Vegetable oil as diesel fuel?

While many Americans are aware that alcohol produced from corn can help run the family car, there is less awareness that vegetable oils offer similar potential to fuel the diesel-powered farm machinery that produces America's food abundance.

But in recent years, there has been a flurry of interest in the research of vegetable oils as a diesel fuel. In East Bend, North Carolina, Hugh Whitted III has been using sunflower oil, peanut oil and used frying fat to power his tractor and his diesel engine Mercedes. (See article on p. 817A.) In Columbus, Ohio, Prof. Helmuth Engelman of Ohio State University and graduate student Mary Kay Fishinger have completed research that has led to a campus bus operating on a mixture of 80% diesel fuel and 20% recycled frying oil from campus cafeterias. In Russellville, Kentucky, a farm implement dealer has run three stationary tractors for more than 350 hours on various soybean oil/diesel fuel mixtures.

Outside the United States, researchers in South Africa and Australia have done extensive work on both short- and long-term effects of using vegetable oils as a diesel fuel. (See related article on p. 811A.)

U.S. research of vegetable oil fuels has included tests of many oils, from mustard seed and canola, to sunflower, corn, soybean and peanut. Sunflower, with its high oil yield per acre, is one of the most popular crops with researchers, particularly in North Dakota, where it is a major crop.

The North Dakota State University Agriculture Engineering Department has designed a research project to test the effects of using sunflower oil in diesel engines and to determine the feasibility of on-farm production of sunflower oil fuel. The engines are tested with a dynamometer to approximate varied working conditions and have run a total of about 150 hours on sunflower oil or sunflower/diesel mixtures with 10, 25, 50, 75, 90 and 100% sunflower oil.

Agriculture Engineering Prof. Kenton Kaufman, head of the project, plans to release his test results at a June 1981 meeting of the American Society of Agriculture Engineers. However, he said, preliminary results indicate the oil may be used as a fuel for limited periods.

Don Zimmerman, research chemist with the Oilseeds Research project of the U.S. Department of Agriculture in Fargo, North Dakota, also is involved, although indirectly, with vegetable oil fuel research. Although his work primarily is concerned with improving the germ plasm of sunflower and flax rather than with their fuel uses, Zimmerman has provided technical assistance and advice to the North Dakota State University Agriculture Engineering Department.

According to Zimmerman, using vegetable oil as a fuel presents an economic problem. When sunflower is transported from the farm for extraction and then the oil is transported back, the resulting fuel costs more than $2 a gallon, he said.

"If (extraction is) done locally, either on the farm or perhaps at a local elevator or county co-op, it can be done for considerably less," he explained. "It (local extraction) might not be the most efficient method, but it does reduce the transportation costs."

In addition, with local extraction, major capital expenditures for solvent extraction equipment are

North Dakota State University's mobile demonstration unit, "Sunflower for Power," has toured most of that state demonstrating that a modern tractor can be operated on pure sunflower oil.

unnecessary. The farmer's own labor contribution also keeps costs down, he added.

Although vegetable oil holds promise as a fuel, Zimmerman was quick to point out its limitations as a cure-all for fuel shortages.

"There's no way that liquid vegetable fuels will ever make a sizable dent in the total use of petroleum products in this country without seriously disrupting our ability to produce food," he said.

Iowa State Studies Sun Oil

Another midwest university, Iowa State, also is involved with sunflower oil fuel research. According to Walt Lovely, professor in charge of Research Support Services for the College of Agriculture, not enough preliminary data is available on vegetable oil fuels.

"What we're doing is conducting some preliminary tests so we can evaluate the need for additional research on production and use of vegetable oil (fuels)," Lovely explained.

Sunflower was selected for testing because its oil yield is 40-50% compared to 15-18% for soybeans, a major Iowa crop. The relatively short growing season for sunflower also may make it suitable for a double-cropping scheme, he said.

Tests will analyze a variety of factors related to using sunflower oil as a fuel, he said, including the need for dewaxing and degumming, engine adjustments for the heavier viscosities of sunflower oil and whether the necessary level of quality control will be available to permit on-farm production of the oil.

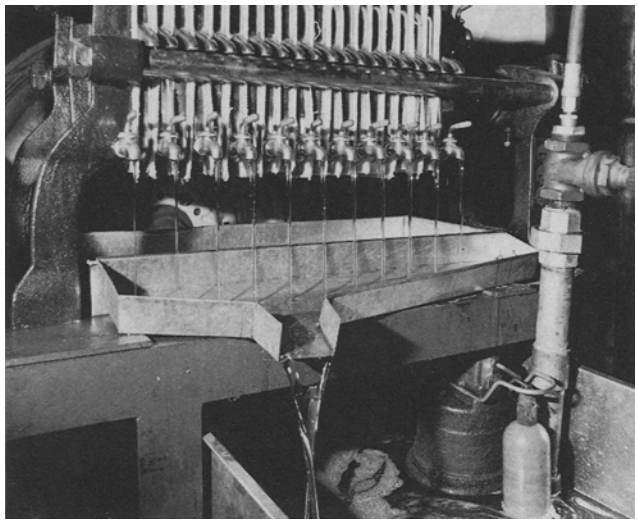
The interest in testing vegetable oil fuels at Iowa State University has stemmed partly from the fact that most farm equipment operates on diesel engines, he explained.

