Fuel From Farm Products

James E. Williams, Acting Program Director, Agriculture

Summary

Imported crude oil provides the raw material for just under half of the liquid fuel consumed in the United States. This dependency on foreign improted oil and shortages of farm fuels in 1979 sparked an interest in producing fuel from alternative sources such as farm products.

Alcohol is a liquid fuel that can be produced on the farm from farm products and holds promise as a substitute for some petroleum based fuels when used straight or as a blend. Considerable interest in alcohol production has been communicated by Arizona farmers and agri-businessmen to Cooperative Extension Service agents, specialists and administrators.

The Cooperative Extension program is a unique educational delivery system which has both financial and program support from federal, state, and local governments. The basic mission of the Cooperative Extension Service is to extend useful and practical information to the people of Arizona. For this reason, the Extension Service is a part of the land grant university system so that research information generated by the Experiment Station can become a part of the information diffused to the people. In Arizona the land grant university is the University of Arizona.

It is not the intent of the Cooperative Extension Service to advise clientele on what decision to make, but rather to provide information on which decisions can be made.

Motor vehicle fuel consumption in Arizona during 1978 amounted to almost one and one half billion gallons according to the Department of Transportation. If ethanol was substituted for ten percent of the total consumption it would amount to nearly one hundred and fifty million gallons. If two hundred gallons of alcohol can be produced per acre of agricultural products, it would require about seven hundred and fifty thousand acres to produce the one hundred and fifty million gallons. This is over half of our total crop acreage. Double cropping could however increase the crop acres each year and some biomass might be available from dry land acreage.

We will try to examine the feasibility of alcohol production from farm products in Arizona by farmers and agri-businessmen. We will try to discuss both the positive and negative aspects of alcohol production. The information presented is not intended to influence decisions as to whether or not anyone goes into ethanol production, but is intended only to inform you.

Farm-Produced Alcohol: Where Do We Go From Here?

Jim Porterfield, Assistant Director
Natural & Environmental Resources Division
American Farm Bureau Federation

Summary

Farmers should protect their investment when buying a still by: 1) Requiring a warranty from the manufacturer; 2) Having an attorney check the warranty; 3) Placing the down payment in an escrow account and withholding a large portion of the payment until the still is installed and operating properly.

A basic unit consisting of a distillation column, cook/fermentation tank, and boiler, if bought commercially, will cost a minimum of $20,000. Extra cooking and fermentation tanks, extra storage tanks, a new building to house the still, and automation could well run the cost of a commercial still to over $250,000 for a unit that produces less than 250,000 gallons of alcohol/yr.

Seventy five percent of tractor horsepower in the United States is diesel. Farmers should be asking the question, "What can readily replace diesel?"

Farmers will have to decide whether or not they want to use their grain crops and wood energy sources to provide liquid fuel for their own operations, or whether they want to try to provide fuel for their urban neighbors. If fuel is provided to our urban neighbors, farmers run a risk. They are not assured necessary fuel for their own use from their own products if crude oil supplies were shut off by another Middle East crisis.

A lot of you are familiar with this cartoon--a motorist drives up to the gas pump, leans out the window and says, "Regular, Lead-Free, Gasohol, Alcohol, Kudzu, Anything?"

Things tend to run in cycles, and such it is with the energy business. In 1875, 75 percent of our energy came from wood in this country. Fifty years later in 1925, approximately 75 percent of our energy was provided by coal. In 1975, 75 percent of our energy was provided by oil. The question now is, "What mix of energy sources will we have by the year 2025--another 50 years hence?"

There were apparently a lot of optimists in 1970. The U.S. Department of Interior and U.S. Geological Survey estimated that we would continue to increase our energy production from 60 quads of energy in 1970 to nearly double that by the end of 1985...when, in fact, what's actually happened is a slight decrease in energy production in the United States. Dr. John McKetta's 1975 predictions seem to run closer to the actual than any other predictions do.

