2007 Producer Led Field Trials of Alternative Oil Seed Crops in Eastern Wyoming - *Camelina sativa*:

Interim Summary Report

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The Northeast Wyoming Resource Conservation and Development Area (RC&D) approved this project on December 7, 2006. Special thanks to the participating producers and to the sponsoring organizations of RC&D in Northeastern Wyoming.

- Weston County NRD
- Sheridan County CD
- Campbell County CD
- Crook County NRD
- Lake DeSmet CD
- Niobrara CD
- Powder River CD
- Coal Bed Natural Gas Alliance
- Big Horn Mountain Country Coalition
- Sheridan County Commission
- NE Wyoming Economic Dev. Corp.
- UW Cooperative Extension

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Project Summary

In 2007, twelve farmers in Eastern Wyoming conducted voluntary field trials of *Camelina sativa*. This oilseed had been under development in neighboring states and showed good potential for cultivation in arid and cool environments. The Wyoming trials followed reconnaissance and outreach by Energy Fuel Dynamics, BlueSun Biodiesel, Niobrara, Campbell and Platte County Conservation Districts, The University of Wyoming (UW) and the US Department of Agriculture (USDA) across the State in 2006 to determine crop viability and producer interest.

Camelina South of Gillette Wyoming – 6/18/07

The project developed very rapidly in the early spring of 2007 following seminars in Wheatland and Gillette on February 12 & 13. Producers who planted Camelina in the six weeks following the seminars did so using their best judgment of field conditions, known planting techniques and available equipment. No systematic monitoring or planting protocol was used.

Staff with the University of Wyoming Cooperative Extension Service and USDA Natural Resources Conservation Service set out to track the producer field trials to the greatest extent possible during the summer of 2007. They responded to farmers requests for information, collected information as was available and coordinated a number of field visits throughout the summer. Twenty tons of pure seed was harvested and marketed from four producers in 2007. Through a marketing contract with Wyoming Biodiesel, the oil was sold in the commercial market and the meal was purchased by UW for beef feed trials.

Biodiesel

The US biodiesel industry has the capacity to produce approximately 2 billion gallons of biodiesel annually, with another billion gallons of capacity under construction. Feedstocks include soy, canola, sunflower, mustard, palm, animal fats and recycled grease. In contrast, petroleum diesel consumption in the US is approximately 60 billion gallons annually. Despite its small share of the overall market, biodiesel is in high demand for fleets, farms, contractors, and long haul truckers due to its performance characteristics. Blends of 2 – 20% biodiesel reduce emissions and have demonstrated improved horsepower, lubricity and mileage performance. Small scale biodiesel producers and cooperatives have also been successful in using local feedstock surpluses to produce very low cost fuel that may be used as a pure bio product.

A recent limiting factor to increased biodiesel production has been feedstock availability and high commodity prices. Strong demand for oilseeds in the US and exchange rates favorable for exports have caused many biodiesel plants to operate at less than full capacity. This in conjunction with a desire for cheaper “farm-based” fuel production has led to research and development of alternative feedstocks. Camelina (*Camelina sativa*) is one non-traditional oil seed crop that has potential to allow producers expand crop acreage and income in the arid western high plains.

Camelina History and Potential

Cultivation of Camelina dates back to the Bronze Age where the oil in the seed was expelled and used as a cooking and lamp oil. Its pleasant aroma and long shelve life made it a popular massage oil throughout Europe and earned it the moniker “oil of pleasure”. Throughout the years the value of Camelina decreased as farmers grew more wheat and flax. Camelina became something to control in fields, rather than a profitable crop. With the identification of its unique properties came interest in revitalizing the crop for modern uses. Camelina has been shown to be compatible with cool arid climates. It is a rapidly germinating, early emergent plant that can withstand moderate spring frosts.

In the last decade, field trials and variety tests have been done in several states including Colorado, Minnesota and Wyoming. Some of this research has had limited findings, and little application in practical agriculture. Montana State University along with private industry interests have proceeded from field trials and many growers are currently using Camelina in their cropping systems.

Camelina has both summer annual and winter hardy biennial forms, is drought tolerant, and is low-input due to its early season characteristics. As a result, it has been shown to have a higher net return than crops such as Canola. Camelina oil can be used to produce low "pour-point"[1] biodiesel, biodiesel blends, or bio-lubricants that can compete with traditional petroleum products both in cost and performance. In addition, the co-products generated from manufacturing biodiesel from these crops are being investigated as nutritious feedstuffs that can be included in livestock diets.

