat, the decline in yield could reduce total income by $62.50 per acre. This reduction is overcome by the increased revenue from winter wheat.

At an estimated price $12.50 per bushel price, the loss of 5 bushels of soybeans per acre reduces total income by $62.50 per acre.

Camelina versus Winter Wheat

To make the switch from Winter Wheat to Camelina attractive, Camelina yields and price for the crop will have to be competitive for farmers. Current USDA winter wheat futures price for the 2011- 2012 crop is $8.09 per bushel. Originally developed at Montana State University, Great Plains has prepared an economic model that allows a comparison of revenue, operating expenses and gross margin for wheat versus Camelina at various yields per acre is as follows[4]:

Camelina versus Winter Wheat

Receipts	**Wheat***	**Camelina****				
Yields/Acre (Wheat –bu., Camelina – Lbs.)	61	500	1,000	1,500	2,000	2,500
Price ($/yield unit)	$8.09	$.15	$.15	$.15	$.15	$.15
Total Crop Revenue	**$493.49**	**$75**	**$150**	**$225**	**$300**	**$375**

[4]*Camelina Aviation Biofuels Report*. Biomass Advisors, 2010, Page *43*.

Operating Expenses						
	Winter Wheat	**Camelina**				
Seed	$30.00	$3.00	$3.00	$3.00	$3.00	$3.00
Fertilizer & Nutrients	$123.56	$48.50	$48.50	$48.50	$48.50	$48.50
Chemicals	$41.60	$10.00	$10.00	$10.00	$10.00	$10.00
Planting	$10.00	$10.00	$10.00	$10.00	$10.00	$10.00
Harvesting	$23.94	$23.94	$23.94	$23.94	$23.94	$23.94
Net Operating Expenses	**$229.10**	**$95.44**	**$95.44**	**$95.44**	**$95.44**	**$95.44**
Gross Margin/Acre	**$264.39**	**($20.44)**	**$54.56**	**$129.56**	**$204.56**	**$279.56**

Sources: *University of Arkansas Division of Agriculture; **Great Plains

Total estimated gross profit per acre for winter wheat is $264.39. Breakeven point for Camelina would be somewhere between 500 to 1000 pounds per acre. Low Camelina yields of 500 to 1500 pounds per acre would make the crop less attractive to farmers with winter wheat at the current high price of $8.09 per bushel. Should yields exceed 1,500 pounds per acre or the price for winter wheat fall, Camelina would provide a more attractive second winter crop. Of particular note, Arkansas cotton farmers normally cannot have a winter crop because of the early planting dates needed to maximize yields. A Camelina crop planted after a cotton harvest with no residual carryover and harvested before cotton is planted would generate additional revenue per acre for farmers.

	Unit/Yields	**Total**
Contract Price per Pound		$.15
Total Cost per Ton	2,000	$300.00
Estimated Processing Cost per Ton		$80.00
Total Expected Cost per Ton		$380.00
Oil Yield per Ton (Lbs.)	30%	600 Lbs.

Camelina Economic Model

Oil Yield (Gallons)	7.5	80
Oil Cost per Gallon		***$4.75***
Estimated Cost per Ton		$380.00
Selling Price of Meal*		$150.00
Reduced Cost per Ton		$230.00
Oil Yield (Gallons)		80
Oil Cost per Gallon (Revised)		***$2.88***

If interested farmers were organized into a cooperative, income from the sale of oil, meal and other by-products would add revenue to the crop. A model developed by Dr. Duane Johnson of Montana State University shows the effect of subtracting meal income from the cost of producing Camelina oil.[5] Using a value of $.15 per pound for seed, the purchase of harvested seeds from farmers would cost $300 per ton. The estimated cost of the extraction process is $80 per ton. Total cost per ton would be $380.00. Approximately 600 pounds oil per ton would be extracted using a conservative 30% oil yield. Studies by Colorado State University have shown that 7.5 pounds of oil equals 1 gallon of oil. Using this formula, a ton of Camelina seed would yield approximately 80 gallons of Camelina oil. ***Cost per gallon for the Camelina oil would equal $4.75.*** The model uses $.80 per gallon to process the oil into diesel resulting in a bio-diesel price of $5.55 price per gallon. At this price the biodiesel would not be competitive with regular diesel. However, if the income from the sale of the meal is subtracted from the $380 cost the ***revised cost per gallon for bio-diesel is $3.68($2.88 + $ .80 processing) which is very competitive to market prices of $3.79***.

At a 90-10 blend, Camelina meal at $150 per ton would reduce the August price to $369.42 ($393.80*90% + $150*10%).

Soybean Meal Monthly Price	
Month	Price
Feb-2011	$410.16
Mar-2011	$393.93
Apr-2011	$388.22
May-2011	$388.26
Jun-2011	$391.54
Jul-2011	$389.29
Aug-2011	$393.80

Livestock farmers currently use different types of meal according to the current market price of the meal. For the purposes of this study, a mixture of soybean meal with Camelina meal is used to calculate possible cost savings for the farmer. In 2011, soybean meal prices have ranged from a low of $388.22 per ton to a high of $410.16 per ton. As the commodity prices for soybeans continue to be high, the high cost for meal is expected to continue. Livestock farmers

[5] Dr. Duane Johnson. Montana State University.

seeking to lower their production costs may be interested in a mixture of Camelina meal and soybean meal to reduce their costs

Assuming the organization could sell Camelina meal to feed processors for a higher price than $150, the additional income would lower the Camelina oil cost down significantly making it a more attractive feedstock for bio-fuels producers. A mixture of 90% soybean meal and 10% Camelina meal would lower the total feed cost per ton to $369.42, a 6.2% savings for livestock producers.