A short refresher course in internal combustion engines illustrates the differences between gasoline and diesel engines, as well as the fuels suited to each. The gasoline or spark-ignition engine requires a more volatile, highly-refined fuel like gasoline or alcohol to begin the combustion process. Combustion occurs when a spark ignites the gasoline or alcohol which is premixed with air.

In comparison, less refined and more viscous fuels like vegetable oil and diesel fuel are suited to the combustion process which occurs in the diesel or compression-ignition engine. Heat is created in the compression-ignition engine when air is compressed in the cylinder. When the diesel fuel or vegetable oil is injected into the intensely heated air, combustion occurs spontaneously.

"We think vegetable oil has more potential as an alternative fuel for diesel engines," Lovely added.

The USDA-SEA-AR Subtropical Texas Area unit in Weslaco, Texas, conducted short-run tests



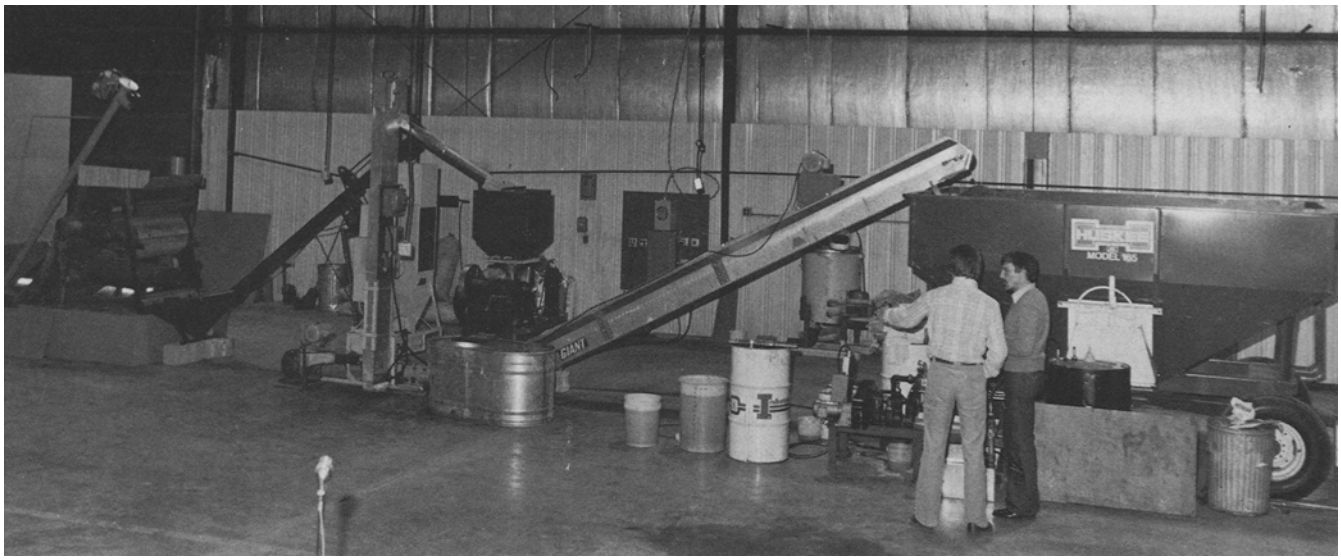
Crude sunflower oil from a small expeller runs into collecting tank.

Vance Haugen, a research technician at North Dakota State University, adjusts screw press as oil is extracted from sunflower seed. (North Dakota State University photographs courtesy of Harold Caldwell, NDSU extension service).

of sunflower oil fuel in the fall of 1979. Tests began after researchers there heard of an investigation of sunflower oil as a fuel from a visiting South African, explained Paul Nixon, agricultural engineer.

"We could hardly believe the story," explained Nixon. "That sparked our interest in it."

A John Deere 4020 tractor, loaded by a dynamometer, was used. Straight diesel fuel and edible-grade sunflower oil, as well as diesel/sun oil mixtures containing 10, 25, 50 and 75% vegetable oil, each ran for about 10 minutes. Results showed that horsepower output decreased slightly as the percentage of sun oil increased and that smoking was visible under heavier loads. Despite these variations, Nixon said, the tests showed that diesel engines could perform well on sunflower oil on a short-term basis, making it potentially suitable as an emergency farm fuel.



Small-scale extraction equipment is part of North Dakota State University Agricultural Engineering Department display. At left, cleaned sunflower seed is moved to screw press at center that removes the oil (running into the tank near center of photograph), then routes presscake onto conveyor belt to storage wagon.

Although Nixon stressed the need for long-term tests of vegetable fuels, he added the major purpose of the tests was just to give the idea a try.

"We really aren't funded or set up to go into it in a big way," he explained. "It's hardly practical from a dollars-and-cents standpoint right now."

But, to a farmer, costs are almost immaterial at certain points in the growing season, he said. At such times, the more expensive, yet available sunflower oil could be used.

A slightly different approach to using plant oils as fuels has been taken by the USDA Northern Regional Research Center in Peoria, Illinois. Its response to the energy crisis has been to study the feasibility of extracting oil and other products from entire plants.

According to Marvin O. Bagby, research leader of the Hydrocarbon Plants and Biomass Research Unit of the Biomaterials Conversion Lab at the Research Center, the concept behind the six-year-old program is a multipurpose one. In addition to identifying plants that might serve as potential fuel oil sources, the center has searched for plant sources of fiber, protein for feedstock and hydrocarbon for natural rubber replacement. Another major criterion in the search has been the plant's adaptability to U.S. mechanized crop production, Bagby explained.

