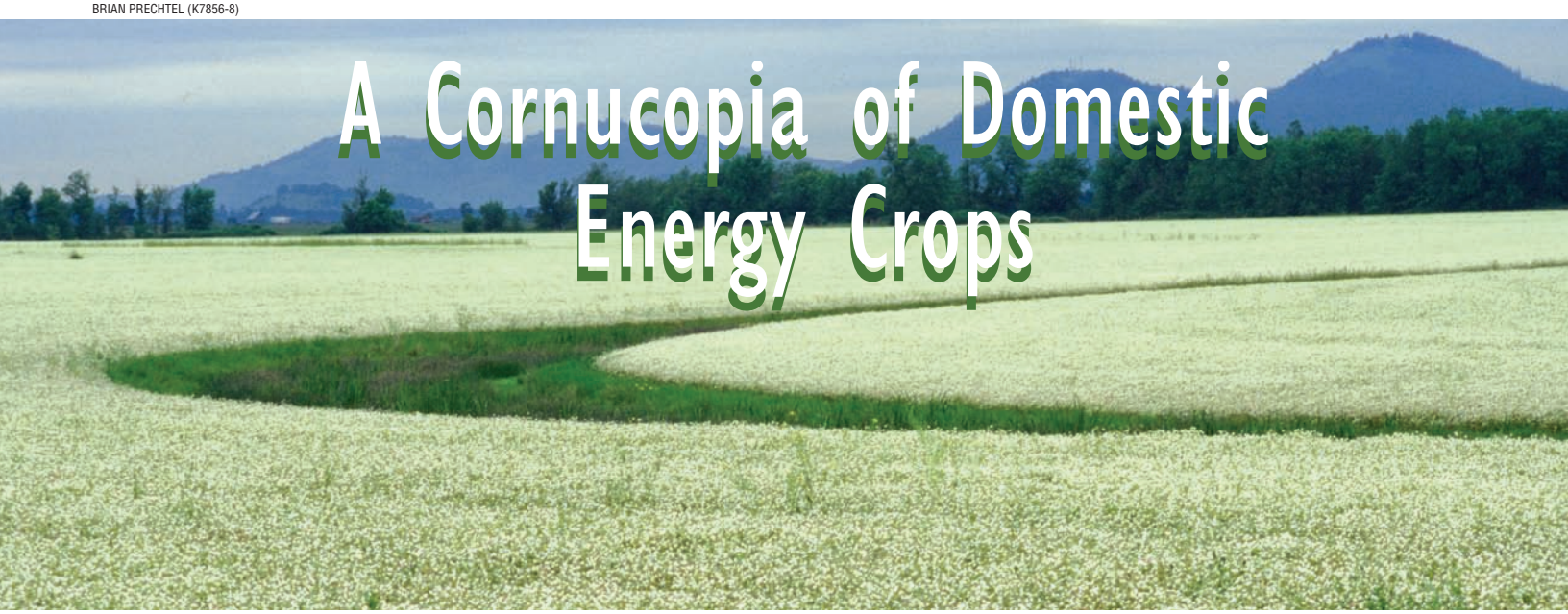
BRIAN PRECHTEL (K7856-8)

A Cornucopia of Domestic Energy Crops



Meadowfoam.

Cuphea is a genus of flowering plants that yield a type of oil similar to palm kernel and coconut oils. These oils, which are produced commercially only in the Tropics, contain the capric, lauric, and other medium-chain-length fatty acids needed to make soaps, cosmetics, motor oils and other industrial lubricants, and hydraulic fluids. At present, *Cuphea* is one of the only sources of these valuable tropical-style oils that can be grown in the continental United States.

Since 1999, plant physiologist Russ Gesch and colleagues at the ARS North Central Soil Conservation Research Laboratory in Morris, Minnesota, have studied *Cuphea*, working hand-in-hand with Terry Isbell and colleagues at the ARS New Crops and Processing Technology Research Unit in Peoria, Illinois. The ARS scientists also work closely with farmers, universities, and industry, including the Procter & Gamble Company of Cincinnati, Ohio, which uses medium-chain-length fatty acids in some of their products, such as laundry detergent. Isbell works with a plant breeder at Western Illinois University at Macomb to find lines more suitable for processing.

In 2000, the team began working with a then-new variety, PSR23 (Partial Seed Retention line No. 23), and since have researched other varieties, such as HC10 (High Capric *Cuphea* line No. 10), which have been selected and developed from a cross between two *Cuphea* species: *C. viscosissima* and *C. lanceolata*. The scientists worked closely with Steve Knapp, the plant geneticist who developed PSR23, HC10, and other *Cuphea* lines used in this research. Knapp, formerly at Oregon State University at Corvallis, is now at the University of Georgia at Athens.

KEITH WELLER (K8680-2)

Chemist Bliss Philips extracts oil from *Cuphea* seeds.