All oil used for feedstock is priced on a per pound basis. Officials with Future Fuels indicated that their price for feedstock is based on the price of yellow grease currently priced at $.43 per pound. Using an estimated yield of 600 pounds of oil per ton and a processing cost of $380.00***, the cost per pound of Camelina oil would be $.63 per pound. Reducing the cost of production by the sale of meal, the cost per pound would drop to $.38 per pound and could be an attractive alternative for a bio-fuels processor.***

A possible option to consider would be to competitively price the oil to sell it as feedstock to farmers or bio-diesel refineries. The income from the sale of oil would offset the purchase price of the seed and the cost of cleaning and crushing. Major source of revenue for the organization would be the sale of meal as livestock feed.

Market Feasibility

Industry Description

Current Camelina production is limited to Montana and areas in the Northwest United States and Western Canada. Most of the research, field trials and other experiments have been completed in these areas. Limited research has been done in other areas including Minnesota, Pennsylvania, California, Florida and other areas. Lack of extensive research in various areas has limited expansion of the crop outside of these areas. Major obstacles to expanded growth of Camelina in the Northwest U.S. are the lack of infrastructure including:

- Lack of crushing capacity in the Northwest states.
- Bio-diesel facilities are located along the coast and can use much cheaper palm oil instead of Camelina oil.
- Limited market for meal in the local geographic area.

Most of these problems are opportunities in the Mid-South Delta area:

- There are several crushing facilities with excess capacity located in the Arkansas Delta.
- Future Fuels is located in Batesville, AR. Other Mid-South bio-fuel refineries have been shut down or production has been reduced. Additional capacity is available.
- Arkansas has a huge poultry industry that would be a local customer for the meal.
- Additional markets for meal are within a one-day drive of the Mid-South area.

Market Drivers

According to the Biomass Advisors Report, there are several market drivers for Camelina that are emerging[6]:

- ***Competitive agronomics*** – low-input crop that can deliver high yields in areas of low rainfall.
- ***Aviation biofuels*** – Rising fuel costs, price volatility and greenhouse gas regulations have airlines looking for sustainable biofuels.

[6] Ibid, pages 1-2.

- ***Interest in Omega-3 Enriched Foods –*** Camelina has been successfully tested as an animal feed that boosts Omega-3 in beef, poultry and dairy products.
- ***Rural and Economic Development –*** brings incremental revenue to rural communities for:
    - Growers of the seed and crop
    - Crushers and meal extractors
    - Transportation of seed, oil and meal
    - Bio-fuel refineries who process the oil into bio-diesel

The study also points out that development of a supply chain faces serious roadblocks. These include[7]:

- ***Seed Varieties and Vendors –*** Sustainable Oils, Seattle, Washington has proprietary rights to the Camelina seed varieties that it has developed. Seeds secured from Montana State University have been used in field trials in the Arkansas Delta. Varieties would have to be developed that would respond better to the Mid-South climate and soil in order for the crop to grow successfully. This is a long-term and very expensive process for local growers.

- ***Commodity Markets –*** Camelina is not a traded commodity by USDA.
    - Only two Northwest companies currently contract with farmers to buy their crops. These companies do not operate in the Mid-South area and do not seem to be interested in expanding at the present time. Growers currently do not have a local market for Camelina seed, meal or oil.
    - Camelina is not eligible for federal crop insurance or subsidies.

- ***Oilseed crushers –*** a key consideration to oil extraction is the availability of suitable oilseed crushers. Several soybean and at least one cottonseed crushers are operating in the Arkansas Delta. All crushing facilities are volume oriented. For the next few years, Camelina seed production will not be enough to add crushing facilities. Tests will have to be conducted with current crushers to determine problems with the small size of

[7] Ibid. pages 2-3.

seeds and cost of crushing Camelina oilseed. Small crushers could be used until volume is sufficient for larger crushing operations.

- ***Transportation and Logistics –*** Camelina oil needs to be transported to fuel processing facilities and meal to feed mixing locations. Bio-diesel cannot be transported through fuel pipelines across the United States. The oil will have to be shipped via truck or rail to Future Fuels in Batesville, Arkansas or other bio-diesel refineries in the southern United States. Meal will be hauled the same way to feed processors located near larger poultry and livestock growing areas. In both instances, the increased transportation costs could make both meal and oil more expensive than other alternatives.

- ***Fuel Processing –*** Future Fuels in Batesville, Arkansas has an annual capacity of 59 Million gallons of bio-diesel per year. The Company currently uses beef tallow, pork lard and other feed stocks including soybean oil. Price of Camelina oil will have to be price competitive with yellow grease currently priced at $.43 per pound. In order to meet the annual needs of Future Fuels (approximately 59 million gallons per year(MGY), Camelina would have to be grown on 708,000 to 1.57 million acres.