So far, about 320 native U.S. plant species have been screened and characterized. Of these, from 40 to 45 plants, including smooth sumac, common milkweed, common elder, giant ragweed and pokeweed have met the multipurpose standards and will be studied further. By searching for species with multiple uses, conflicts that might result if farm land is used for non-food purposes may be lessened, he asserted.

Implement Dealer's Research

In Russellville, Kentucky, local farmers and an implement dealer have conducted their own tests of a soybean oil/diesel mixture as a fuel. Their long-term goal is to raise soybean prices.

The experiments began with Carl Harper and Richard Dickinson, two area farmers, and John Shipp, a John Deere implement dealer.

"A couple of my customers had the idea," Shipp said. "They had read just a line or two in some publication that vegetable oil could be used as a kind of substitute diesel fuel."

The three men agreed the idea was worth trying and began testing a John Deere 2440, 60 hp tractor in late February 1980 on a 50% soybean/50% diesel fuel mixture. By June 1980 the engine had been run for about 250 hours, with a dynamometer varying the load during about 70 test hours. A second 2440 tractor and a larger John Deere 4630, 150 hp tractor also have been operated for a total of about 100 test hours, Shipp said.

The initial soybean oil used in the soy/diesel mixture was a grade so crude it contained visible particles, he said. After burning about 50 gallons of this oil, with no apparent ill effects, those involved with the test learned of refined grades of soy oil. About 100 to 150 gallons of once-refined, degummed oil next fueled the tractors until the final switch to a table-grade oil was made.

The only problem which resulted from using the unconventional fuel mixture was a thickening—almost to solidity—of the crankcase oil which appeared after about 70 to 90 hours of testing, he said. However, Shipp hopes this problem probably could be eliminated with additives to the crankcase oil or more frequent oil changes.

A lower percentage of soy oil in the mixture also might have prevented the thickening, he explained.

"I think the problems we've encountered are real, real small compared to the problems the fellow had who first built the diesel engine. He had a whole bunch of problems to overcome," Shipp said.

After a pause he added, "A lot of the skeptics have trouble seeing past the ends of their noses. I think it'll work."

The Russellville project was funded through individual contributions made to a trust fund. A dinner meeting that attracted 100 to 125 farmers netted more money.

Gradually, as the possibility of using soybean oil fuel to raise soybean prices was discussed, interest in the testing expanded and the project became a community effort, Shipp said.

At first glance, raising soybean prices by using soy oil to power farm equipment seems to be an impossible dream. But according to Shipp, it would work something like this: using a 50/50 blend of diesel fuel and soy oil, farmers would pay about $1.50 a gallon for the fuel if diesel (without federal and state taxes) remains at about the $1/gallon farmers pay and soybean oil remains at about $2/gallon. Although that computes to a 50% increase in fuel costs for the farmer, Shipp contended that long-run benefits would outweigh initial costs.

Because fuel costs are a relatively small part of soybean production, the $1.50/gallon price would raise the cost of producing soybeans by only about 7 to 10 cents more per bushel. If farmers were to need enough of the soy oil as a fuel, soybean prices would increase as demand increased.

In addition to raising soybean prices, Shipp is interested in finding a substitute fuel for diesel farm equipment, a need which he says has been seemingly overlooked by alcohol enthusiasts.

"Ninety percent of farm work today is done with diesel engines," he said. "In order to make a reasonably good conversion to alcohol fuel, diesel engines must be practically converted to gasoline engines."

Ohio State University

Most U.S. research of vegetable oil fuels, whether headed by individuals, government, universities or industry, is still in the testing phase. But, at least one series of tests conducted by the Mechanical Engineering Department at Ohio State University already has had practical applications. As a result of research by Prof. Helmuth Engelman and graduate student Mary Kay Fishinger, a campus shuttle bus was operated on a mixture of recycled vegetable oil from university cafeterias at 35¢ a gallon and No. 1 diesel fuel from October 1979 to June 1980. The project was shut down for the summer because of a lack of student help.

When the Mechanical Engineering Department started the research, most of it was based on older studies.

"The general tenor of all the reports was pretty much in unison," Engelman explained. "It (vegetable oil) smokes too much and it cruds up the engine."

But instead of dismissing the idea, the department began a testing program with the primary aim of eliminating the gumming and smoking problems. Soybean, peanut, cottonseed, olive and corn oils also were tested in various percentage mixtures with diesel oil. Engelman and Fishinger finally settled on a mixture of 20% recycled frying oil, strained twice and boiled once to remove water, and 80% No. 1 diesel fuel.

With this mixture, the only problem the researchers faced was some gumming and a resulting plugged filter which had occurred both as a result of use and after a few days of extremely cold temperatures. To overcome this problem, a dewaxer, normally sold to commercial truckers who use No. 2 diesel fuel, was added to the vegetable oil/diesel mixture.

Although only one bus burned the mixture of vegetable oil and diesel, a proposal to burn the fuel in the entire 12-bus fleet is under consideration. Because the new fuel would require an investment in a fueling facility and preparation equipment, it may be some time before the proposal is approved, Engelman said.

Even if the proposal is not accepted, the research has generated a great deal of interest in the possibilities of using recycled cooking oils to fuel vehicles, Engelman said.