European Camelina Butter

Camelina oil seeds are relatively high in oil content, 29-38%. Up to one-third of Camelina oil content is the omega-3 type. This characteristic produces stable oil with excellent storability and health market potential. Omega-3s are known to reduce inflammation in humans, aiding in the prevention of disorders such as heart disease, stroke, arthritis, and others. The human body cannot make its own omega-3s from scratch, but it can create the more complex omega-3 fatty acids from alpha-linolenic acid found in omega-3 oils. Typically the source for omega-3 oil has been cold water fish, which rely on the oil for low temperature survival. Very few plants contain these oils, and the health claims indicating their benefit have stimulated the demand for them.

[1]"Pour point" (& "cloud point") is a temperature indicator for all petroleum, vegetable or animal based diesel under extreme cold conditions. The pour point refers to the temperature of the diesel fuel as it thickens and will no longer pour. The cloud point refers to the fuel's temperature as it begins to thicken and "cloud." Some engines will fail to run at the cloud point, but all engines will fail at the pour point. Usually the cloud and pour point are 20 degrees apart. Biodiesel has vastly different winter properties depending on the feedstock. Measures are generally taken to "winterize" all petroleum and bio based diesels.

Camelina Sativa Fact Sheet

(As distributed to Wyoming producers in February 2007)

Camelina Sprouts

Plant Characteristics:

- Annual or winter annual
- 30-90 cm (~24-36 inches) tall
- Prolific, small, pale yellow flowers
- Adapted to cooler northern climates
- 85-100 days to maturity
- Drought avoidance characteristics. Camelina is better able to compensate for early water deficits.
- Produces quite a bit of straw that is too thick to no-till. No use has been found for the straw.
- Maturity occurs very quickly, often within days of first pod color change
- All pods are located at the top of the plant canopy

Seed Characteristics:

- Seed size: 0.7x1.5 mm (more than 375,000 seeds per pound)
- Pale, yellow-brown seed with a ridged surface
- 29-39% oil composition
- Oil composition:
    - ~34-36% omega 3 oil
    - ~12% saturated (relatively low)
- Substantial amount of linolenic acid (omega 3)
- Camelina meal is comparable to soybean meal (45-47% crude protein, 10-11% fiber)

Agronomic Suggestions:

- Can be sown or broadcast in late fall (drill suggested) or early spring on stubble without seedbed preparation
- Can be drilled at ¼ to ½ inch depth
- Performance of winter sown camelina is equal or superior to conventional sown flax
- Seeding rate: 2.5-5 lb/acre 2.5-3 recommended unless weed competition is an issue.
- Early emerging, cold tolerant, survives minor spring frosts.
- Small seedlings (non-competitive by themselves) provide excellent competition with many annual weeds if planted in high densities.
- No broad-leaf herbicides are available for camelina at this time. However, camelina has been reported to be allelopathic[2] .

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[2] Allelopathy refers to biomolecules produced by a plant that are released into the environment and subsequently inhibit the growth and development of neighboring plants. This allows the allelophthic plant to out compete surrounding plants for water and nutrients. (Note: There was no clear evidence of allelophthic behavior observed during the 2007 Wyoming Camelina trials.)

- Camelina responds to nitrogen fertilizer similarly to mustard or flax
    - For basic yields ~35 lb N and 20 lb P
    - Response has been measured up to ~100 lb N and 60 lb P
- Camelina is highly resistant to blackleg (Lepotosphaeria maculans) and Alternaria brassicae.
- Insect damage has been observed only infrequently. The flea beetle is sometimes seen on camelina, but is not reported to be the problem it is on canola.
- Costs of production and yields similar to flax
    - Production costs vary – based on average Montana costs, variable and fixed costs total $48-68 per acre.
- Potential for having lowest input costs and lowest environmental impact of all oilseeds:
    - compatible with reduced tillage
    - low seeding rate
    - competitiveness with weeds
- Combine settings similar to alfalfa seed or canola
- Rapid germination has been seen once soil temperatures reach 38-40˚F
- Seed can be easily cleaned using window screening or 3/64 X 3/8 slotted screens
- The potential and characteristics remain to be fully explored.

Camelina Northeast of Gillette – June 2007

Use and Markets:

- Biodiesel production
- Meal may be used in production of "green" coal
- Edible oil
- Animal and bird feed
- Cosmetics
- Replacement for petroleum oil in pesticide sprays
- Manufacture of linoleum
- Ornamental crop, dried flowers
- Other possibilities that have yet to be determined

*Sources: *Montana Camelina 2005,* Duane Johnson, MSU NARC; *Camelina: A Promising Low-Input Oilseed,* 1993, D.H. Putnam, J.T. Budin, L.A. Field, and W.M. Breene; *Omega-3 Fatty Acid,* Wikipedia online encyclopedia; *Camelina*, 2003, Seedtec- Terramax, Discussion on Camelina, 2006, Jim Krall, University of Wyoming Extension Agronomist; Discussion on Camelina, 2006, research assistant, Creston Research Center, Kalispell, MT.