Camelina Oil

Camelina oil is extracted by running raw seed from harvest through presses that "squeeze" the oil out of the seed in a manual extraction process or can be extracted using a solvent extraction process. Commonly used oils such as soybean oil (12-18%) and cottonseed oil (30-35%) have much lower percentages of oil content. Other oil seed crops such as sunflower, peanuts and canola have similar oil yields but are not extensively grown in the Delta area for various reasons. Researchers at Arkansas State University have been able to extract oil at the 30% range using a small scale crusher and extractor. More efficient extraction methods will be needed to improve oil yields.

Crop	Oil % per Ton
Cotton	30-35%
Soybean	12-18%
Sunflower	40-45%
Camelina	40-45%
Peanuts	40-45%
Canola	40-45%

Because of the high oil content (40-45%), Camelina oil is being studied as a replacement for other types of oil used in various markets including: foods, feeds, cosmetics and industrial products including bio-lubricants and biodiesel. Research has outlined possible high demand for Camelina oil as feedstock for bio-fuel producers in particular bio jet fuel. Research has shown that Camelina oil contains 64% polyunsaturated, 30% monounsaturated, and 6% saturated fatty acids. The oil is very high in alpha-linolenic acid (ALA) and Omega-3 fatty acid essential in human and animal diets. Camelina oil also contains high levels of Vitamin E. Specifically, researchers are evaluating the following areas:[8]

- ***Nutritional*** – using Camelina oil to increase nutritional value of baked goods such as bread and spreads such as peanut butter.
- ***Health*** – benefits of Omega-3 from Camelina oil in a breast cancer risk study for overweight or obese postmenopausal women.
- ***Biodiesel*** – Camelina biodiesel performance appears to be equal in value and indistinguishable from biodiesel produced from other oilseed crops including soybean.
- ***Bio-lubricants*** – Camelina oil can be converted to a wax ester that will replace more expensive and less available Jojoba waxes used in industrial and cosmetic products.
- ***Seed Byproducts*** – Gum layer surrounding each seed can be removed and utilized as a seed coating for other seeds to improve germination in challenging environments. Camelina gum also has potential to be used as a soil amendment to stabilize exposed soils for erosion control.

Camelina oil is widely used in cooking in European countries. The health benefits available make the oil attractive for use in salad dressings, baking and cooking oil. When approved by the FDA, a possible market for small quantities of Camelina grown initially may be selling the oil to restaurants and the public. The oil could be bottled in small batches that can be sold at

[8] *Camelina Production in Montana, MontGuide, March 2008, page 2.*

farmer's markets, health food stores and other locations until demand increases. As larger growers begin growing the product, production volume may be high enough to produce enough oil to meet the needs of larger users.

Camelina Meal

After the Camelina seed has been cleaned, it is run through an extraction process to extract the oil and meal. According to the Biomass Advisors study, the Food and Drug Administration (FDA) has approved up to 10% maximum of Camelina meal in livestock rations[9]. The FDA has also allowed an exception for swine ratios and has written a "letter of no objection" for feeding Camelina meal to broilers at no more than 10% in final diet. Efforts by private companies such as Sustainable Oils to gain unrestricted use of Camelina meal as a feed ingredient are ongoing and will require additional research and testing.[10] According to research, livestock and poultry consume about 98% of domestically produced soybean meal.[11] The top ten soybean meal consuming states are: Iowa, North Carolina, Arkansas, Georgia, Texas, Minnesota, Alabama, Mississippi, California and Oklahoma. Iowa and Minnesota are the only two states of the top ten that produce enough meal to meet the needs of consumers. In studies performed by researchers at Montana State University and University of Georgia, poultry readily consumed feeds containing up to 15% Camelina meal.[12] There was no adverse effect on chicken health or egg production. The content of omega-3 in the egg increased with increasing Camelina content. Eggs from chickens fed Camelina contain enriched levels of Linolenic acid. Increase in the omega-3 content is relative to the percentage of Camelina meal in the feed. Arkansas is one of the top poultry producing states in the United States.

[9] Ibid. Page 38.
[10] Ibid. Page 38.
[11] Animal Analysis Update. Page 2
[12] *Camelina Sativa: A Montana Omega-3 and Fuel Crop*, Page131.

In Arkansas, livestock consumes 1,744,000 short-tons of soybean meal annually. Broilers alone consume 1,367,000 tons annually. Turkeys and laying hens consume large amounts of soybean meal as well. Significant additional potential markets in surrounding states are located within a day's drive from the Arkansas Delta. Arkansas livestock feed producers could be a significant market for Camelina meal to mix with soybean meal and other ingredients in feed rations. An estimated demand of 174,400 tons would be needed if soybean meal was mixed with Camelina meal at 10%.

