



From seed to sky

THE FIRST AEROPLANE TO FLY ON 100% BIOFUEL FLEW ON CARINATA IN 2012 AND WAS FOUND TO PERFORM AS WELL AS CONVENTIONAL FOSSIL FUELS WHILE EMITTING FEWER PARTICULATES

Carinata produces an excellent biofuel and its meal can be fed to cattle, but the crop shines best as a feedstock for aviation biofuel. Charlotte Niemiec looks at its success in the air and efforts to improve and scale up production

Is carinata the 'Holy Grail' for aviation biofuel? Those involved with the crop believe so, as it meets all specifications for commercial jet use with no need to blend in any petroleum-based fuel and emits fewer particulates than conventional fuel. *Brassica carinata*, or Ethiopian mustard, is a crop similar to canola or rapeseed that produces a non-edible oil ideally suited for the manufacturing of biofuel.

It has many advantages: it is tolerant to both heat and drought and resistant to many diseases, making it ideal for production in regions typically not well-suited to growing major food crops. Additionally, it fits well within different crop rotations, enabling efficient and sustainable use of land resources. It is certified sustainable under the Roundtable of Sustainable Biomass (RSB).

The crop's residue can be ground into a meal for use in cattle markets, increasing its crop value. An article submitted to *Biofuels Digest* in May last year by Don Konantz, president and CEO of Calyx Bio-Ventures, an agricultural technology company focused on renewable fuels, notes that this "recaptures so much of the costs and assists in the economic viability of this burgeoning biofuel [because] when the meal's full value is achieved, and at scale, the cost of producing biofuel with carinata is cost-competitive for energy customers".

Dr John McKinnon, Saskatchewan Beef Industry chair, University of Saskatchewan, Canada, places another tick in the carinata checklist: "Carinata meal is relatively low in fibre and an excellent source of crude protein that is readily degradable by rumen bacteria. As such, this meal can be used

effectively to meet the rumen degradable protein needs of growing cattle."

Carinata has a very low level of saturated fat – lower even than canola oil, an oil that provides one of the best biodiesel fuels. In conventional biodiesel, saturated fats are responsible for crystal formation that leads to clouding and filter plugging in cold temperatures, making carinata oil a preferred feedstock for biodiesel in colder climates. The oil contains over 40% erucic acid, a C22 monounsaturated fatty acid. Traditional aviation fuel is composed of C9 through C13 molecules and the longer carbon chain length of carinata oil allows for more efficient conversion into aviation fuel with reduced amounts of low-value secondary products such as liquefied petroleum gas (LPG) and naphtha when compared to other feedstocks used.

Furthermore, carinata's long-chain fatty acids are used in multiple industrial applications that include high performance lubricants, coatings and use as a feedstock to create chemical intermediates. Carinata oil is believed to be a sustainable source of these fatty acids for the emerging sustainable or 'green' chemistry industry.

Agrisoma leads the industry

One company involved with the research into, and production of, carinata is Agrisoma, which sells seeds to farmers for the production of renewable oil. It is the world's largest carinata breeding company and has amassed the largest collection of carinata genetic resources, introducing its commercialised carinata to the crop seeds market. The company ▶

explains that, as a close cousin of canola, carinata readily drops into existing agricultural practices and the oilseed value chain without the need for new equipment or changing practices.

The complete value chain that takes carinata from seed to oil has been established using existing farm equipment and oilseed processing facilities. This could encourage farmers that might otherwise be reluctant to invest in new systems to grow carinata as a rotation crop; too many times have farmers switched from one crop to another on the promise of a 'miracle' crop (think jatropha or camelina), only to find that yields were not as expected, nor profits.

This is not the case with carinata, says Agrisoma. The company's programme includes a large Canadian nursery effort, where hundreds of advanced pre-commercial lines of carinata are tested for performance in the core production region and are assessed for yield, seed and oil quality, herbicide tolerance and disease resistance, as well as overall agronomic performance. On an annual basis, Agrisoma evaluates tens of thousands of new lines across the major target production zones to select varieties that are best suited for commercial sales. Its 'Resonance carinata' brand is currently being grown in Canada using sustainable farming practices.

Agrisoma has collaborated with key research institutes to develop a comprehensive genetic map of carinata, identifying key traits that are instrumental in achieving yield and quality, it says. It uses these molecular markers to assemble new genetic combinations, making it a leader in the genetic research of carinata and using its advanced technology to improve oilseed yield and produce the best oil profiles for the biofuel industry.

