BIOdiesel Tech NOTES

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POTENTIAL OF CAMELINA BIODIESEL IN THE PACIFIC NORTHWEST

Based on the Life-Cycle Analysis and Production Potential of Camelina Biodiesel in the Pacific Northwest by N. Dangol, D. S. Shrestha, J. A. Duffield, 2014

Camelina (Camelina sativa), is an oilseed crop from the Brassicaceae family similar to mustard, canola, and rapeseed. It is a relatively new crop in the USA and is currently being grown on approximately 50,000 acres, primarily in Montana, Eastern Washington, and the Dakotas. Camelina has a relatively high oil content (30-40%) and could potentially be an attractive biodiesel feedstock crop in some areas of the Pacific Northwest (PNW).

Wheat is the primary crop grown in the Pacific Northwest (PNW) since it provides the highest return on investment (UI, 2012). Peas, lentils, or canola are rotated with wheat to break wheat monoculture once every 3-4 years in higher rainfall regions (>38 cm per year). However, in lower rainfall regions, the land is left fallow. Camelina could be grown in these fallow areas because it has a relatively short growing season (85–100 days) and a low moisture requirement.

From the agronomic standpoint, camelina can be incorporated into low rainfall areas of the PNW as a rotational crop. Wheat areas of the PNW with annual rainfall from 19 to 38 cm and currently incorporating fallow into their rotations were considered as potential areas for camelina and are shown in Figure 1. There were 846,500 hectares (2.1 million acres) of land meeting the criteria in the region that could potentially produce 443.0 million liters of biodiesel (117.1 million gal) and 1.2 billion kg of meal per year. This makes up 12.1% of the approved amount of camelina meal that could be used in livestock feed within the PNW.

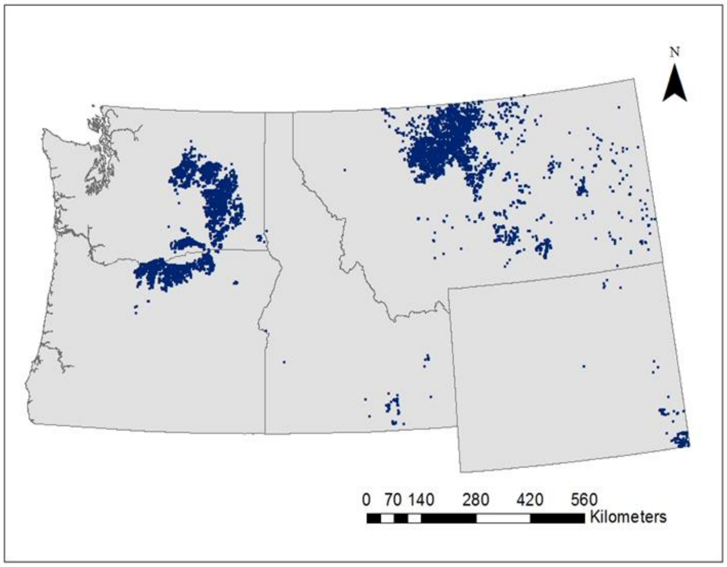

Figure 1: Potential camelina cultivation areas in PNW

A study was conducted in order to determine the viability of camelina biodiesel production in the PNW if it is planted as a rotational crop in areas of the region that are left fallow. The study included a comparative analysis between camelina and canola on seed size, fatty acid profile, and biodiesel quality. Research for the study was then focused on assessing the energy balance and greenhouse gas emissions relative to its petroleum fuel counterpart. It also quantified the potential acreage, production and market demand for the camelina meal in the PNW. Field data were collected from a camelina farm in the region and crushing and transesterification data were measured using facilities at the University of Idaho.

Camelina can be cultivated and harvested using the same equipment used for canola although, because of the smaller seed size, care must be taken to avoid seed being lost through holes or cracks in the equipment. Since the hull contains almost no lipid or protein, larger seeds such as canola have more overall oil percentage even though the meal lipid percentage is the same. The average oil content of canola was 40.5%, compared to 34.2% for camelina.

In addition to smaller meal to total volume ratio, smaller seeds also require more energy to break open. Compared to canola, camelina required 23.9% more energy per kg of seed to crush the seeds, and 46.2% more energy per liter of oil expelled. Additionally, canola has a better fatty acid profile with higher percentage of monounsaturates compared to camelina, which had higher percentage of polyunsaturates. Oil with higher polyunsaturates tends to increase NOx emissions and reduce oxidative stability. Camelina biodiesel didi not meet the ASTM D6751 for oxidative stability without use of additives.

Cold pressed camelina meal contains 10–14% oil by weight, which potentially can be extracted using a solvent extraction method. However, further extraction is not likely since the current scale of camelina crushing is inadequate to justify the cost. More importantly, the high oil content of the meal has a greater demand as animal feed. Camelina meal is better suited than rapeseed or mustard meal for animal feed because of lower glucosinolate levels. Canola, however, has comparable or slightly lower glucosinolate levels. Lower glucosinolate makes a meal more suitable for livestock feed and as a result, camelina meal had been approved by the FDA up to 10% in poultry and beef cattle, and 2% in swine feed mix.

Assessment of the energy balance and greenhouse gas emissions was done by conducting a life cycle analysis (LCA) using life-cycle models GREET and using data from GHGenius. LCA results were reported in terms of net energy ratio, fossil energy ratio, and net greenhouse gases emissions. The net energy ratio (NER) is the ratio of energy output from biofuel per unit of total energy used to produce the fuel. NER can be used to compare the production efficiency of a biofuel to a petroleum fuel. For instance, petroleum diesel uses 0.13 units of energy for one unit of energy mined. This causes the NER for petroleum diesel to be about 6.7. The net energy ratio for camelina biodiesel was found to be 3.6, as compared to 5.5 for soybean biodiesel. This indicates that petroleum diesel and soybean biodiesel would yield more energy per unit of energy spent.

The fossil energy ratio (FER) measures the renewability of a biofuel. FER is the ratio of energy output from the biofuel per unit of non-renewable or fossil energy input. A higher FER value corresponds to higher renewability of a fuel. Fossil energy ratio for camelina biodiesel was found to be 4.2, or about four times more renewable than petroleum diesel.

Greenhouse gas (GHG) emissions are important to biofuels producers since tax credits and Renewable Identification Numbers (RINs), as created by Renewable Fuel Standard (RFS2) program, have higher value depending upon how the biofuel is classified. For camelina produced biodiesel the "advanced biofuel" classification would provide the highest incentive. A biofuel qualifies as an advanced biofuel if the fuel reduces GHG emissions by at least 50% compared to baseline petroleum fuel. Results of the study estimated that the use of camelina biodiesel reduces GHG emissions by 69% compared to 2005 baseline diesel. Thus, it was concluded that camelina biodiesel meets GHG reduction threshold of 50% to qualify as an advanced biofuel, as set by the Energy Independence and Security Act (2007).