State	Total Soybean Meal Used (1,000 Short Tons)
Iowa	3,503
North Carolina	2,999
Arkansas	1,744
Georgia	1,896
Texas	1,587
Minnesota	1,374
Alabama	1,475
Mississippi	1,254
California	971
Oklahoma	827

Industry Competitiveness

Growing Camelina as a field crop and then processing the seed into oil and meal is very new and has been confined to the northern Great Plains and Northwest states in the U.S. and western provinces of Canada. Field trials and other research have been done in other areas of the U.S. as well. Acres planted and harvested have not expanded as rapidly as expected due to the supply chain roadblocks outlined above. Arkansas production has been limited to research plots at ASU Jonesboro and UA Phillips County in Dewitt.

Key Competitors

According to the Biomass Advisors report, two partnership groups are trying to develop Camelina supply chains from farmers to aviation users.[13] The first group of seven companies is working together to fulfill a memorandum of understanding to produce and sell 750 million gallons of aviation biofuel by 14 airlines over the next 10 years. These companies include:

[13] Ibid. Page 83.

- ***Sustainable Oils – (***joint venture of ***Targeted Growth*** and ***Green Earth Fuels LLC***) Camelina research and development, grower seed supplier and grower contracting.
- ***Altair –*** fuel processing.
- ***Honeywell UOP LLC –*** fuel processing technology and equipment provider.
- ***Tesora –*** refinery and pipeline capacity.
- ***Air Transport Association –*** purchase coordinator for 14 airlines.
- ***SeaTac Airport –*** support and co-purchaser (for use of fuel for ground equipment)

The second group of potential competitors is not as well organized up and down the supply chain as the first group.

- ***Great Plains the Camelina Company –*** Camelina research and development, grower seed supplier and grower contractor.
- ***Biojet –*** According to their website, Biojet is a leading international supply chain integrator for renewable (bio) jet fuel and related co-products. The Company operates across the supply chain by owning or controlling large quantities of bio-feedstock, developing refining capacity, solving aviation fuel supply logistics, and handling sales to end users.

According to the Biomass Advisors report, the second group intends to develop integrated Camelina cultivation and associated refinery projects in the United States, Europe, South America and Asia. They have not announced a major purchase agreement or definite refinery project.

Building Mid-South Camelina Market

In order to build a complete supply chain around Camelina crops in the Mid-South area, organization(s) would need to be developed to provide:

- ***Plant Breeding Research & Development –*** Very expensive process limited to a few very large seed companies (See insert, top 10 seed companies have estimated 67% of global

Top 10 World Seed Companies

1.Monsanto (US) - $4,964m - 23%
2.DuPont (US) - $3,300m - 15%
3.Syngenta (Switzerland) - $2,018m - 9%
4.Groupe Limagrain (France) - $1,226m - 6%
5.Land O' Lakes (US) - $917m - 4%
6.KWS AG (Germany) - $702m - 3%
7.Bayer Crop Science (Germany) - $524m - 2%
8.Sakata (Japan) - $396m - <2%
9.DLF-Trifolium (Denmark) - $391m - <2%
10.Takii (Japan) - $347m - <2%
Top 10 Total - $14,785m - 67% [of global proprietary seed market]
Source: ETC Group

proprietary seed market), Federal Government agencies and land-grant colleges and universities[14]. Because of the high costs of research and development, private sector varieties have to be commercially viable, highly competitive and well protected by intellectual property rights. Because of the size of their investment, plant breeders play a central role in managing the entire production, distribution and marketing processes in the seed industry resulting in extensive vertical integration of the industry[15]. Research shows that price is not a major competitive factor and seed choices may be based on:

- Highest yields
- Resistance to disease and local pests
- Adaptation to local climate condition
- Quality of seeds.

> ***Contract growers are selected by seed firms to insure:***
> 1. ***Desirable plant characteristics are carried through to subsequent generations.***
> 2. ***Prevention of open pollination.***
> 3. ***Prevention of disease and pest infestations***
> 4. ***Prevention of other types of problems that could affect product quality.***

- ***Seed Production –*** The ERS/USDA report states that seed firms with a marketable seed product contract out seed production to farmers, farmer's associations and private firms.[16] Plant breeders provide:
  - ***Foundation seed –*** parent seed stock produced from the original seed developed by the plant breeders. Foundation seed can be used to produce more foundation seed for continued research and development ***or***:
  - ***Registered seed –*** contracted foundation seed with farmers for large-scale production purposes, ***or***:
  - ***Certified seed –*** contracted registered seed sold to farmers conforming to standards of genetic purity and quality status according to state agencies such as Arkansas Plant Board.

Production of certified seed in the right quantities is critical to meet market demand. Companies must:

- Determine the quantities of the each variety to be produced.

[14] *The Seed Industry in U.S. Agriculture/AIB 786,* ERS/USDA. Page 28.
[15] Ibid. Page 28.
[16] Ibid. Page 28.

- Determine inventory levels to produce to meet forecasted demand and avoid immediate or future shortages.
- Reduce risks associated with crop failure because of weather conditions, disease and pest infestations.

- ***Seed Conditioning –*** After harvest, certified seed is conditioned for sale to farmers. Conditioning includes:
  - Drying, cleaning and sorting the seed.
  - Treating the seed with insecticides and fungicides.
  - Packaging the seed for sale and distribution.
  - Testing by state agencies for: purity, germination, noxious weed seeds and moisture content.
- ***Seed Marketing and Distribution –*** Large seed firms have a direct role in marketing and distributing the seed through various channels to regional, national and international markets. Many firms license or outsource marketing and distribution to private firms and individuals to improve access to local markets. These local markets may include: farmer dealers, farm cooperatives, company salespeople and private wholesalers and retailers. Some seed firms may use marketing reps to visit farmers directly. Seed marketing and distribution will be critical to the success of expanding Camelina production in the Mid-South.