Nine states--Alaska, Kansas, Kentucky, Louisiana, Montana, New Mexico, North Dakota, West Virginia, and Wyoming produce more energy than they consume.

Eight states--Alabama, California, Colorado, Mississippi, Pennsylvania, Utah, Virginia, and Washington produce somewhere between 51 to 100 percent of their energy needs. The other 33 states produce less than 50 percent of their energy use.

That gives you an idea of where we are now. The question is....Where do we go from here? The cost of a barrel of imported crude oil, in early 1980, was $22 a barrel; six months later, in mid-1980, we were at $28 a barrel; and McKetta estimates that even if the rate of inflation was 10 percent--a low estimate--by the year 1990 a barrel of oil would cost almost $80. Now, if the inflation rate should go to 30 percent, we will reach $80 a barrel by 1983-84. During 1979 and early 1980, spot prices in the crude oil market were much more than 30 percent higher than a year earlier.

That tells you a little bit about the cost of where we are going. What other things can we do besides let the cost rise? In 1979, it was estimated by a report from Georgetown University, that the U.S. used 80 quads of energy. Where did it all go? There was a significant amount that went to electrical generation, residential and commercial use, industrial, and transportation. Nonenergy use (including agricultural production) represents a small minority of this amount. The important thing is that we currently only need 15 to 20 quads of energy. We use 80 quads...Where does the rest of it go? Fifteen to 20 quads go to unavoidable losses--something that one of the laws of thermodynamics says--there is nothing we can do about it--it is going to be lost. What about the other 30 to 40 quads of energy? Nearly half the energy we use is lost. Yet, if we applied our technology and increased the efficiency of present equipment and buildings, we could utilize a great deal of those 30 to 40 quads. Our real energy needs in this country could double, triple, and we could theoretically meet those needs through more efficient utilization of the 80 quads we currently use. However, economics and the laws of science and thermodynamics will, in great part, determine how much of that amount we are able to utilize.

As you are well aware, there have been a number of things done by the government in the last two years in an attempt to stimulate energy production and energy conservation. On the other side of the fence, the private inventors have been busy, as indicated by this cartoon. Apparently, the fellow's been out back experimenting with alcohol and gasohol fuels, and he had a small explosion. He comes in the house and his wife says, "Why don't you just let the government develop gasohol?" I am not sure that is a very good route to take, seeing how government has handled the Postal Service, OSHA, etc.

There are quite a number of people working in the area of gasohol and alcohol fuels. A lot has been said and printed about alcohol fuels. Some of it good; some of it not very well researched. As an example, Mr. Lance Crombie was written up in a popular magazine called Mother Earth News. In that article, it claimed that Mr. Crombie could get four to five gallons of alcohol out of a bushel of corn. In another interview with Mr. Bob Soletta, Director of the National Gasohol Commission at that time, Mother Earth News came out and said, "Bob, there is a certain professor in Minnesota that says he can make five gallons of alcohol out of a bushel of corn. Can you comment?" Mr. Soletta: "He might be a bit high on the five-gallon bit."

As with any idea, many of them start out simple, and many of them also get reinvented. The revitalized interest in alcohol is due in large part to articles published in 1978 about a solar still. As with any idea, someone else saw it and thought of a way to make a "better mousetrap," or alcohol still as the case may be. Accordingly, it was found that a solar-powered still was only as reliable as the sun, and therefore, someone designed a small wood-fired still. The progression included a portable "OPEC Killer" still, designed for a much larger, automated solar still, new bacterias and fermenter designs, and a number of large commercial stills capable of producing over one million gallons of ethanol per year. That just goes to prove that people believe they can make better alcohol stills. Indeed, we hope they can.

The United States has 5 percent of the world's population; we use 30 percent of the world's energy (78 quads); but we also produce 30 percent of the world's goods. You may be unfamiliar with the term, "quad." It is a quadrillion British Thermal Units. It's a one with 15 zeros behind it. In other words, a billion times a million. A BTU (British Thermal Unit) is the heat needed to raise the temperature of one pound of water by one degree Fahrenheit.

