ALCOHOL FUELS:
SOME AGRICULTURAL AND ENERGY ISSUES

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The potential of alcohol based fuels such as gasohol as a solution to the nation's energy problem is controversial. This article discusses some of the issues including: 1) incentives for alcohol production, 2) energy balance of ethanol production, 3) food versus fuel, 4) impact of alcohol fuels on petroleum imports, 5) cost of ethanol versus the cost of other conventional and synthetic fuels, and 6) ethanol as a fuel versus gasoline or diesel fuel. The intent is not to give you all the answers but to get you to think about the issues.

The term gasohol usually is applied to a mixture of 10 percent ethanol with 90 percent unleaded regular gasoline. There are many kinds of alcohol. The one used in gasohol is ethanol while the other common form is methanol. In this article, alcohol and ethanol are used interchangeably.

Incentives for Ethanol Production

While there are a number of federal and state programs to encourage the production of ethanol, the most important are exemptions from motor fuel taxes. Currently, the 4 cents per gallon federal tax on gasoline is not collected on gasohol. This is a 40 cent per gallon subsidy to ethanol because only one-tenth of a gallon of gasohol is ethanol.

Many states, particularly grain producing states in the midwest and great plains, have gasohol tax exemptions ranging from 2 to 9.5 cents per gallon. The total subsidy to alcohol in each state is the federal tax exemption plus the state tax exemption multiplied by 10; for example, the total subsidy in Oklahoma is $1.05. The subsidy enables gasoline distributors in some states to pay a price for alcohol equal to the wholesale gasoline price plus the state and federal subsidy and yet sell gasohol at the same price as unleaded gasoline. The federal and state tax exemptions are not permanent but at least some are likely to be extended beyond current expiration dates.

Alcohol plants are eligible for Federal and New York State investment credits and for the Federal business energy investment credit. There is also a 40 cent per gallon Federal tax credit for alcohol of greater than 190 proof (30 cents if between 150 and 190 proof) that does not go through the commercial gasohol market.

Little economic analysis has been done on the appropriate level of federal and state tax exemptions or other incentives for alcohol production. There is some evidence that current state plus federal tax exemptions may be higher than necessary. For example, the price of ethanol has jumped dramatically in the last two years and now appears to be more closely related to the wholesale price of unleaded gasoline plus the federal and some of the higher state gas tax exemptions than to the cost of producing ethanol. As gasohol sales increase, the tax exemptions will have substantial impacts on state and federal highway funds.

Energy Balance

Much has been written about whether ethanol production results in a positive or negative energy balance. The answer depends to some extent on whether one looks only at the energy required to operate the ethanol plant compared to the energy in the ethanol produced, or whether the energy in the feedstock (such as corn), the distillers' grains produced, and that energy required to grow the feedstock is included. According to the Department of Energy (DOE), ethanol made from corn results in about 5 percent more energy in the ethanol and byproducts than is consumed in producing the corn and converting it to ethanol--not very encouraging. Some other crops such as sugar cane and sweet sorghum have been estimated to produce positive energy balances of 43 to 100 percent--somewhat more encouraging.

The energy balance in ethanol production may have been somewhat overemphasized. The crucial factor is not the energy balance but the source of energy used to produce the feedstock and convert it to ethanol. Currently, our most serious energy shortage is in liquid fuels--gasoline, diesel fuel, and heating oil. Natural gas and propane are also premium fuels. If we could make liquid fuels, such as alcohol, economically from an abundant energy source such as coal or solar, the fact that there was only a small energy gain or even a loss would not be very important.

What energy sources are used to produce ethanol from agricultural products? At least part of the energy used to produce feedstocks such as corn, sugar beets, or sweet sorghum is gasoline or diesel fuel. However, the energy used to cook the feedstock, distill the ethanol, and dry the distiller's grains (if they are dried), does not need to be liquid fuels or natural gas or propane. Energy sources such as coal, solar, agricultural residues, or biogas from manure could be used to run the ethanol plan. Perhaps federal and state policies to encourage or subsidize alcohol production should specify that liquid fuels, natural gas, and propane not be used in the ethanol plant, but there are few such requirements in the current tax incentives nor in most other government policies toward alcohol.