KEITH WELLER (K6054-8)

Alpine pennycress.

"Partial seed retention" refers to the fact that seed capsules of line No. 23 don't break apart and disperse as easily as those of other *Cuphea* lines. This was one of the problems scientists had to solve to make harvesting easier and increase oil yield from the seeds.

Useful *Cuphea*

In addition to its industrial usefulness, *Cuphea* can serve as an alternative to soy, sunflower, or canola as a biofuel source. ARS scientists are working with the University of North Dakota at Grand Forks and several industry collaborators from around the country to develop a process that can convert crop oils such as *Cuphea* oil into jet fuel. This extensive project is being funded by the Defense Advanced Projects Research Agency, a branch of the U.S. Department of Defense.

Cuphea is one of many bioenergy crops ARS scientists are using to increase income to farmers who grow the usual corn-soybean-wheat rotations. Mustard crops—camelina, pennycress, and canola—are also being eyed for their potential as seed

oil crops for biofuel and other industrial products.

Isbell sees an important advantage to these alternative crops. "When you plant a crop like pennycress as a winter crop, followed by soybean as a summer crop, you get fuel in the winter and food in the summer," he says.

Gesch and his colleagues at Morris handle ways to grow the crops profitably, while Isbell and his colleagues at Peoria handle the crops' processing into industrial products. The Peoria unit has a pilot commercial-scale plant that has processed barrels of oil from camelina, canola, *Cuphea*, lesquerella, milkweed, mustard greens *(Brassica juncea),* pennycress, soybean, and sunflower. Isbell also works with coriander and meadowfoam.

These alternative crops not only help provide new sources of farm income and provide new ways to control pests, but could also help reduce our reliance on imported oils. The United States buys about $1.5 billion worth of palm and coconut oils each year to meet half of its industrial needs for medium-chain-length fatty acids; the rest comes from petroleum.

STEPHEN AUSMUS (D1128-1)

Seeds of *Cuphea,* one of many oil-producing crops being evaluated for its bioenergy potential.

PEGGY GREB (K9159-1)

ARS scientists examine common milkweed along an Iowa roadside.

Making It Farmer Friendly

Gesch and colleagues developed a set of farming practices and published a farmers' guide to growing *Cuphea*. These guidelines were developed with the help of farmers who agreed to test the crop. Technology Crops International, a seed company in Winston-Salem, North Carolina, distributes the guide and seeds to farmers who grow *Cuphea* under contract. The company began the on-farm commercialization project in 2004.

Frank Forcella, an ARS agronomist at Morris, has so far identified seven herbicides that can be used to control weeds in *Cuphea*, whose seedlings develop slowly and are highly susceptible to weed competition.

The Morris lab has worked longest on *Cuphea*, but researchers have done work on other alternative energy crops too. They're beginning a long-term corn-soybean rotation study that will include switchgrass and other perennial grasses—big bluestem and indiangrass—for processing into cellulosic ethanol. They will also test an annual grass, a sorghum-Sudangrass hybrid.

Sharon Weyers, the ARS soil biologist who is leading this study, says, "The main goal is to develop cropping systems for optimal biomass production while maintaining or enhancing soil productivity. We will evaluate effects on soil productivity by measuring changes in soil carbon and nitrogen as well as total biomass and crop yields. We will evaluate how well perennial grasses fit into a 3-year soybean-corn-soybean rotation and how well the annual sorghum-Sudangrass hybrid fits into a 2-year rotation with soybean. Also, we'll evaluate the effectiveness of establishing winter ryegrass as a cover crop and red clover as a continuous living mulch."

When crops are harvested for their leaves and stalks after grain harvest, they are known as "biomass energy crops." This, again, has the advantage of not diverting crops or plants used for human food to energy production.

"We chose cropping systems based on the ability of cover crops, living mulches, and grasses to contribute additional crop residue or root matter to make up for removal of crop biomass for bioenergy production," Weyers says. "These plants will also provide additional carbon and nitrogen, which may be important to carbon storage and soil quality."

Soil scientist Jane Johnson will work with Weyers to investigate how soil properties are affected by residue removal for energy production.

For comparison, data is also being collected on grasslands and pastures on private farms in the Morris area. The grasslands were chosen because they are enrolled in the federal Conservation Reserve Program (CRP), which takes erosion-prone farmland out of production and requires that it be seeded with grass. As CRP contracts expire, the land often goes back into crop production.

This study should help scientists learn whether it harms conservation goals to harvest some of the grass for biomass energy. And it helps to find more ways to grow fuel and industrial products sustainably without depleting either our food supply or our soils.—By **Don Comis,** ARS.

This research is part of Agricultural System Competitiveness and Sustainability (#216) and Crop Production (#305), two ARS national programs described on the World Wide Web at www.nps.ars.usda.gov.

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