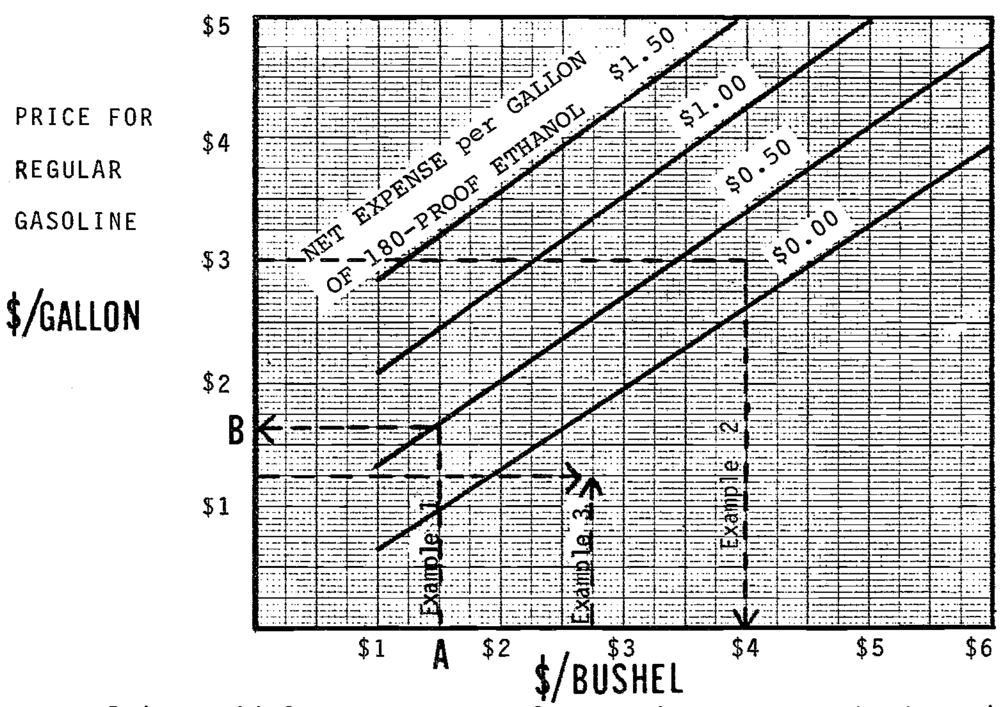
A quad is a tremendous amount of energy--it is about the amount of energy needed to run San Francisco for one year. It would take 13 billion gallons of ethanol to equal one quad of energy, but the same 13 billion gallons would replace 1½ quads of crude oil. Let's look at that in other terms.

The gasohol potential in the United States (a mixture of 10 percent alcohol, 90 percent gasoline) would require about one quad of alcohol (that would replace 4 percent of our petroleum needs; or looked at another way, it would replace 9 percent of our total imports). How much alcohol do we produce in this country today? In 1979, we orginally produced about 50 million gallons of fuel alcohol; most of it by Archer Daniels Midland (ADM). Today, in mid-1980, we have at least 100 million gallons of ethanol production per year on-line. By the end of 1981, we will see at least 300 million gallons a year, possibly up to 1 billion gallons a year of production capacity on-line. Archer Daniels Midland alone will have a capacity of 225 million gallons/year by the end of 1981. The incentives, I believe, are in place, and there will be a rapid growth in the number of alcohol fuel plants being constructed.

Archer Daniels Midland produces ethanol out of corn, but there is interest in a lot of other products to be used to make alcohol. As an example--take this letter I have from someone in Idaho. He says, "You may be interested in knowing a little bit about our fodder beet work which we are doing here in Idaho as well as Utah and Arizona. Harvest of the first crossing will be done by mid-July; the fodder beets themselves are showing tremendous growth as predicted. We feel confident that we will reach 40 to 50 tons-per-acre, which projects to 900 to 1,000 gallons of alcohol per acre. The first plant (in Idaho) producing alcohol from corn and using gasoline for anhydrous production is in operation at a capacity of three million gallons per year, so things are moving, and more will be done as we all pull together."