In Arkansas, growing and/or selling seed is regulated by the Arkansas Plant Board. A complete listing of ***Regulations on the Planting of Seed in Arkansas*** is at the board's website: http://plantboard.arkansas.gov/Seed/Documents/cir10.pdf A complete analysis of the regulations is beyond the scope of this study. Information on lab services, seed certification, licensing and enforcement and arbitration is included. An example of some of the rules in place covering wheat seed in Arkansas would be similar to Camelina:

- Have an Arkansas Seed Dealer's / Labelers License
- Have a Complete Analysis (germination and purity) & provide all required labeling information to buyers

- Comply with Plant Variety Protection Act (PVPA 1994) requirements for protected varieties
    - Must be sold by variety name
    - PVP Title V protected varieties must be sold as a class of Certified Seed
    - Purchasers of wheat for Grain (non-reproductive purposes) may not convert that grain to Seed
    - A farmer can still save and plant seed on his own farm
- Some varieties are protected by patents and cannot be saved for planting or sold without permission from the variety owner

Rules are in place to protect growers. Licensed dealers may purchase Camelina in addition to other grain or seed.

Distribution

A key asset for development of the Camelina market in the Mid-South Delta is access to reliable distribution options. The area is served by truck, train and barge traffic with key loading and unloading options throughout the area. Trucks are the primary means for hauling oilseed crops from the field to on-farm storage or to dry-bulk storage facilities. Research has shown that most Arkansas farmers own or lease trucks to haul their grain. From the storage, Camelina would be moved to local crushing facilities. Bulk or pelletized meal can be moved via truck or railcar to feed mills for mixing. Oil can be moved via truck, train or barge to area bio-refineries for processing.

Initially, small crushing operations and micro bio-refineries may be established to process crops locally. In this scenario, local farmers would grow and harvest Camelina. The seeds would be hauled via truck to a local micro refinery where crushing would take place. The micro crushing operation would yield meal and oil. Camelina oil would be cleaned and moved into a micro bio-diesel refinery for processing into bio-diesel.

Sales Projection

Based on industry data, one-ton of Camelina yields the following:

Products	Yield
Camelina Meal or Pellets	1,300 lbs.
Camelina Oil (30% yield)	600 lbs.
Hulls and other (1%)	100 lbs.

Because of the limited research available, sales projections cannot be made at this time. If feed mills have a 10% ratio of Camelina meal with soybean meal, the demand for Camelina meal in Arkansas would be approximately 174,400 tons. Because of the close proximately to other markets, this number could be much larger. Demand for oil depends on the price. If oil can be extracted at a competitive price with yellow grease, demand for Camelina oil could be significant. However, the lack of FDA approval will limit demand for oil and meal until the current limits are abolished or improved.

Technical Feasibility

Oil and Meal Production

Critical to the success of Camelina as a biofuel crop in the Arkansas Delta is the process of extracting the oil and meal from the seeds. Management of a Mid-South Delta organization will need to determine if the organization or other organizations will:

- Build facility or lease existing facilities for manufacturing space.
- Purchase equipment, hire and train personnel to run manufacturing facility to extract oil and meal from harvested seed.
- Manage the manufacturing facility for oil extraction and meal production to meet the needs of potential customers for both products following a process outlined below.
- Market and sell the oil and meal to potential customers.
- Distribute oil and meal to customers.

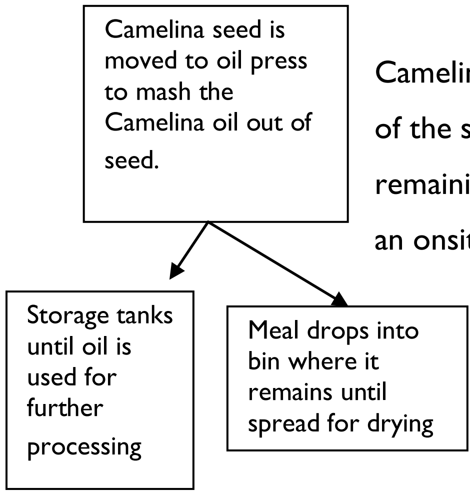
Facility Needs

Because of limited seed production, small crushers will need to be used initially. Production equipment will be used to process bulk Camelina seed into oil and meal using the following process:

- Camelina seed will be purchased directly from local and area growers under a contracted price and hauled via trucks to crushing facility.
    - Camelina seed is weighted and unloaded into a hopper for storage.
    - Seed is monitored for moisture content. It is important to note that the moisture content of Camelina seed cannot exceed 8%.
- When ready, an auger system will move the seed to the production facility according to production schedules.

Whole Camelina seed is moved via conveyor to drop into feed hoppers of seed cleaners.