Summary of Producer Led Field Trials – Camelina Sativa Summer 2007

Grower (Location)	Acres	Field Setting	Field Prep	Planting	Precipitation April 1-June 30	Harvest (Pure Seed)
T. Stanley (Central Campbell Co.)	50 (7.4 Harv.)	Sandy loam soil Wheat stubble	Worked with chisel plow and harrow twice prior to planting	7 lbs/acre $^{1}/_{16}$ – $^{1}/_{4}$ inch planting depth Brillion type seeder	17”	631 lbs/acre
C. Rourke (Central Campbell Co.)	40	Sandy loam soil Winter wheat stubble	Spring 2006 Roundup Summer 2006 24-D Ester 1/3 lb & 1 ounce Tordon	4 lbs/acre $^{1}/_{16}$ – $^{1}/_{4}$ inch planting depth Brillion type seeder Planting date: 3/12-13/07	14”	462 lbs/acre
D. Wood (W. Crook Co.)	40	Clay loam soil Summer fallow		3 lbs/acre Planting date: 3/20-24/07	12”	95 lbs/acre
G. Goertz (SE Platte Co.)	60	Sandy Loam Wheat Stubble Organic Manure in last 2 yr	Fall “V” cut, Spring harrow	4 lbs/acre $^{1}/_{4}$ – $^{3}/_{4}$ inch planting depth Drilled 3/21/07	(Abundant early soil moisture) Apr – Jun: 3.8”	220 lbs/acre
D. Baker (SW Goshen Co,)	40	Sandy Loam Wheat Stubble Organic	Fall “V” cut, Spring – plow, pack with drill, spring tooth lightly	4 $^{3}/_{4}$ lbs/acre $^{1}/_{4}$ – 1 inch planting depth Drilled 3/15 & 3/20/07	(Abundant early soil moisture) Apr – Jun: 4.75”	81 lbs/acre (retained)
J. Buyok (N. Sheridan Co.	2	Clay Loam Dryland Hayfield	Light Disc and Harrow prior to planting	3 lbs/acre Planted 3/27/07	8”	No
M. Avery (Campbell Co.)		Clay loam soil	Chiseled fall of 2006	3.5 lbs/acre Planting date: 3/11-12/07	12”	No
I. Cranston (Campbell Co.)		Clay loam soil Wheat stubble	None	4 lbs/acre Planting date: 3/20/07 John Deere press drill	11”	No
K. Collins (Campbell Co.)		Sandy loam Summer fallow		3 lbs/acre Planting date: 3/20/07	11”	No
B. Kissack (Campbell Co.)		Clay loam soil Barley Stubble	None	4 lbs/acre $^{1}/_{16}$ – $^{1}/_{4}$ inch planting depth Brillion type drill Planting date: 3/14-15/07	11”	No

Wyoming Producer Data			Test Data - University of Montana Grain Lab						
ID	**Storage Gillette Coop**	**Shipped Weight (after shrink)**	**Machine Dockage**	**Hand Picked Dockage**	**Total Dockage**	**Net Seed Weight**	**Test Weight (lbs/bu)**	**Moisture**	**Oil**
Goertz	(on farm)	19880	32.8%	0.7%	33.5%	13220	46.2	9.8%	36.4%
Wood	4460	4394	8.6%	4.6%	13.2%	3814	49.3	4.9%	38.0%
Rourke	19100	18819	0.7%	1.0%	1.7%	18499	51.4	6.0%	33.2%
Stanley	6360	6266	25.1%	0.4%	25.5%	4669	49.3	6.6%	35.9%
Totals		49360				40202			
Averages		98.53%			18.6%		48.9	7.5%	35.3%
					Results:	Montana State Grain Lab Box 1397 Great Falls, MT 57403			

Ripe Wyoming Camelina - 2007

Camelina in bin prior to expelling

RESULTS DISCUSSION

The following narrative is an attempt to provide some additional information based on observations of the authors and from discussions with the producers and agronomic experts who were present during field visits. Five main categories of observations are presented. Distinctions will be made between the NE Region – Campbell & Crook Counties and the SE Region – Goshen and Platte Counties, when relevant.

Field Prep – Early guidance had been that Camelina was an aggressive early season competitor and potentially allelopathic. The Wyoming producers did not find any evidence of this although the seed germinated very quickly once the air temperature was over 60^0F. The producers that harvested seed all had mechanical or chemical weed management practices in place prior to planting. Producers that used only slight or nonexistent tillage before planting did not have a viable crop due to strong weed populations from early season moisture. Note that the one producer with herbicide control the previous fall had the lowest dockage.