At the University of Nebraska-Lincoln, interest in testing the effects of soybean oil fuel on diesel engines and developing a simple device for on-farm extraction of soybean oil has picked up since the summer of 1979. That summer, a simple test by the Agriculture Engineering Department demonstrated that a single-cylinder diesel engine was able to burn corn, soybean and peanut oils, according to Dr. William Splinter, chairman of the department. But there was interest at the university in vegetable oil fuels even before this demonstration, as exhibited by a thesis written in 1950 by Kenshou Fang, dealing with soybean, tung and castor bean oils as fuels. With a recent grant of $17,000 from the Nebraska Soybean Growers' Association, that research will be resurrected and expanded, Splinter explained. Test results of a dynamometer-equipped engine should be available within a year, he predicted.

Equipment Manufacturers' Interest Varies

Rather than concentrating on a single vegetable oil, other experimenters around the country are test-

ing a whole slough of oils as diesel fuel.

Currently, Deere & Co. has tests under way on soybean, cottonseed, sunflower and peanut oils. Planning for these tests began several years ago, according to Bill Burrows, principal scientist and leader of the Product Energy Group at the company's technical center in Moline, Illinois.

"For diesel engines, vegetable oil certainly appears to have a distinct advantage over alcohol fuels," Burrows said. "But until recently, we could not find any real interest among our customers for using vegetable oils as fuels. Now, the economics have changed and farmers are looking for energy self-sufficiency. We need to know the long-term as well as the short-term effects on our engines of using vegetable oil as fuel."

Although the long-term effects of vegetable oil fuel are not known, Burrows said, the company hopes to solve problems it discovers through fuel modifications, such as further refinement or additives, rather than engine changes.

International Harvester has received inquiries from people around the world about using vegetable oils as diesel extenders in IH machinery. In response to these requests, the company has "looked at" the use of vegetable oil fuels, according to F.K. Waechter, staff engineer for fuel and lubricants at the Agricultural Research Center in Hinsdale, Illinois.

"We haven't really done any extensive work on it," he explained.

Because the idea of burning vegetable oil in a diesel engine is relatively new, the company's main efforts will remain in other directions, he explained. Before large sums of capital are devoted to the new fuel, important questions must be answered, he added.

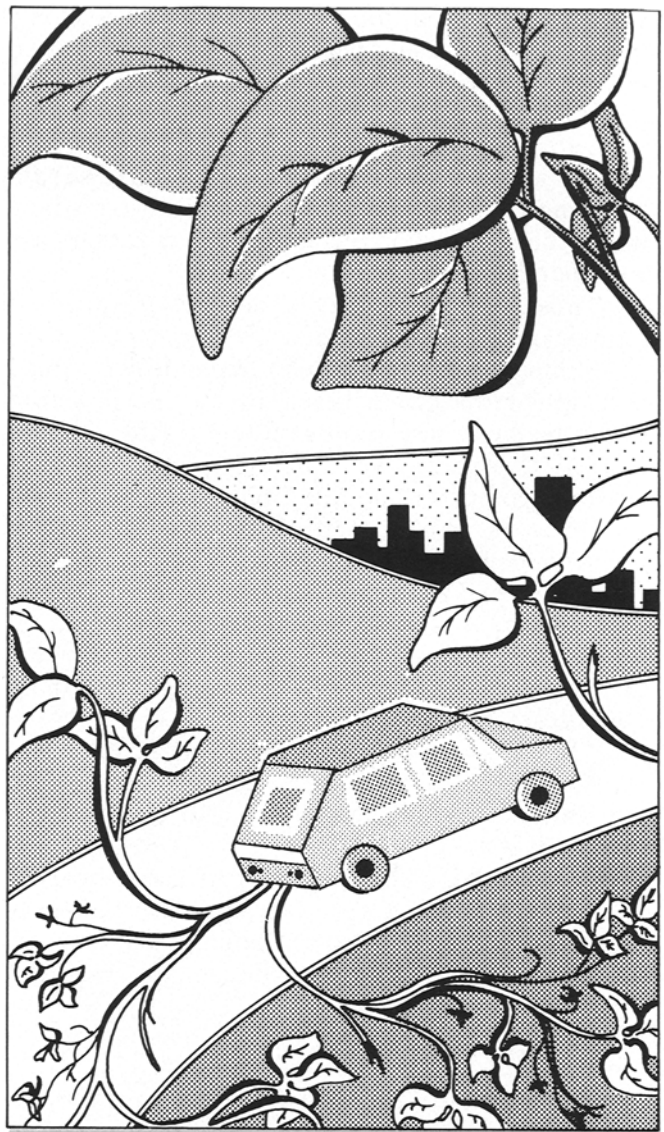
"Is the fuel defined well enough and is it in a large enough supply that it is economical for the manufacturer to produce engines to run on it?" he questioned.

Caterpillar, another major diesel manufacturer with its headquarters in Peoria, Illinois, has an alternative fuel program in which a number of fuels are being evaluated, said Steve Newhouse, public information representative. However, because of company policy, details about the research are not available to the public, he said.

Although several diesel manufacturers are involved with testing vegetable oil as a fuel, most are proceeding cautiously until further testing is completed. Lyle Stephens, research engineer at the Deere & Co. Technical Center, probably best summed up the reasons behind the industry's caution.

"You feel very reluctant to commit your customers to a fuel that may not be available," Stephens explained.

Other researchers cautioned against long-term use of vegetable oil fuels because of a lack of



C. Ronto

From Milwaukee to Denver on soybean oil

Truck fleet operator Harry Somme of Denver, Colorado, drove his diesel VW Rabbit from Milwaukee to Denver—1,344 miles—on 100% soybean oil during the summer of 1979.

