New Oilseed Crops

The big seeds of the jojoba plant, a native of the Sonoran Desert, yield an oil similar to embargoed sperm whale oil. Unshelled seeds are shown on right.

Although the United States is a major producer of edible vegetable oils and animal fats, a substantial tonnage of specialty vegetable oils and waxes used by industry have to be imported. In addition, the United States depends on foreign supplies for at least half its petroleum needs, and billions of pounds of petrochemicals are consumed each year for industrial purposes other than fuel. They include plastics, lubricants, elastomers, surfactants, and a multitude of adhesives, thickeners, coatings, and other industrial chemicals.

At one time, before cheaper compounds were derived from coal and petroleum, many of these industrial chemicals were made from vegetable oils. Today, with higher petroleum prices and uncertainties over supply, it may be to industry's advantage to rely less on petrochemicals and more on oils from agricultural crops. With America's negative balance of payments, it also seems prudent to develop specialty crops in the United States that can replace imported vegetable oils.

Since 1957, ARS scientists have conducted a program of new crops research, screening some 8,000 wild plant species from around the world. Most of these plants have been studied by the Northern lab as potential suppliers of industrial oils and fatty acids. In analyzing them, NRRC chemists have discovered some 100 new fatty acids or derived compounds called lipids previously unknown from any source. They also found several likely candidates for new U.S. oilseed crops. If one or more of these new crops could be commercialized, it would not only lessen American dependence on imports of petroleum and such foreign-grown raw materials as coconut oil, but it would also provide U.S. farmers with the opportunity to grow alternative crops not in surplus.

Crambe. Erucic acid, an inedible long-chain fatty acid, is used for many industrial purposes. Oils with high levels of erucic acid are remarkably stable at high temperatures. They have high fire and smoke points, enabling them to withstand the high temperatures required of lubricating and heat transfer oils, while remaining fluid at lower temperatures. At present, the United States uses the equivalent of 40 million pounds of high erucic acid oil annually, most of it imported. Much of this is processed into a product called erucamide, used in making polyolefin films for food storage bags and bread wrappers.

Two good sources of erucic acid are industrial rapeseed, currently a major source of imported oil, and a wild Mediterranean plant called crambe. More than one-third of the seed weight of both plants is oil, of which 50-60 percent is erucic acid. While not yet widely grown in this country, crambe hardly deserves to be called new. It was one of the first oilseed crops studied in the Peoria lab, and 20 years ago, NRRC researchers discovered nylon 1313, produced from a derivative of erucic acid. Nevertheless, today crambe and possibly rapeseed appear to be better bets than ever as important new U.S. crops. In 1990, 2,000 acres of crambe and 15,000 acres of high-erucic acid rapeseed were planted in the United States.

(A low-erucic-acid variety of rapeseed, bred by Canadian researchers, is canola, now grown in both Canada and the United States as a source of edible vegetable oil.)

In 1986, a High Erucic Acid (HEA) Oil Project was begun, with several State universities and the NRRC participating. Its broad goals are to expand commercial use of crambe and industrial rapeseed and to encourage U.S. agriculture to produce more raw materials for industry. So far, research has focused on reducing production costs through increased crambe and rapeseed yields per acre, solving problems associated with processing the seed of both crops, and expanding the market for HEA oils and nylon 1313.

Meadowfoam. Another oilseed plant high in certain long-chain molecules but low in erucic acid was discovered in the early years of plant screening. Meadowfoam, a native of northern California and Oregon, is being grown commercially on a small scale in Oregon, where growers have sold several tons of the oil to Japan and other countries for cosmetics. Meadowfoam oil is expensive, but it has several unique properties. Among other things, it contains virtually no polyunsaturates, which makes it stable to oxidation and temperature. So far, however, no niche has been found for the oil by U.S. industry.

Cuphea. Manufacturers of soap and detergents are heavily dependent upon lauric acid, found in coconut oil and palm kernel oil. About one billion of pounds of these oils has to be imported each year by U.S. industry, since there is no domestic source of lauric acid. In the early 1960's, NRRC researchers discovered that a wild oilseed plant called cuphea was an excellent source of lauric acid and other medium-chain fatty acids. Some cuphea seeds contained a much higher percentage of lauric acid than coconut oil.

