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Utilizing Locally-produced Canola to Manufacture Biodiesel

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Canola (*Brassica napus* L., Brassicaceae) research in Virginia began in the mid 1980s. A concerted and focused cooperative effort was initiated, with USDA-CSREES-National Canola Research Program funds, in 1993 by Virginia's two Land Grant Universities: Virginia State University and Virginia Tech. A major goal of this effort, until recently, has been establishment of canola as a domestic source of edible oil. Currently, we are interested in using canola oil for food and as a feedstock for biodiesel.

CANOLA

Canola is closely related to turnip, cabbage, cauliflower, broccoli, and mustard. It is now the third most important source of vegetable oil in the world. Canola is the name given to a group of rapeseed cultivars that are low in erucic acid and low in glucosinolates. The consumer interest in canola oil, in human diet, is increasing due to its low content of saturated fatty acids (5% to 8%) and moderate concentration of poly-unsaturated fatty acids.

Even though efforts to produce canola in the United States are beginning to bear fruit, most of the canola oil used in the United States is still imported from Canada. During the period 1995–1996 to 2004–2005), United States imported 390,000, 424,400, 418,900, 409,600, 456,100, 540,500, 506,400, 446,000, 536,300, and 522,200 tonnes (t) of canola oil from Canada indicating a great potential for this crop in the United States. A lack of crushing facilities in most areas where canola has been shown to be highly adaptable, such as Virginia and the mid-Atlantic region of the United States, has been a major block in the domestic production of canola. It is often stated in farming circles that "*without a crusher, canola would not be grown on a commercial scale and without a large enough acreage of canola, a crusher would not be established.*"

Canola research in Virginia began in the 1980s at Northern Piedmont Agricultural Research and Extension Center of Virginia Polytechnic Institute and State University (Virginia Tech). Extensive research to develop canola as an alternate winter crop for Virginia was initiated in 1993 when Virginia State University and Virginia Tech began a cooperative research program with funding from USDA-CSREES-National Canola Research Program. This research has been conducted at three locations: Orange, Petersburg, and Suffolk. The Orange location is managed by Dave Starner (Virginia Tech) whereas Petersburg and Suffolk locations are managed by Harbans Bhardwaj (Virginia State University).

A new canola cultivar, tentatively named 'VSX-1', has been developed by Virginia State University. This cultivar is well adapted to Virginia and has been a top yielder in Virginia and other locations in the National Canola Variety test for the last several years and is to be named 'Virginia' and released during 2007/2008.

CANOLA PRODUCTION DETAILS

Based on research conducted in Virginia and information available from elsewhere, the following recommendations are made for canola production in Virginia:

- Planting Time: middle of September to early October in the Northern Piedmont region, October in the Southern Piedmont region, and middle of October to early November in the coastal plain region of Virginia.
- Seeding rate: 5 to 6 kg of seed/ha. Canola should be planted as shallow as possible.
- Fertilizers: 112 kg/ha each of N, P, and K (on soils testing medium in P and high in K) and 33.6 kg/ha of sulfur.
- Row spacing: Even though canola can be planted in rows varying from 15 to 92 cm or broadcasted, preliminary recommendation is for canola to be planted in rows varying from 30 to 61 cm.
- Canola should be harvested promptly upon maturity. Canola, in Virginia, generally matures in mid to late June.

BIODIESEL

Biodiesel is the name of a clean burning alternative fuel, produced from domestic, renewable resources. Biodiesel contains no petroleum, but it can be blended at any level with petroleum diesel to create a biodiesel blend. It can be used in compression-ignition (diesel) engines with little or no modifications. Biodiesel is simple to use, biodegradable, nontoxic, and essentially free of sulfur and aromatics.

Biodiesel is made through a chemical process called "transesterification" whereby the glycerin is separated from the fat or vegetable oil. The process leaves behind two products—methyl esters (the chemical name for biodiesel) and glycerin (a valuable byproduct usually sold to be used in soaps and other products).

Biodiesel is defined as mono-alkyl esters of long chain fatty acids derived from vegetable oils or animal fats which conform to ASTM D6751 specifications for use in diesel engines. Biodiesel refers to the pure fuel before blending with diesel fuel. Biodiesel blends are denoted as, "BXX" with "XX" representing the percentage of biodiesel contained in the blend (i.e.: B20 is 20% biodiesel, 80% petroleum diesel). Extensive details about biodiesel are available from National Biodiesel Board (www.biodiesel.org/).

Biodiesel is better for the environment because it is made from renewable resources and has lower emissions compared to petroleum diesel. It is less toxic than table salt and biodegrades as fast as sugar. Since it is made in the US from renewable resources such as soybeans, its use decreases our dependence on foreign oil and contributes to our own economy.

In 2000, biodiesel became the only alternative fuel in the country to have successfully completed the EPA-required Tier I and Tier II health effects testing under the Clean Air Act. These independent tests conclusively demonstrated biodiesel's significant reduction of virtually all regulated emissions, and showed biodiesel does not pose a threat to human health.

Biodiesel contains no sulfur or aromatics, and use of biodiesel in a conventional diesel engine results in substantial reduction of unburned hydrocarbons, carbon monoxide, and particulate matter. A US Department of Energy study showed that the production and use of biodiesel, compared to petroleum diesel, resulted in a 78.5% reduction in carbon dioxide emissions. Moreover, biodiesel has a positive energy balance. For every unit of energy needed to produce a gallon of biodiesel, 3.24 units of energy are gained.