Camelina Sprouts near Chugwater 5/14/07

Planting – Drills were the most common implement with some Brillion type seeders used. There was a strong sense that firmer seed beds gave the most uniform and desired shallow seed set. Soft field conditions in one case created a situation where the germination period extended over two months due to some seed set over 1” deep. This field of Camelina had quite uneven height and maturity with fully ripe seed pod and growing plants together. Most growers planted 3 to 4 lbs per acre and had to use caution with seeder adjustments due to very small seed size. Alfalfa boxes on grain drills were used with success. Most fields were seeded in mid to late March as there were very cold conditions prior to this time.

Precipitation – All fields were dryland. Seedlings did not exhibit any moisture related stress at 2, 4 &6 leaf stages. There was very good early season moisture everywhere, but cool. This led to 6-8” deep root growth by May but slow top growth. SE area had good soil moisture at planting from snowmelt, then light rain. NE area had drenching rain right after planting and through April. Seedlings were very green and commonly dense at 20-30 sprouts/ft^2. Lack of early season top growth was not due to lack of moisture. The observed correlation between the Apr-Jun precipitation in the 2 regions and yield is difficult to certify given other agronomic variables.

Nutrients – There was no fertilizer application on any plots. Selected soil samples in NE Region showed marginal nutrient levels but this area received nearly one-foot of rain on light soil in the month right after planting. This may have leached nutrients. SE Wyoming fields were organic and light with one having had some manure in last two years. Observations were that with adequate moisture, plants were constrained by the lack of nutrients which limited early season growth and later yields. Few fields "filled in" indicating a lack of nitrogen especially.

Temperature – Temperatures in both regions were unseasonably cool until mid- June then hot through harvest. Several frosts, light snow and ice events were observed in the fields early. Temperatures 15-20^{0}F did not appear to damage seedlings. The cool spring is also likely to have contributed to lack of early season top growth. As late as May 14 in the SE, plants were still in 2 to 4 leaf stage. This observation would reinforce the importance of weed control under these conditions.

Harvest – Three growers direct combined the oil seed and one of these used a stripper head on a JD 9610. Two others combined from a windrow. In one instance, the use of a windrow was due to the lack of an available combine harvester. This was less than ideal since the crop was ripe and a good deal of seed was lost. Actual dockage on the various fields ranged from 2-34% with a weighted average of 19%. The stripper head picked up a significant volume of seed hulls.

Harvest Day in Gillette

Storage & Marketing – Storage for Camelina crop was not established prior to summer 2007 and was an obstacle at harvest. Elevators that were used to handling wheat could not augur or store Camelina due to it small size. Prior to shipping, the crop was stored in a seed cleaning unit and on-farm (trailers and shed floors). The extent of handling was much higher than would be ideal.

The University of Wyoming purchased crop from four growers that was marketed by Energy Fuel Dynamics in September 2007. Twenty-five tons of Camelina seed and 19% dockage was processed into meal and oil at a Chambers, Nebraska oilseed expeller facility. The oil was marketed in Nebraska while the meal is currently being fed to heifers on beef trials in Laramie, Wyoming.

Expellers in Chambers, Nebraska used to press Wyoming Camelina

Ripening Camelina near Chugwater, Wyoming – 7/11/07

SUMMARY RECOMMENDATIONS

- Field Prep –Mechanical weed control is recommended prior to planting and to firm the seed bed. Care should be taken to not over-cultivate on light soil, in order to provide for a consistent shallow planting depth.

- Planting Time – Plant in early to mid March when fields can be worked - but no later than March 30. Conventional wisdom is still that cold temperatures are not an issue but that late planting would potentially miss early season moisture and shorten the growing season.

- Planting Technique – A seed drill set to ¼ to ½ inch (alfalfa box & settings) with a packer wheel behind is recommended. Alternately, a *Brillion*[3] type seeder would be effective for shallow and consistent seed set.

The alfalfa box was used on this drill to seed Camelina

- Nutrients – The application of 20-30 lbs/acre of Nitrogen is recommended, especially if not planting on summer fallow. Field observations were that Camelina does not fill in the field when nutrients are lacking inhibiting yield. A lack of nitrogen may lead to uneven growth and ripening.

- Harvest – The 40 acres harvested using a reel head had the lowest dockage and 2nd best yield. Allowing the crop to ripen in a windrow before combining may be an alternative, if direct combining is not viable.

- Marketing – Growers should consider the lack of a developed Camelina market and consider two marketing options:

    1) Build longer term on-farm storage. This will allow for optimal back-haul transport to an out-of-state elevator that is receiving this crop at the best price. Consider that the small size of Camelina may require handling adjustments and fully sealed silos.

    2) Inquire if mobile expeller services are available to convert the crop to ⅓ oil and ⅔ meal. The meal may be marketed locally as livestock feed while the oil is easily stored in tanks.

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[3] Brillion seeders are designed to drop small seeds between two offset packer wheels.