We have made some hard calculations about the cost of farm-produced alcohol.

FIGURE NO. 1 COST OF GASOLINE VS. COST OF FARM-PRODUCED 180 PROOF ETHANOL



Price paid for, or expense for growing corn or wheat used to make farm-produced ethanol. Assume 2.5 gallons of 180 proof ethanol per bushel. Source: AFBF NER Division May 1980

<u>Cost of Gasoline vs. Cost of Farm-Produced Ethanol From Corn or Wheat</u>

Prepared by AFBF NER Division - May 1980

Use Figure #1 to determine whether or not it would be more profitable to buy gasoline or to make ethanol from corn or wheat.

<u>Definition</u>: "Net Expense" is equal to the cost of making a gallon of ethanol (not including the cost of grain) minus the by-product credit.

Example #1. Assume that all your expenses (such as insurance, fuel, depreciation, chemicals, repairs, labor, and interest) for making a gallon of 180-proof ethanol are $1.00. Assume you can sell your stillage by-product for 7½ cents per pound (6.8 lbs. stillage/gal. x 7½¢/lb. = about $0.50/gal.). Net Expense is then $1.00 minus $0.50 which equals 50 cents/gallon. If you paid $1.50 per bushel for corn, then start at point "A" on Figure #1, move up to the Net Expense line labeled $0.50 and go across to the gasoline price axis (point "B"). In this case, gasoline prices would have to be above $1.65 per gallon in order for it to be profitable to make motor fuel ethanol from corn.

Example #2. Assume your cost of gasoline rises to $3.00/gallon and your Net Expense for making ethanol is 25 cents/gallon. At what wheat price will it become too expensive to make your own fuel ethanol? Answer: $4.00 per bushel.

Example #3. Assume gasoline costs $1.25 per gallon and wheat costs $2.75/bushel. What is the maximum Net Expense you can afford to make ethanol? Answer: Your Net Expense would actually have to be about -$0.40 (a profit). In other words, if you could sell the stillage for 7½ cents/pound (50 cents/gallon of ethanol), your expenses would have to be less than 10 cents/gallon, which is unrealistically low.

Figure Your Own ---	Total Expenses/Year	
Labor	$ ______	$ ______
Insurance	______	______
Chemicals & Yeasts	______	______
Repairs & Maintenance	______	______
Interest	______	______
Depreciation	______	______
Electricity	______	______
Fuel for Heat	______	______
Other	______	______
Total Expenses	$ ______	$ ______

Total Output (Gallons 180-proof ethanol/yr.) ________.

Total Expenses divided by total output equals $ ________ per gallon minus the by-product credit of $ ________ per gallon = $ ________ Net Expense per gallon.

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Protect Your Investment When Buying a Still

If you purchase a still or are thinking about ordering a still, you should:

1. Insist on a written warranty;
2. Have an attorney check the warranty before you close the order or pay any money down;
3. Put your down payment in an escrow account and withhold a sizable amount until the still is operating as promised.

As a MINIMUM, make sure the manufacturer you deal with offers these services:

* Hands-on training at company headquarters
* On-site training at your farm once the still is installed
* Problem hot-line telephone
* Lab analysis
* Technical rep service to your farm, if needed
* Equipment warranties
* Guaranteed performance of alcohol output if manufacturer's conditions are followed.