With agricultural commodity prices approaching record lows, and petroleum prices approaching record highs, it is clear that more can be done to utilize domestic surpluses of vegetable oils while enhancing our energy security. Because biodiesel can be manufactured using existing industrial production capacity, and used with conventional equipment, it provides substantial opportunity for immediately addressing our energy security issues.

If the true cost of using foreign oil were imposed on the price of imported fuel, renewable fuels, such as biodiesel, probably would be the most viable option. For instance, in 1996, it was estimated that the military costs of securing foreign oil was $57 billion annually. Foreign tax credits accounted for another estimated $4 billion annually and environmental costs were estimated at $45 per barrel. For every billion dollars spent on foreign oil, America lost 10,000–25,000 jobs.

Increased utilization of renewable biofuels results in significant microeconomic benefits to both the urban and rural sectors, and the balance of trade. A study completed in 2001 by the US Department of Agriculture found that an average annual increase of the equivalent of 200 million gallons (757 million L) of soy-based biodiesel demand would boost total crop cash receipts by $5.2 billion cumulatively by 2010, resulting in an average net farm income increase of $300 million per year. The price for a bushel of soybeans would increase by an average of $0.17 annually during the ten-year period.

In addition to being a domestically produced, renewable alternative fuel for diesel engines, biodiesel has positive performance attributes such as increased cetane, high fuel lubricity, and high oxygen content, which may make it a preferred blending stock with future ultra-clean diesel.

Biodiesel is registered as a fuel and fuel additive with the EPA and meets clean diesel standards established by the California Air Resources Board (CARB). B100 (100% biodiesel) has been designated as an alternative fuel by the US Department of Energy and the US Department of Transportation. Moreover, in December 2001, the American Society of Testing and Materials (ASTM) approved a specification (D6751) for biodiesel fuel. This development was crucial in standardizing fuel quality for biodiesel in the US market.

The National Biodiesel Board, the trade association for the biodiesel industry, has formed the National Biodiesel Accreditation Commission (NBAC) to audit fuel producers and marketers in order to enforce fuel quality standards in the US. NBAC issues a "Certified Biodiesel Marketer" seal of approval for biodiesel marketers that have met all requirements of fuel accreditation audits. This seal of approval will provide added assurance to customers, as well as engine manufacturers, that the biodiesel marketed by these companies meets the ASTM standards for biodiesel and that the fuel supplier will stand behind its products.

Effective November 1998, Congress approved the use of biodiesel as an Energy Policy Act (EPAct) compliance strategy. The legislation allows EPAct-covered fleets (federal, state and public utility fleets) to meet their alternative fuel vehicle purchase requirements simply by buying 450 gallons (1703 L) of pure biodiesel and burning it in new or existing diesel vehicles in at least a 20% blend with diesel fuel. The Congressional Budget Office and the US Department of Agriculture have confirmed that the biodiesel option is the least-cost alternative fuel option for meeting the Federal government's EPAct compliance requirements. Because it works with existing diesel engines, biodiesel offers an immediate and seamless way to transition existing diesel vehicles into a cleaner burning fleet.

CANOLA AS A BIODIESEL CROP FOR VIRGINIA

Canola could provide an alternate crop to Virginia farmers. Even if 25% of winter wheat acreage was replaced with canola, it could mean a tremendous difference in the income of many farmers. During 2003, winter wheat was harvested from 64,800 ha for a production value of $21.7 million, in Virginia. One-fourth of this area (16,200 ha) would produce approximately 55,388 t (Approximately 2.4 million bushels, each bushel is 22.7 kg of seed) of canola seed. Based on the purchase price on December 1, 2005 (www.canola-council.org/canolaprices.html of $6.25 per bushel in Canada (CDN $275.60/t), the return in Virginia would be approximately $941/ha from canola assuming an average yield of 151 bushels/ha. When compared to returns from winter wheat, with an approximate price of $2.95/bushel, the returns from canola will be substantially higher than that from winter wheat. Virginia farmers have produced an average of 113–156 bushels of winter wheat per ha during 2001–2003 with an approximate cost of $3 per bushel ($341 to $467/ha).

If the farmers adopt use of canola oil for manufacture of biodiesel at their own farms, the returns from reduction of fuel costs would be tremendous. It is envisaged that each farmer with 2–3 tractors could grow his own canola, invest in a small crusher and a biodiesel processor (At a cost of approximately $7,000), and reduce his off-farm purchases of fuel. In the case of small farmers, a few of them could join together and produce their own biodiesel for use in their farm machinery.

An alternative for Virginia farmers would be to either sell canola seed or canola oil. This effort would be extremely helpful to the agricultural economy even if the reductions in off-farm fuel purchase would be meager. Farmers in the central Virginia region have a ready buyer in the bio-diesel plant in West Point. The estimated income for Virginia farmers related to utilizing canola oil for manufacture of bio-diesel in Virginia is mind-boggling.

Canola seed contains approximately 40% oil and 60% meal. This meal is an excellent feed for livestock and also as a "natural" fertilizer. Availability of this meal will support production of poultry, swine, and other live stock and also support production of organic crops.

Current feedstock of choice for biodiesel is soybean oil. Average soybean yields in Virginia are approximately 79 bushels/ha (1792 kg/ha) which results in approximately 358 kg of oil (approximately 20% oil in soybean seed). In comparison, average canola seed yields are more than 2.24 t/ha (2000 lbs/acre) which results in 896 kg of oil (approximately 40% oil in canola seeds). Biodiesel manufactured from canola oil is expected be superior to that from soybean oil especially in the areas of viscosity and cloud point.

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