One such requirement is that alcohol plants constructed in 1983-85 must obtain at least 50 percent of their energy requirements from something other than natural gas or oil or their products in order to be eligible for the 10 percent business energy tax credit.

Recent publications indicate that alcohol plants to produce fuel alcohol rather than beverage alcohol can be designed to have a positive energy balance. Even if this is true for large scale alcohol plants, some analysts question whether most farm scale alcohol plants will be net energy producers.

Food vs. Fuel

Some people rebel at the idea of using grain or other crops to produce fuel for automobiles when there are people in the world who do not have enough to eat. They may be even more upset with government policies to subsidize the production of ethanol from agricultural products. To shed light on the competition between food and fuel, we need to look at the crop requirements to produce ethanol for gasohol, potential for increased crop production, and the possibilities for making ethanol from crop residues and food wastes.

Energy from Crops

The U.S. currently uses about 110 billion gallons of gasoline annually; conservation due to higher prices and other reasons is likely to reduce this use somewhat. To convert all gasoline to gasohol would require about 10 billion gallons of alcohol per year. If all the alcohol were made from corn, about 4 billion bushels of corn would be required annually--more than half the largest corn crop ever produced in the U.S. While we had a "surplus" of over 1.5 billion bushels of corn inthe fall of 1980, USDA projections indicate that carryover in the fall of 1981 will be only about a half billion bushels.

Proposals have been made that the crop mix could be changed so that we grow more of crops such as sugar beets and sweet sorghum for alcohol production, maintain our exports of soybeans, wheat and corn, feed our livestock at least partly on residues from alcohol production, and bring more land into production. All these changes supposedly would allow us to continue current levels of food consumption and yet produce a substantial amount of fuel energy from agriculture. Complete and careful analysis of such proposals has not yet been published but some comments could be made. Much of our cropland will not produce high yields of sugar beets and sweet sorghum: the soil and climate are not suitable. Also, the amount of idle cropland is far less than many believe.

Research published in 1979 by Meekhof, et al, indicated that up to 2 billion gallons of alcohol annually (about 2 percent of current gasoline consumption) could be produced from crops without causing serious adverse impacts on agriculture or elsewhere. The increased grain production needed (equal to about 800 million bushels of corn) could be produced from idle land or land that has been set aside in some years. Alcohol subsidies could be substituted for agricultural program costs at little or no change in cost to the government. These researchers might be less optimistic after the 1980 corn crop.

The same research indicates that larger alcohol programs such as 4 billion gallons per year (equal to about 4 percent of gasoline use) would have substantial upward impacts on corn prices and downward impacts on exports. Unless fundamental changes in our crop production and food consumption patterns could be made economically, I believe that a large alcohol program such as 5 or 10 billion gallons per year would lead to substantial increases in farm and food prices--good for grain farmers but perhaps not so good for consumers and farmers who buy grain.

Realistically, we are not likely to produce enough alcohol from crops in the near future to significantly affect food prices because the alcohol production capacity does not exist; for example, the government's goal of 500 million gallons in 1981 is not likely to be attained. Even if it is, the equivalent of only 200 million bushels of corn would be required, about 3 percent of the 1980 corn crop.

Energy from Crop Residues and Food Wastes

Large amounts of ethanol (or perhaps biogas) could be produced from agricultural residues such as straw, corn stalks and beet tops, and food wastes such as cheese whey, supermarket trimmings, and municipal garbage. Most analyses have calculated potential gross energy production without accounting for energy needed to collect and residues and wastes and convert them to alcohol.

It is useful to separate these sources into two categories--crop residues and food wastes--for several reasons. Crop residues usually must be collected while food wastes are already collected, at least to some extent. Crop residues left in the field provide some fertilizer value and help protect the soil from erosion, while food wastes may be causing pollution problems which might be alleviated if the wastes were converted to ethanol.

While crop residues could provide a tremendous amount of energy, a substantial amount of energy would be required to gather and process the residue. According to Tyner and Bottum, more than three-fourths of the residues in the country should probably be left in the field to keep erosion at acceptable levels. In addition, use of residues to produce ethanol is dependent on conversion of cellulose to ethanol, which is feasible, but the process is not yet commercially available.