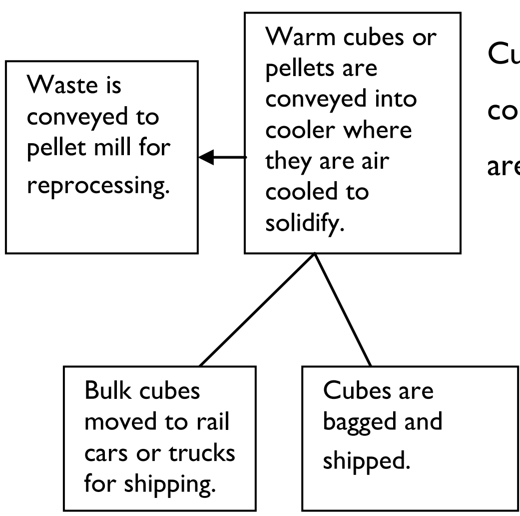
Camelina seed is cleaned. The cleaning process separates the seed from refuge such as stalks, grass and other field debris collected during the harvesting process. This step will help provide a cleaner seed and oil.



Camelina seed goes through a micro press that mashes the oil out of the seed. Oil then goes through a centrifuge that helps filter remaining debris and moisture from the oil before it is pumped to an onsite storage tank.

Meal is dropped into storage bin where it will wait to be spread on a drying table to allow the meal to dry and cure.

Meal mixture could be conveyed to pellet mill machine that pelletizes the meal into pellets or cubes for easier handling. Because of the heat generated, the pellet mill will drop the pellets/cubes onto slides headed for pellet cooler.



Cubes or pellets are conveyed into an air cooled cube cooler where cubes are cooled to room temperature and are dropped onto a dragged type conveyor.

Cubes can be moved in bulk to railcars or trucks and shipped to customers. Cubes can also be bagged and shipped via truck to customers. Storage facilities include a 50-ton day bin and 50-ton meal storage bin. For customers ordering bulk meal, the meal can bypass the pallet mill and be shipped in bulk via rail or truck.

Suitability of Production Technology

The mini-mill is using proven mechanical technology that has been used for decades. The mechanical design retains 5-7% of the oil in the remaining pressed cube or pellet which makes the meal much more desirable for dairy and beef cattle. This is important because of the primary product of the mill is Camelina meal and not oil.

Most new mills use a solvent extraction process. This process involves extracting oil from oilseed by treating it with a low boiler solvent. The solvent extraction method recovers almost all of the oils and leaves behind only .5% to .7% residual oil in the raw material. This process leaves a meal with much less oil.

Company management will need to evaluate both methods of oil extraction. Solvent oil extraction equipment is more expensive and does not retain much oil in the finished meal product. Mechanical extraction mills are slower to operate but equipment is less expensive and produces a higher quality meal. Primary products for the Company will be the meal cube and the mechanical process produces a more "tasty" product that poultry, dairy and livestock farmers can mix for their animals.

Availability and Suitability of Site

Currently, seed crushing facilities are located in England, Stuttgart and Dewitt. Biodiesel production facilities include:

- Future Fuels Chemical Company, Batesville, AR, 59 Million Gallons per Year (MGY) the only plant currently in production.
- Delta American Fuel, Helena, AR, 40 MGY, idle.
- Pinnacle Bio-Fuels, Crossett,10 MGY, idle.
- Dewitt Oil and Seed Enterprises, Dewitt, AR (8MGY) idle.

As outlined above, small crushing operations and micro bio-refineries could be established in local communities to process Camelina seed into oil and meal that would be used locally. Local farmers could grow and harvest very small fields of Camelina as a winter crop. A commercial harvesting company could provide harvesting for local farmers that lack the capacity. Harvested seeds would be hauled via truck to a local community micro refinery where crushing would take place. The micro crushing operation would yield meal and oil. Camelina oil would be cleaned and moved into a micro bio-diesel refinery for processing into bio-diesel. If economically feasible, the combined operation could be located in the same building.

Financial/Economic Feasibility

Estimate of Total Capital Requirements

Growing off season crops such as winter wheat or Camelina does not require any additional capital investment for most existing farmers. Equipment used will include:

- Disk to turn soil and break up the soil and turn under crop residue
- Ditcher if needed to remove wet spots and allow proper drainage of water.
- Field cultivator to prepare seed beds.
- Fertilizer, broadcast spreader.
- Planter Grain Drill.

In a report issued by the University of Arkansas Division of Agriculture: *Preliminary Economic Outlook for 2010 Arkansas Field Crops,* estimates for each of these operating costs for winter wheat have been prepared:

Cost per Acre-Trip, $ per Acre					
Implement	**Capital Recovery**	**Repairs**	**Fuel & Lube**	**Labor**	**Total**
Disk	3.08	.78	1.75	.59	$ 6.20
Ditcher	.28	.03	.25	.08	$ 0.64
Field Cultivator	1.82	.51	1.22	.41	$ 3.96
Land Plane	2.10	.27	2.13	.71	$ 5.21
Fertilizer, Broadcast Spreader	.73	.18	.62	.27	$ 1.80
Planter Grain Drill	3.65	1.74	2.26	.81	$ 8.46
Totals	$ 11.66	$ 3.51	$ 8.23	$ 2.87	$ 26.27