Somme said he can't abide the thought of losing his personal mobility and therefore wanted to test whether vegetable oil could be used in his Rabbit's diesel engine. He used 104 quarts of generic soybean oil purchased from a Denver supermarket for $1.57 a quart—or $6.28 a gallon. The soybean oil went into an auxiliary fuel tank Somme added to the Rabbit.

In traveling from Denver to Milwaukee on regular diesel, Somme said he averaged roughly 50 miles per gallon, about the same as he averaged on the return trip when the Rabbit was fueled with soybean oil. The only discernible differences: (1) a bluish exhaust from burning soybean oil, and (2) a definite vegetable oil odor. Examination of the fuel injectors showed no abnormalities, Somme said.

His next goal is an interstate trip in a diesel truck on soy oil—if he can find someone to provide the oil.

research into the long-term effects. The long-term effects of using vegetable oil in the modern tractor are not known, Zimmmerman, USDA research chemist in Fargo, North Dakota, explained.

"If they (farmers) are doing it, they should be using the most highly refined, purest grade. I would definitely not recommend that anyone use a crude oil."

Those using a vegetable oil fuel are doing it at their own risk, he added.

Shipp, the Kentucky John Deere dealer, agreed that long-term effects need to be tested before widespread use of vegetable oil fuel is safe.

"At this point, we're not recommending that anybody go out and do this," Shipp said.

However, should petroleum shortages occur, Shipp said he would suggest soybean oil as an emergency fuel to his farmer customers.

Splinter, University of Nebraska Agricultural Engineering Department chairman, had a warning for the adventuresome who are currently burning 100% vegetable oil in diesel engines.

"That's a good way to burn an engine out."

Kaufman, after his tests of sunflower oil at the University of North Dakota, also urged further long-term tests.

"We're talking about a fuel that could be used in an emergency and not as an alternative," Kaufman explained. "If you're looking at it as an alternative, you need to re-design the engine."

Safflower, Canola, Mustard Tested

Another university engaged in research of oilseed crops as a fuel is Montana State University at Boseman. According to Dr. William Larsen, head of the Agriculture Engineering Department and project leader, the main concentration is on three crops particularly suited to Montana's cool and dry growing conditions: canola, safflower and mustard seed. The project includes engine tests, chemical analyses and economic studies of these oils.

Engine tests were begun this past summer and will continue throughout the fall until the end of the year when preliminary results should be available, Larsen said. So far, a crude grade of canola oil has been mixed with various percentages of diesel fuel and burned in a nonturbocharged 302-cubic-inch engine under dynamometer-induced load. Early results indicate slightly poorer torque characteristics and poorer fuel economy. The higher viscosity of canola also began to affect engine performance when less than about 25% diesel fuel was mixed with canola oil. Later, results of field tests of a crude grade of mustard oil also will be available, he said.

Another feature of the test program will be a chemical analysis of the test oils, he said. By studying the fatty acid content of the oils and their effects on engines, scientists may find that altering the fatty acid content could improve fuel efficiency.

Waechter:

"Is the fuel defined well enough and is it in a large enough supply that it is economical for the manufacturer to produce engines to run on it?"

Also of concern to the researchers is the importance of finding vegetable oils whose use as a fuel would not upset food economics, he explained.

The list of experiments and the number of experimenters goes on. At the University of Idaho, Dr. Chuck Peterson, agriculture engineer, and Dr. Dick Auld, plant scientist, are conducting extensive tests of engines running on safflower, sunflower and winter rapeseed oils. As the research continues over the next one to two years, the possibility of on-farm production of the fuel also will be studied. In Canada, at the University of Saskatchewan, in Saskatoon, Dick Strayer of the Agricultural Engineering Department is studying both the economics of using rapeseed oil as a fuel and the effect of its use in diesel engines.

However, all the research may be overshadowed eventually by the question of whether edible oils should be used for fuel. Although a protein meal residue results from vegetable oil extraction, the dilemma remains over using even part of an important food source as a fuel. Shipp predicted increasing debate over food for fuel as surplus supplies of vegetable oils are removed from the market and used as a fuel. But the debate would be untimely, he said, because the current U.S. agriculture policy to make cheap food available and to stockpile surpluses is increasing the difficulties farmers face in succeeding in their businesses.

"If we let surpluses continue to drive the markets down, we're not going to have any farmers to feed the hungry world," he added. The debate over food for fuel currently is "blown all out of proportion," he said.

Zimmerman also predicted gradually increasing debate over food for fuel, with a conflict coming to a head in about 10 years between U.S. export of food and domestic use of agricultural products as fuels. He said he found it difficult to support using food crops for fuel except in emergencies.

"I think it is viable for on-farm use," he said. But he added, "From a philosophical standpoint, I don't think that vegetable oils should be used to fuel personal vehicles. We just burn too much fuel in this country and the only way you can justify this (vegetable oil fuel) is for a farmer to use it to continue to produce food crops."

How much would America's farmers need?

The question of whether an edible foodstuff, vegetable oil, should be used to provide fuel for diesel-powered farm equipment poses no dilemma for F.J. Dougherty, associate director of the Center for Entrepreneurial Development at Carnegie-Mellon University in Pittsburgh.

At the Seminar on Vegetable Oil for Diesel Fuel held during September, Dr. Dougherty told the participants that during the 1930s, in India, farmers used bullocks to pull their plows and out of each four acres of harvest, one acre went to feed the bullock. That's using 25% food production for fuel.

