# A New Crop for Missouri Farmers?

By Jo Seltzer, special to the Beacon

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Modern plant science could be instrumental in finding replacements for dwindling petroleum supplies. And the Danforth Plant Science Center is looking into a hardy plant that could be grown in Missouri as a key in making the transition.

"It is absolutely inevitable that the price of fuel will go up. In about 10-15 years the supplies of petroleum will begin to go down," said Jan Jaworski, vice president for research at the Danforth Center. " There is not very large disagreement about that—the disagreement has to do with whether the decrease begins in 2018, 2020, or 2025."

*Camelina sativa*
Photo courtesy of Donald Danforth Plant Science Center

Jaworski and his colleagues at the Danforth Center are focusing on Camelina sativa, pictured at right. It was grown for centuries in northern Europe as a source of lamp oil. In this country, companies have begun cultivating camelina in Montana as a source of omega-3 oils contained in in some food supplements.

Recently, the Missouri Life Sciences Research Board awarded two grants totaling $1.5 million to scientists at the Danforth Center. One of these grants, to explore the possibility of developing *Camelina sativa* as a non-food crop for Missouri will be shared by Danforth investigators Eliot Herman, Monica Schmidt, and Roger Beachy and University of Missouri Delta Center investigator Gene Stevens.

The scientists envision that this rediscovered "near-crop" could be a vehicle for producing commodities to either replace some petroleum products, or be part of the manufacturing process of petroleum supplements such as ethanol—or both. If Camelina could be grown as a seed crop in Missouri, oils could be pressed from the seeds, and the remaining proteinaceous matter used as a source of enzymes used in the production of biofuels.

There are a number of reasons for the buzz of scientific excitement around Camelina.

- It is not a food.
- It is relatively cold hardy, and does not require much fertilizer.
- It has a short growing span, from seed to seed in about three months.
- It is closely related to Arabidopsis, the plant most used as a model in plant biology and technology.

**Not a food**

Our main food crops are corn and soybeans.  Although the public is hoping for development of petroleum substitutes to fuel cars and heat homes, the use of foods to make these substitutes is not popular.  Too many people are hungry, and food prices have been rising steeply.  Furthermore, thanks to books like Pollan's "The Omnivore's Dilemma" the reading public knows that corn is a fertilizer-intensive crop, and its culture is enmeshed in politics.

More important, a nonfood crop like camelina can produce bioengineered products that could never mistakenly get into the consumer food chain.  As Jaworski explains, Camelina's seeds are 30-35% oil, but the omega-3 structure is unstable, making the oil unsuitable for fuel.  However, bioengineering can modify that structure to make the oil suitable for biofuel.

**Hardy and does not require much fertilizer.**

Cold hardy is a good thing for Missouri winters—more on winters later.  Low fertilizer requirements makes good economic sense, as well as reducing environmental concerns about the effects of fertilizer overuse.

**Short growing span**

For farmers, a short lifespan of three months would enable camelina to be grown as a third crop.  That is, seeds planted either in later fall or early spring could be ready for harvest in May; the same field could then be planted with soybeans.  At present some farms use winter wheat in such a three crop system—wheat and then soybeans one year, followed by corn the next.

For researchers, the wait between experiment and results is shortened from six or seven months for soybeans to three months.

**A close cousin of  Arabidopsis**

Arabidopsis is the experimental mouse of the plant world.  It is the plant of choice for research, with a completely sequenced genome.  It is used as a model system for plant biology and biotechnology, but has no commercial value.  Its seeds are tiny—less than a speck of pepper.

Camelina, on the other hand, has seeds large enough to consider harvesting, as shown in the photo.  These seeds contain a lot of oil, and might be made to produce even a higher percentage.

Eliot Herman holds Camelina sativa seeds in his hand.

All the biotechnology developed in Arabidopsis can be transferred easily to Camelina, including the method of genetic modification called the "flower dip," explained in the sidebar.