Source: University of Arkansas, 2010

It is estimated that costs will be similar for planting and fertilizing Camelina. The study also analyzed the costs per acre-trip for harvesting winter wheat:

Cost per Acre-Trip, $ per Acre					
Harvest	**Capital Recovery**	**Repairs**	**Fuel & Lube**	**Labor**	**Total**
Combine	13.01	4.67	5.79	1.53	$ 25.00
Wheat/Sorghum Head	1.30	1.74	N/A	N/A	$ 3.04
Grain Buggy	4.75	1.29	4.27	1.53	$ 11.84
Totals	$ 19.06	$ 7.70	$ 4.27	$ 1.53	$ 39.88

Small farmers may not have the equipment to plant and harvest the crop. An organization could provide planting and harvesting services to these small farmers for a fee. This would create additional wealth opportunities for entrepreneurs.

Risk Assessment

Product Risk

Product risk has been evaluated and the following results are determined:

- ***Seed Availability –*** Seed used in local trials have been purchased from Montana State University. Sustainable Oils and Great Plains Oil own proprietary rights to various seed varieties they have developed.
    - Both companies also contract with growers to produce seed for them.
    - There is currently no local source for Camelina seeds to produce.
    - Plant breeding and seed development is a very expensive process. Development of local Camelina seed varieties may require partnerships with large seed companies.
- ***Crop Production –*** There has not been enough research to understand if Camelina can be grown successfully in the Arkansas Delta. Research at Arkansas State University-Jonesboro, UA-Phillips Community College in Dewitt and other local locations needs to be continued and expanded.
    - Various seed varieties from Montana need to be evaluated under local Delta growing conditions including local climate and soil conditions.
    - Possible pest and weed problems need to also be tested and evaluated.
- ***Production Expertise –*** Farmers in the Arkansas Delta have no experience growing Camelina. Information on nitrogen, phosphorous and sulfur needs have been based on Montana field trials. Again, local tests need to be expanded.
    - Information can be shared with interested farmers through field days, seminars and other means.
- ***Commodity Markets –*** Currently, Camelina is not a commodity tracked by the USDA and commodity markets. Seeds are grown under contract with seed producers. Local interests will have to work with growers in other parts of the U.S. to lobby for USDA commodity status.
- ***Oil and Meal Products –*** Cost of extraction of Camelina oil is too high to be an economical feedstock for bio-diesel. In addition, USDA has only approved the use of

Camelina meal up to 10% of livestock rations. In order to make oil and meal affordable, markets for both need to be expanded. The sale of meal could be used to offset the high price of oil. However, the limited use of Camelina meal in feed rations may not create enough demand.

Market Risk

There is market risk if no demand for Camelina oil and meal can be generated. Company managements has evaluated market risk and concluded:

- ***Camelina Crop Failure –*** There are no guarantees that Camelina will be adaptable to grow under Mid-South growing conditions. Current results have had marginal yields. Until varieties have been developed specifically for this area, the possibility of crop failure is high.
- ***Camelina Oil Demand –*** The FDA has not approved Camelina oil for human consumption. Research has shown that the oil can have other uses including bio-lubricants, biodiesel, etc. Due to the small acreage of Camelina that will be initially grown, the volume of oil processed will not be significant enough to meet the demands of larger processors.
- ***Camelina Meal Demand -*** The USDA has only approved up to 10% of Camelina meal to be used in livestock rations. Price of Camelina meal will be competitive with soybean and cottonseed meal as a supplement. However, most livestock producers have no experience using the meal. An education program would need to be conducted to explain the benefits of mixing the meal with current rations.
- ***Pricing –*** Seed, oil and meal prices are estimated at the present time. These estimates are based on contracts issued in the Northwest U.S. Camelina is not an approved commodity that has historical pricing information available. Price of seed would have to be contracted with seed companies until viable markets have been established. A market for oil and meal will have to be established in order to have stable pricing.
- ***Distribution –*** The Mid-South has an excellent distribution system available to move seed, oil and meal. The area has major north-south (I-55) and east-west (I-40 and I-30) interstate highways. Over 60% of the U.S. population can be reached within one day

from the area. Train and barge service is available in the area with major grain handling facilities throughout the area. Growers of broilers and layers are spread throughout Arkansas providing a potential market for meal.

- ***Competition -*** Currently the major seed companies, who are contracting with Camelina growers, are located in Northern Plains and Northwest U.S. There are no major competitors located in the Mid-South area.

Business Risk

The risk with developing a new industry around an unproven product is high. In this case, Camelina has been successfully grown in other parts of the U.S. but not in the immediate area. Crop yields in these areas have not reached projections and total acreage planted has not grown as rapidly as expected. Only two major companies located in other parts of the U.S. are currently contracting with growers. Business risk has been evaluated:

- Cost of breeding and testing new varieties of any crop are substantial. In order to speed time to market, large seed companies have research facilities located in the northern and southern hemisphere so that varieties can be tested year-round.
- Establishing seed growers also takes huge resources and time. Growers have to be educated on proper planting, growing and harvesting seed to meet certain specifications.
- Marketing new crops to existing farmers also is expensive. Farmers have to be educated about the risks and cost-benefit of growing something new.
- Production, storage and marketing of meal and oil will also take substantial resources.