Its technologies include new genomics, proteomics and DNA-based tools that develop scientific understanding of carinata. The Canadian National Research Council (NRC) provides further access to advanced capabilities that include genome sequencing, bioinformatics and advanced analytical tools such as nuclear magnetic resonance (NMR) imaging and mass spectrometry.

Carinata makes aviation history

As an aviation fuel, carinata soars. A report from the Coordinating Research Council (CRC) claims that the fuel 'ReadiDiesel', made from Resonance carinata, meets ASTM D975 specifications (the standard specifications for diesel fuel oils, biodiesel, biodiesel blends, diesel, fuel oil, petroleum and petroleum products) "without blending and has a molecular make-up that is almost indistinguishable from the ultra-low sulphur diesel tested ... and was the only fuel tested that had the same level of aromatics as petroleum-based diesel fuel".

The tests have proved positive in the airfield, too. On 29 October 2012, a Dassault Falcon 20 twin engine took off from Ottawa, Canada, and made a 90-minute round-trip flight to Montreal. The fuel that powered the jet was made from 100% carinata oilseed, making it the first aeroplane in history to fly on 100% biofuel. Until then, biofuel flights were restricted to a 50% blend with petroleum as the technology for a pure biofuel product was "largely unproven", a *South East Farm* press report said.

Even more positively, the carinata aviation fuel emitted fewer particulates than conventional jet fuel and the pilots said they did not detect any



LIKE RAPESEED, CARINATA PRODUCES SMALL YELLOW FLOWERS AND CAN BE GROWN ON MARGINAL LAND

difference in performance compared with flying with conventional fossil fuels. Agrisoma president Steven Fabijanski said of the flight: "To date, all powered flight has relied on fossil fuel. This flight changes everything; we have witnessed petroleum-free aviation."

Agrisoma further explains carinata's benefits as a biofuel: "For biofuel manufacturers, Resonance carinata provides a lower-cost, uniform, long-chain monounsaturated fatty acid profile that enables additional efficiencies and returns from biofuel manufacturing processes. Resonance carinata oil has been used for advanced biofuel manufacturing as well as traditional biodiesel. [It] makes an excellent biodiesel and provides a very useful blend stock for improving the quality of biodiesel made from lower quality feedstocks."

In addition to its performance as a biofuel and aviation fuel, using carinata has further benefits. Carinata fuels need only a minimal amount of refining once the oilseeds are crushed and filtered, and farmers stand to benefit financially.

David Wright, project director at the University of Florida's North Florida Research and Education Centre in Quincy, said: "With the technology proven, we estimate a total income to be from US\$550/acre to US\$750/acre, generating an income of US\$100M/year to US\$375M/year for the state of Florida." He adds: "This technology will not take land out of food production and has the benefit of creating jobs in Florida with a minimal impact on the environment."

Government incentives needed

Despite its potential, *The Western Producer* reported last year that, while there were plenty of

carinata research plots, there had been no grower contracts in Western Canada by July. The article explained that plans made earlier in the year to offer production contracts had been scrapped when the federal government took longer than expected to approve carinata meal for cattle feed and the US government hadn't approved the oil as part of its biofuel blending mandate.

Another problem was that the US Environmental Protection Agency (EPA) had not issued renewable identification numbers (RINs) for carinata. Ken Mudry of Paterson Grain – a buyer, importer and exporter of grain commodities in Canada – said these approvals from both the US and Canadian governments were needed to increase the value of the crop for growers and marketers.

"We're over one hurdle and we're working toward the approval with the EPA in the USA to get approved for RIN credits," he said, adding "We're quite optimistic it will get approved before [this] spring."

While aviation fuel was the ultimate market for carinata oil, until production was scaled up, the oil was going into the biodiesel market, he said.

"The challenge is to ensure that we scale up and that Agrisoma continues to look at enhancing the performance of the crop itself, enhancing yield [and] looking at the profile of the oil and meal."

Will carinata take off? If there is incentive to grow the crop, yes. Mudry asserts: "Producers in Western Canada have told us they would grow it if it was at parity to canola values, so that's the thing we're targeting. Before we go full-scale contracting, we have to ensure that we can deliver that value to producers."

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