**“Flower Dip” process speeds genetic transformation**

In plants, biotechnology is usually extremely labor intensive. Plant embryos have to be dissected, and the pieces cultured in incubators to turn into the plant equivalent of stem cells. Tiny pieces of the stem cell material are exposed to the transforming genetic material, and allowed to grow into tiny plants in many Petri dishes. Those that grow are transplanted again into soil, and may need to be transplanted again. Then the plants must mature in order for the scientists to assess the effects of their experiments. Lots of hands and time are involved in the process. (To see a slide show about this process, click on a previous Beacon article)

A few years ago, a method for doing biotechnology with Arabidopsis was developed to bypass all the labor and time-intensive tissue culture steps. This method, called the "Flower Dip," simply takes plants in early flowering stages and dips them into the genetic transforming agent. The plants continue to grow, and eventually make seeds containing the new genetic material. Successfully transformed seeds can be identified because they will also carry a marker, such as a fluorescent protein that makes them glow.

The seeds then are simply planted in soil and grown as any other plants. As they grow to maturity, the scientists can pick out any plants where the transformation has given a desired result.

To see pictures of the "flower-dip" go to http://www.plantsci.cam.ac.uk/Haseloff/teaching/PDFlists/2000_PDFs/Bent2000.pdf . The text is highly technical, but the photos are accessible.

Camelina could become a factory making enzymes for biofuel synthesis.

With their new grant, scientists Herman and Schmidt will work on getting Camelina to put into its seeds significant quantities of enzymes involved in producing biofuels. As Herman explains, at present the protein component of the seed left after oil extraction would be destroyed as it is not approved for animal feed. But if it could be used as a source of commercial enzymes, it would be extremely valuable. Enzymes are catalysts, and it takes only tiny amounts of them to make biochemical reactions go. The plant could be used as a little factory.

If biofuels are to be made from biomass such as switch grass, enzymes called "cellulases" will be needed to break the cellulose of cell walls into its component sugars. The sugars could then be fermented into ethanol, which is already used in gasoline formulations.

**Camelina sativa seeds would have an "On-Off" switch**.

Roger Beachy, Ph.D., President of the Danforth Center will add a feature to ensure that any camelina seeds from bioengineered plants will be unable to germinate on their own. If a bird eats seeds that contains extra cellulases, and 'deposits' undigested seeds in a faraway field, the seeds will not grow. They must be supplied with a specific man-made chemical to go into "On" mode.

**Yes, but will it grow?**

A crucial question to be answered with this new grant is whether camelina can be grown in Missouri in an economic fashion.  Here is where Gene Stevens, of the Delta Center in the Missouri bootheel comes in.

Stevens, an agronomist, is charged with trying to find a strain of the plant that will grow under conditions quite different from its native northern Europe or its transplant to Montana.  The main problem is our wet spring.  Camelina grows well in dry climates. When growers in Ireland tried raising it, they encountered disease problems.

Stevens is hoping to find a strain that is resistant to Missouri plant diseases, or that can be easily treated with fungicides.  If he does find such a strain, he still encounters the problems of working the fields.  If harvest is to occur in May, the seeds must be sown in late February or early March, and the fields may be unworkable.

Therefore, he is looking for a strain that can be planted in late fall, goes dormant over the winter (like winter wheat), and starts growing again in the spring.  He has obtained 42 strains from the USDA germplasm bank in Ames, Iowa and is currently growing them in his greenhouses.  He says he has at least one line from Germany that may work, and has learned that some strains will go dormant in winter.

Stevens has other tricks up his sleeve, such as growing the crop on raised beds, but says that for now he will be kept busy exploring the variety of strains that nature provides and hoping that one of them will be suitable for our four seasons climate.  He will also be testing at least some of the strains in far northeast Missouri in the Novelty Research Station run by the University of Missouri.  Plants that don't do well in the Mississippi delta region may thrive further north.

**Other Grants in Saint Louis Area**

In the same round of funding, the Missouri Life Sciences Research Board awarded additional monies to the Danforth Center to purchase a new state of the art instrument, a mass spectrometer. The two grants totaled $1.5 out of the $13.1 million awarded. The

Center for Emerging Technologies was granted $520, 000 to equip labs and offices in their new facilities.