Could U.S. farmers produce enough vegetable fuel oil to be completely self-sufficient in fuel?

Dr. Everett Pryde of the Northern Regional Research Center told the seminar participants that the latest reliable figure he could obtain was that on-farm use of diesel fuel totaled 3.3 billion gallons in 1978, or about 25 billion pounds of diesel fuel. If vegetable fuel oils are slightly less efficient than diesel, Pryde estimated it would take 28 billion pounds of vegetable oil to fuel America's farm equipment.

- If soybeans produced 285 pounds of oil per acre, it would require 91 million acres; the 1980 harvested acreage will be approximately 68 million acres.
- If sunflower yields 525 pounds per acre, it would require 53 million acres; the 1980 harvested acreage will be approximately four million acres. With the increased-yield sunflower varieties that are being developed, Dr. Pryde estimated oil yield could be 800 pounds an acre, requiring 35 million acres of crop.
- If peanuts yield 705 pounds of oil per acre, then 40 million acres would be required; 1980 harvested acreage will be about 1.5 million acres. That's based on peanuts yielding about 40% oil when extracted. Dr. Lawton Samples, of the University of Georgia Extension Engineering staff, said one variety can yield 60% oil.

The above figures assume all the oil produced is used for fuel.

Edward S. Lipinsky of Battelle in Columbus, Ohio, noted that farmers are not the only potential users of vegetable oil fuels. The electrical power industry's research organization is expected to begin a research program during 1982. And, if a suitable fuel is developed, then there also is a large potential market as a home heating fuel, Lipinsky said. □

South Africa researching sunflower fuel

Rising fuel costs affecting all parts of the globe have encouraged studies of a variety of vegetable oil fuels in many countries.

Continued on page 815A.

Continued from page 811A.

During a visit to the United States this fall, Dr. J.J. Bruwer, director of agricultural technical services, spoke at the seminar in Peoria on work done by the division of agricultural engineering in South Africa.

The work thus far is strictly experimental, but extensive field trials have been conducted on use of sunflower oil in a variety of diesel engines from different manufacturers. In a series of nine trials, Bruwer said, that compared sun oil with standard diesel fuel, the best result showed 1.4% more power and 9.9% better efficiency, whereas the worst showed 6.4% less power and 3.9% less efficiency.

The main problem has been that incomplete combustion during less than peak load operation results in lubricating oil becoming contaminated with the sunflower oil, Bruwer said.

Incomplete combustion apparently is a result of injector nozzles coking up during part-load conditions. To avoid the problem, the South Africans have changed lubricating oil more often. Oil changes initially were made after each 200 hours of operation.

No problems were reported in gumming or deposit on other engine parts and quite frequently parts looked cleaner than would be expected if they had been functioning on diesel fuel, Bruwer said.

Initial tests were conducted with cooking quality oils, Bruwer reported, but fuel filters would clog up after only 30 hours use. Eventually, field tests were conducted on a degummed sunflower oil that had been through a four-micron filter unit. Fuel filter problems have been at a minimum with this oil, he said.

Even better results have been obtained using an ethyl or methyl ester of sunflower oil. One problem has been deposits on the injector nozzles which, Bruwer says, their researchers suspect is related to the catalyst used in transesterification of the sunflower oil.

Bruwer noted that results in South Africa may not reflect what would happen elsewhere. The coldest temperature there, he noted, is 4 C (40 F) and the altitude is about 1,400 meters above sea level.

Future work in South Africa will look at engine life, possible modifications to diesel engines, lubricating oils, and on-farm production of oil including farm-scale extractors/expressers for sunflower oil, on-farm scale refining and storage. Sunflower oil stored on-farm protected from light and oxygen has performed well after eight months' storage, Bruwer said.

The basic conclusions to date:

- Power and fuel consumption are satisfactory with undilated sunflower oil and blends with diesel fuel; deposits have not been a problem with a 20:80 blend of sunflower oil and diesel fuel.
- Coking of injectors is a serious problem as it leads to lubricating oil problems.
- Atomization of sunflower oil is inferior to that of diesel fuel and therefore it is desirable to develop blends with physical properties comparable to diesel fuel specifications.

In Australia, rapeseed, safflower, linseed, peanut, soybean and other vegetable oils are being studied, Dr. Graeme Quick said in an interview published in the April 1980 issue of *Sunflower*. Quick is the principal research

scientist for the agricultural engineering unit of CSIRO (Commonwealth Scientific and Industrial Research Organization).

In New Zealand, work has begun on using rapeseed oil as a replacement for diesel fuel. One New Zealand firm this fall offered to process oil for farmers who wished to conduct performance tests. Thus far, the New Zealanders have used only alkali-refined oils, reporting good results on starting and power output. No gumming up has been reported when using refined oils. The New Zealanders may be using a canola-type rapeseed that has been cultivated there for several years. □

What's needed next

One of the purposes of the Sept. 26 seminar at the Northern Regional Research Center was to identify what questions remain unanswered regarding use of vegetable oil as a diesel engine fuel.

There were a lot of them.

First, it was clear that diesel engine specialists need to learn more about vegetable oils, and vegetable oil researchers need to learn more about diesel engines. One seminar participant noted that most reports to date provide quite detailed descriptions of the engines, but would describe the oil burned as "soybean oil" or "sunflower oil," without noting whether it was crude, degummed, refined or deodorized oil.