Financial Risk

As outlined above, the financial risks of building a new industry with unproven products are substantial. Costs of each process will be high and possible financial options will be limited. Small scale development is an option but total economic impact will be delayed until the volume of seed, oil and meal produced is high enough. Partnerships with larger seed companies with available resources may be an option.

Organizational/Managerial Feasibility

Business Structure

Various types of business structures could be used to develop Camelina crop in the Arkansas Delta. Key consideration would be if the organization is willing to invest in the plant breeding and field trials needed to determine varieties of the crop that will grow in the Delta conditions. Possibilities include:

- A cooperative of local growers, seed companies, bio-refineries, feed processors and other interested parties could be formed to help generate the capital needed.
- A corporation is also a viable option to bring together interested investors.
- Partnerships with large seed companies could be an option. The seed companies would partner with a local organization to test various varieties and handle costs of breeding and proprietary registration.
- Cleaning and processing of the seed can be done by local or regional seed companies.
- Seed crushing could be contracted with local crushers. Local oilseed crushers have excess capacity. Tests would need to be done to see if these large crushers can handle the small Camelina seed without significant loss in oil yields.
- Oil and meal processing can be done using existing facilities or small micro facilities can be developed to handle the small initial volumes.
- Marketing of the oil to bio-refineries and the meal to feed processors would be a major function of any type of organization as well.

Projected Business Model

Step One - A locally owned organization (a cooperative for example) is started to continue research in Camelina trials with partnerships including area university research sites. Using the Sustainable Oils model, a group of Arkansas Delta researchers, growers and other interested parties will expand field trials of Camelina to various seed varieties in different areas of the

Delta. Purpose of the field trials would be to evaluate yields of Camelina under various soil, moisture and climate conditions common in the Delta.

Step Two - As promising Camelina varieties are identified, the Company would begin growing seed or contracting with small area farmers such as:

- Minority farmers.
- Beginning farmers.
- Women owned farming enterprises.
- Other small farm entities.

Seed growers would be responsible for growing seed under strict specifications developed by the Company in order to meet requirements of Arkansas State Plant Board and other organizations.

Step Three - The Company can begin a marketing campaign to educate Delta farmers through meetings, seminars, field tours and other methods about the crop and its potential as seed, crop data and other information becomes available. An economic model will be developed to show farmers the profit per acre potential for growing Camelina under various scenarios.

Step Four - The Company will contract with area farmers for certain quantities of Camelina grown in the same manner as existing crops such as rice, cotton, soybeans and wheat are handled. Farmers would book production with the Company at a certain price. *Note: It is critical that USDA classify Camelina as a commodity to establish market prices for seed, oil and meal. Failure to do so will limit the number of farmers willing to contract to grow Camelina without market knowledge. Commodity status could also qualify the crop for insurance and possible crop subsidies.*

Step Five – The Company will sell the crop purchased to seed crushers or buy crushing equipment to do the processing themselves. Cost and benefit of crushing seed from only one crop can be limited. Micro crushers could be used in the process or larger more versatile equipment could be purchased to crush the seed and extract the oil and meal from various oil crops including Camelina, soybeans, cottonseed, sunflowers, canola and other oilseeds.

Step Six - Until volume is sufficient to generate interest of large biodiesel refineries, the Company will build and operate micro-refineries to process the oil into bio-diesel used by local users such as schools, city and county governments, local businesses, farmers and other users. As quantities increase oil will be sold to larger biodiesel refineries to aggregate volume.

Step Seven - Meal produced during the oil extrusion process will be sold to feed producers who will mix the meal with other feedstock to meet USDA requirements. If economically feasible, the meal could be pelletized for easier handling.

Step Eight – As demand for the seed, oil and meal grow, the Company could expand operations along the entire value chain. However, critical to wealth creation would be the smaller companies that could be started to meet the needs along the value chain.

Alternative Plan

An alternative to developing the entire value chain for Camelina production and processing would be to develop parts of the chain in the Delta while using outside sources to develop the rest of the chain.

Alternatives – A cooperative of local farmers can be organized to grow Camelina for sale to larger crushing facilities and bio fuel producers such as Future Fuels in Batesville, AR and others.

Sustainable Oils, Seattle, Washington is conducting field trials throughout the United States and Canada to develop new high yielding varieties of Camelina. Under this alternative, Sustainable Oils or a subsidiary would develop new seed varieties and sell the seed to Arkansas Delta farmers who would grow Camelina under contract with the company. This may not be a feasible option because Sustainable Oils is conducting most of the research and contracting production in the Northwest United States including Montana, Idaho, Washington and Oregon and Western provinces of Canada. Sustainable Oils is also conducting trials in California and Arizona. There is a lack of crushing

Sustainable Oils is a joint venture between Green Earth Fuels, LLC, a biodiesel company located in Houston, Texas and Targeted Growth, a privately-held crop biotech company located in Seattle, and biodiesel processing facilities in the Northwest United States area and the crop would be trucked to locations outside the growing area. In addition, poultry farmers who may use the meal are located in the Southeast United States. Both of these factors would be overcome if Camelina becomes a viable crop in the Arkansas Delta and is processed close to the place of production.

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