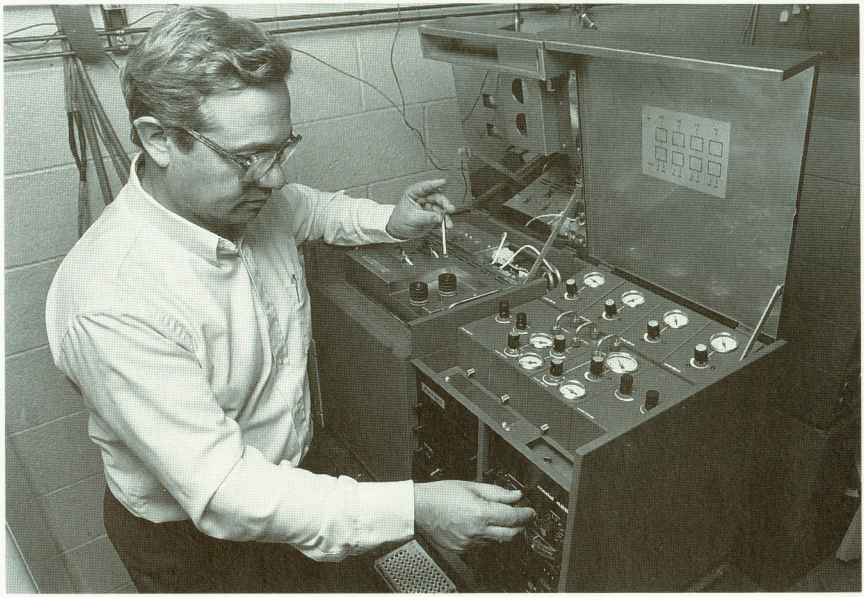
The information lay dormant until the late 1970's, when weather cycles and political instability in several countries exporting coconut oil made many manufacturers uneasy about continued supply. Researchers at the University of Göttingen in West Germany, using NRRC data, began an extensive research program to develop cuphea as a commercial crop. This work was soon expanded to new research in the United States, and today there is close cooperation to learn more about cuphea among industry, university, and government scientists in several countries.

Jojoba. For many years, sperm whale oil was the only commercial source of liquid wax esters for high-performance lubricants, cosmetics, pharmaceuticals, and many other products. Its use was banned by Congress in 1972, however, as part of an international effort to preserve the whale species. Research at the NRRC that began in the 1960's had evaluated oil from a desert plant called jojoba and found it to be a promising replacement for sperm whale oil. Since the ban on whale oil, international interest in jojoba oil has increased rapidly. The unique chemical structure of jojoba was discovered earlier at SRRC.

A native of the Sonoran desert of Mexico, Arizona, and California, jojoba is a bushy plant with seeds about the size of peanuts. Oil from the seeds is nearly 100 percent liquid wax esters; it is similar to sperm whale oil. Commercial plantations as large as 10,000 acres are now producing seed in the United States, Israel, and Latin America, and new plantations are being created in India, Australia, and other countries. Even at present high prices, producers have had no difficulty in marketing their supplies. The high cost of jojoba oil, however, has limited its current use to cosmetics, and industry so far is using synthetic oils to replace sperm whale oil. Recent NRRC research has centered on detoxification of jojoba meal so that it can be fed to cattle.

Lesquerella. The only commercial source of ricinoleic acid, a hydroxy fatty acid, is castor oil, a strategic material. At present, this country has to import about 100 million pounds a year. Screening at the NRRC has turned up several plant species that might be raised as substitutes for the castor plant. One is lesquerella, another desert plant that grows wild in the United States and Mexico. Yields of seed are high and reliable, and prospects for commercial development of the plant look promising to NRRC scientists and others. At present, NRRC is evaluating the oil in comparison with castor oil and developing new products based on its unique composition. This continues a Western lab project begun in the 1960's on lesquerella and

Robert Kleiman, who conducts new crops research at NRRC, uses gas chromatograph to determine fatty acid composition of cuphea seed oil, a product high in lauric acid.



castor, in which WRRC scientists evaluated these oils as components of urethane polymers, among other things.

Vernonia. A native of Africa, *Vernonia galamensis* is a source of epoxy fatty acids, first found to occur naturally in another *Vernonia* species. Production work has been carried out in Africa and Central America by a British investment group, which gave the NRRC enough seed to extract oil for evaluation and product development. The oil proved to be an excellent binder for baked enamel coatings and for other industrial purposes. Current research is aimed at adapting this tropical species to respond to a U.S. day length and climate. *Euphorbia lagascae,* a native of Spain that is another good source of epoxy fatty acids, was also discovered during the NRRC screening. There is currently considerable interest in this plant in Europe.