Second, unresolved is the question of whether research should be aimed at providing small-scale oil extraction or expeller equipment suitable for use by clusters of farmers or whether research should be aimed toward large-scale production.

Third, who's going to provide the funds for research?

Fourth, what analytical methods and what tests are necessary to characterize and analyze vegetable oil fuels? Should oils be modified to meet engine requirements, or engines modified to meet fuel requirements, or both? It was suggested the ASTM and AOCS should form a joint committee to consider such questions.

Fifth, should consideration be given to regionalized research efforts concentrating on the oilseed crop most suitable to the region, i.e., peanut and sunflower in the South, soybean in the Midwest, sunflower in the northern tier?

A report on the meeting has been prepared by S.S. DeForest of the Technology Transfer Program staff at the Northern Agricultural Energy Center, with offices in the NRRC, 1815 N. University St., Peoria, IL 61604. □

Seminar tidbits

One unanticipated side effect of using vegetable oils for diesel fuel was reported at the Sept. 26 seminar at the Northern Regional Research Center by F.J. Dougherty of the Carniegie-Mellon University. "People keep asking, 'Where's the popcorn machine?'" Dougherty said.

North Dakota State University's George Pratt reported one farmer ran his tractor on 100% sunflower oil during planting; then later during the summer had to tear down the engine twice to get it running properly. Pratt noted that some farmers who had 20% mold damaged sunflower from storage said they were ready to process it to use the oil for fuel. Pratt also reported that Simon Rosedowns and Anderson International have shown interest in extraction equipment suitable for use by a local grain elevator or local farmer co-op.

North Central land grant universities have prepared an extensive program to research the use of vegetable oils for diesel fuel, if they can get the funds. B.A. Jones of the Ag Experiment Station at the University of Illinois said a proposal was developed in response to a congressional budget item, but the funds were later deleted.

Equipment manufacturers were guarded in their comments at the seminar, expressing support for the concept. One manufacturer's rep noted good performance with his firm's main engines, which use a precombustion chamber.

What else?

The preceding articles review some formal and informal research projects on the use of vegetable oil as fuel for diesel engines. *JAOCS* welcomes brief letters from readers who know of other such projects and, of course, researchers preparing formal papers on their work are encouraged to submit them for publication in *JAOCS*.

Bibliography

The following is a list of published articles related to experiments with using vegetable oils as diesel fuel. Although most of the articles have been published only recently, sevseveral date back to the 1940s. The list includes both technical and non-technical references.

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Carolina farmer runs Mercedes and tractor on vegetable oil

Hugh E. Whitted III is an enterprising farmer in East Bend, North Carolina, who is conducting his own brand of research on vegetable oil fuels. Since January 1980, his International Harvester 544D tractor and Mercedes-Benz 220D automobile have been fueled by sunflower seed oil, peanut oil, used soybean oil (from a fried chicken franchise), and mixtures of vegetable oils and diesel fuel.

His experimentation has included standard engine tests plus a dose of what Whitted calls "common sense." He has checked injector pumps for gumming, examined combustion chamber components for corrosion, looked at fuel filters, and paid for an emissions test. Except for one time when peanut oil clogged a filter, the unorthodox fuel has not caused any engine problems. His conclusion: vegetable oil makes a good diesel engine fuel.

Blooming sunflowers on Hugh E. Whitted's farm were cultivated with a tractor powered on sunflower oil.

Whitted is familiar with diesel engines. He is a licensed aircraft mechanic, has worked as a metallurgist and product development engineer, and has studied math, physics and chemistry at Wake Forest University.

Whitted said he partially judges how well a diesel engine is running on factors such as vibration, noise and exhaust. With that kind of "common sense," Whitted says he knew vegetable oils were effective fuels before the formal checks of injector pumps.

Whitted burned his first vegetable oil, part of a bottle of corn oil purchased at a grocery store, in his Mercedes-Benz in about 1972 or 1973. His curiosity about whether vegetable oil was usable as a fuel had been piqued by a friend's remark about Chinese experiments with soybean oil as a fuel. He called his early attempts "mundane experiments" just to see if the oil burned. But now even his neighbors know when he is burning vegetable oil as a fuel. "Everybody sniffs and says, 'What's cooking?'" he said.

Since that first bottle of corn oil, he has burned soybean oil purchased from a grocery, a 50% refined sunflower oil/50% No. 2 diesel mixture, a 25% diesel/75% refined sunflower oil mix, refined sunflower oil, crude peanut oil, crude sunflower oil and finally, a mixture of 20% No. 2 diesel and 80% waste soybean frying oil. Whitted estimates he ran his tractor on these and other vegetable oil/diesel combinations for a total of about 100 hours during the 1980 planting season, while his automobile has operated for an undetermined number of hours on the unconventional fuel.

Whitted, along with two neighbors, Bill and Archie Doub, primarily are interested in the on-farm growth and processing of oilseed crops as fuel. In their case, the fuel oil would be sunflower, Whitted said, because of its high oil yield per acre and ease of oil extraction.

Whitted and the Doub brothers began growing sunflower for fuel this year. Whitted had devoted five acres of his 53-acre farm to sunflower and the Doub brothers have done the same on their farm. Although the South provides a good habitat for sunflower because of the length of the growing season, average temperature, and rainfall received, their acreage is some of the first planted in the East Bend region, he said.