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LIQUID FUEL USE AND THEORETICAL ETHANOL POTENTIAL FROM AGRICULTURAL CROPS AND RESIDUES

State Arizona

	Gasoline 1,000 gals.	Diesel 1,000 gals.	LP Gas 1,000 gals.	Total Liquid Fuel Energy Trillion BTUs	200 Proof Ethanol Needed to Replace all liquid Fuel on an equivalent BTU Basis (million gallons)
Agricultural Fuel Use (1974 Data Base)	24,181	16,530	1,301	5.5	64.9
State's Fuel Use (1978 including Ag Fuel)	1,411,141	225,960 *	---	208.0	2,476.5

*1977 data

CROP	Units	Crop & Residue Production: 1979 Acres (1,000)	1979 Yield per acre	1979 Total Yield (1,000)	Ethanol Potential of 1979 Ag Crops and Residues: Ethanol Yield 1/ Gallons per unit	Theoretical 200 Proof Ethanol Yield 2/ (million gallons)
Corn for Grain	Bu.	45	115	5,175	2.5	12.9
Corn for Silage	Tons	12	22	264	80.0	21.1
Sorghum for Grain	Bu.	72	71	5,112	2.5	12.8
Sorghum for Silage	Tons	4	17	68	10.5	.7
Oats	Bu.	--	--	--	1.0	--
Barley	Bu.	43	75	3,225	2.1	6.8
All Wheat	Bu.	125	76	9,540	2.5	23.8
Rice	Cwt.	--	--	--	4.0	--
Rye	Bu.	--	--	--	2.5	--
Sunflower	lbs	--	--	--	---	--
Flaxseed	Bu.	--	--	--	---	--
Peanuts	lbs	--	--	--	---	--
Soybeans	Bu.	--	--	--	---	--
Cotton	Bales	643	1,060 lbs.	1,420	---	--
Alfalfa	Tons	205	6.4	1,312	100.0	131.2
All other Hay	Tons	37	2.3	85	80.0	6.8
Dry Edible Peas	Cwt.	--	--	--	4.0	--
Dry Edible Beans	Cwt.	--	--	--	4.0	--
Potatoes	Cwt.	6.2	210	1,300	1.1	1.4
Tobacco	lbs	--	--	--	---	--
Sugar Beets	Tons	11.4	19.2	219	20.0	4.4
Sugar Cane	Tons	--	--	--	17.0	--
Total From Agricultural Crops						221.9

CROP RESIDUES 3/	Units	Harvest Fraction	Yield Tons/ Acre	Usable Residue (1,000)	Gallons per Ton	Theoretical Yield 200 proof Ethanol (million gallons)
Corn Residue	Tons	.70	.42	8.7	80.0	0.7
Small Grain Residue	Tons	.60	2.27	458.4	80.0	36.7
Sorghum Residue	Tons	.70	.79	55.1	80.0	4.4
Rice Residue	Tons	--	--	--	80.0	--
Sugar Cane Residue	Tons	--	--	--	80.0	--
Total From Crop Residues						41.8

WOOD FEEDSTOCK 4/	Total Yield (1,000 dry tons)	Methanol Equivalent Million gallons/yr	Ethanol Yield (gallons per ton)	Theoretical Yield 200 Proof Ethanol (million gallons per year)
Mill Residues	271	↓	80.0	↓
Commercial Forestland				
Forest Residues	588		80.0	
Surplus Growth	0		80.0	
Annual Mortality	353		80.0	
Non Commercial Timber	471		80.0	
Non Commercial Forestland				
Reserved & Deferred	176		80.0	
Unproductive	3,235		80.0	
Total Wood	5,094	680	80.0	407

1/ Ethanol Yields are slightly on the conservative side.

2/ The theoretical yield of 200 proof ethanol is a conservative maximum. It does not take into account the fact that some of the crop produced would be: 1) used for seed for next year's crops, 2) used for food and industry products, 3) used for livestock feed, and 4) exported.

3/ Crop Residue information adapted from "The Potential of Producing Energy from Agriculture," Draft Report, January 1979, Office of Technology Assessment, U.S. Congress.

4/ Potential Wood Feedstock Resource based on 1976 Statistics Adopted from the USDA Forest Service Forest Statistics of the U.S. 1977, Review Draft (1978).