Whitted's efforts have been somewhat hasty, he said, because he wanted to assess the feasibility of the idea as quickly as possible. With feasibility proved to his satisfaction, he has applied for a $48,000 U.S. Department of Energy grant to finance a more extensive project. If he receives the grant, he plans to continue growing sunflower and possibly lease a small screw press. Extraction efficiency would be monitored and leftover meal would be used as a livestock feed, Whitted said. Whitted hopes eventually to construct a small extraction and filtering apparatus, possibly with degumming capabilities.

To test the actual use of the sunflower fuel, Whitted said he would replace the engine components of his automobile and tractor with new parts to evaluate the

effects of the fuel. A Duke University mechanical engineering professor also has promised help, Whitted said.

If Whitted does not receive the grant, he has alternate plans. He said he will resort to a more extensive "show and tell" effort to try to obtain other funds.

"I'll do it although I don't like it. It seems like part of the game you must play to get public funding," he said.

Should these efforts fail, the project will no longer be the full-time one it has been since March, when he quit his job to devote his time to it.

"If I don't get the grant, I'll have to go back out in the job market. It just depends on how long the money holds out."

However, Whitted said he likely will work through the end of the year to find sources of funding.

Whitted has been invited by the University of Miami to report on his experiments at the Third Miami International Conference on Alternate Energy Sources to be held during December.

His paper, tentatively titled "The Use of Vegetable Oils in Diesel Engines—Operating Experience," will describe his observations made while operating the tractor and automobile on vegetable oil, as well as technical data detailing results of both city and highway mileage tests, acceleration tests, fuel flow rate measurements and exhaust gas temperature measurements. In addition, the possible toxic effects of the vegetable oil exhaust will be discussed.

In addition to his work on the grant proposal, Whitted has applied for a patent on a device associated with vegetable oil fuel use. The device "circumvents certain difficulties" which can arise from fueling an engine with vegetable oil, he said. He declined to discuss the device because the patent application is still being processed.

Meanwhile, he has visited the Washington, DC, office of North Carolina Rep. Stephen Neal, giving the congressman's aids first-hand experience in vegetable oil-powered engines during a ride around the city in Whitted's Mercedes-Benz.

He has also written to President Carter about the project and has corresponded with the Department of Energy about a federal vegetable oil fuels study budgeted for fiscal year 1981. According to Ralph D. Fleming, alternative fuels specialist with the U.S. Department of Energy Office of Transportation Programs, the project probably will include a "paper analysis" of various oils, based on supplies, economics and other factors. As part of this analysis, researchers are invited to submit their studies of vegetable oil fuels. Whitted said he plans to submit his own characterization of vegetable oils as diesel fuel. In addition, Fleming said, the most promising oils will be used in actual engine tests.

Fuel from special containers is fed to engine of Hugh Whitted's diesel automobile during a fuel mileage test. Average result on three tests on each type of fuel showed 37.62 miles per gallon on No. 2 diesel fuel and 35.86 miles a gallon on crude peanut oil. (Photographs courtesy of Hugh Whitted).

Whitted also drove around Raleigh, North Carolina, in his vegetable oil-powered Mercedes with North Carolina Governor James Hunt. In response, the governor said he would consider state funding for the project if federal funds are unavailable, Whitted said.

Whitted said his interest in vegetable oil as an alternative fuel can best be summarized as a desire to help secure energy independence for farmers. But, despite the large percentage of diesel equipment used on most farms, alcohol fuel has attracted the most public attention, he said.

"I'm not trying to lay alcohol to rest, but maybe at present the vegetable oil route needs a bit more attention than the alcohol route," he said. "Neither one of them may prove to be valid in the long run. However, I do know that vegetable oil is a fuel. I've used it, and I think I can produce it."

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Staley picks Tennessee for fuel plant

A.E. Staley Mfg. Co. of Decatur, Illinois, has chosen London, Tennessee, as the location for a $200 million plant to manufacture corn syrup and fuel-grade alcohol. Capacity is expected to be 600 million pounds of corn syrup and 40 million gallons of fuel alcohol a year. The alcohol is to be sold to firms in the Southeast for production of gasohol.

PSI Process Systems Inc. of Memphis, Tennessee, will handle engineering and design responsibilities for the corn processing and syrup units for the new plant.

AACC expands check sample program

The American Association of Cereal Chemists has expanded its check sample program to include microbiological checks, vitamin analyses and protein analyses. In addition, three samples formerly combined have been split into quarterly flour samples, cocoa/chocolate-liquor samples, and spice samples for sanitation analysis.

The program is designed to permit cereal and food science laboratories to check the accuracy of their analytical techniques. It is similar to the AOCS Smalley Program for fats and oils.

More information is available from the AACC National Check Sample Service, 3340 Pilot Knob Rd., St. Paul, MN 55121.

Miwa Jojoba Laboratories formed

Miwa Jojoba Laboratories, directed by AOCS member Thomas Miwa, has been opened at 505 S. Rockford Dr., Tempe, Arizona, as the first laboratory working exclusively with jojoba oil.

The lab is a subsidiary of Jojoba Plantation Products, Inc., of Los Angeles, California. The lab will work on product development, consultation, and will provide analysis and certification of all jojoba oil produced and sold by the parent firm. The product firm is associated with Jojoba Plantation Partners which have planted more than 1,000 acres of jojoba near Hyder, Arizona.

Dr. Miwa worked extensively with jojoba oil at the USDA's Northern Regional Research Center in Peoria, Illinois, before retiring from there a few years ago and moving to Tempe. He has been active in several organizations on jojoba research and development. □