Ethanol from food wastes currently may be more attractive than ethanol from crop residues. For example, whey from some types of cheese is not readily convertible to food and presents a waste disposal and pollution problem but could me made into ethanol. A recent Cornell study by Kalter, et al, indicates that under some conditions, cheese whey in Northern New York could be profitably converted to alcohol. According to DOE, food wastes could produce around 450 million gallons of ethanol per year which, although substantial, would substitute for less than 0.5 percent of gasoline use.

Impact of Alcohol Fuels on Petroleum Imports

There are several aspects to the potential for achieving energy independence through alcohol production. As pointed out earlier, it would take more than half the corn crop to put 10 percent alcohol in all our gasoline. Since we import about half our petroleum and a large amount is used for diesel fuel and heating oil as well as for gasoline, it is unlikely that alcohol production from crops, residues, and food wastes could reduce oil imports to zero even if the energy to produce ethanol was taken from non-imported sources.

A more realistic goal would be to attempt to reduce oil imports by producing ethanol; however, a USDA publication warns that production of ethanol might even increase oil imports if the energy balance for ethanol production were negative and imported oil were used to grow the crops and fuel the ethanol plants. On the other hand, if crop residues or coal were used to fuel the ethanol plants, ethanol production probably would result in reduced oil imports.

Another source of alcohol for fuel use is methanol from coal. Perhaps we could come closer to achieving energy independence through this route rather than with ethanol biomass sources.

Cost of Ethanol vs. Other Synthetic Fuels

Synthetic fuel alternatives to ethanol, such as syncrude from either coal or oil shale and methanol from coal, have substantial environmental problems, but they may not be insurmountable.

Many estimates have been made of the cost of producing energy from the various synfuel sources (Tyner and Bottum), but the range of estimates is wide for all the sources--generally in the range of $1 to $2 per gallon for syncrude from coal and oil shale. The estimate quoted by Tyner and Bottum for methanol from coal is 40 to 80 cents per gallon, but this fuel contains about half as much energy per gallon as gasoline; when the energy correction is made, cost is about $.80 to $1.60 per gallon. Their estimate for ethanol from grain is $1.00 to $1.20 which may be low and should be corrected for its lower energy content compared to gasoline. If the midpoints of the estimated costs are used, all of these fuels are more expensive then the price of gasoline at the refinery at the time the cost estimates were made. The data quoted by Tyner and Bottum are now at least two years old and current estimates would be higher. All the alternative sources of liquid fuel probably are still more costly than the price of gasoline at the refinery.

The major points about ethanol compared to other synfuels are probably not cost but other factors. Production of synfuels from coal and oil shale is in the development stage and five to ten years will be required to produce significant amounts. Plants operating to produce ethanol from grain can be set up in a month to two years, depending on plant size and complexity. Therefore, we can probably produce appreciable amounts of ethanol in the short run but much larger amounts of synthetic fuels from coal and oil shale in the longer run. Thus, ethanol may be relatively more important as a fuel during the transitional period than in the long run.

Ethanol as a Motor Fuel

Many papers have compared the power output of ethanol to gasoline and diesel fuel; not all writers agree. Ethanol contains about 76,000 Btu per gallon compared to 116,000 for gasoline and 138,000 for diesel fuel (lower heating values); however, the octane rating is higher for ethanol than for regular unleaded gasoline. Some people claim that the Btus in ethanol are used more efficiently than those in gasoline or diesel fuel, but a number of researchers disagree.

Research reviews by DOE and the Office of Technology Assessment (OTA) indicate that miles per gallon are likely to average about the same for gasohol (10 percent ethanol) as for unleaded regular gasoline. Some cars do a little better and some a little worse on gasohol. If substantially more ethanol (say 25 to 30 percent) were mixed with gasoline, mileage per gallon would deteriorate despite the claims being mady be some ethanol proponents.

Most gasoline engines could be run on gasoline-ethanol mixtures with more than 10 percent alcohol or on straight alcohol or alcohol less than 200 proof. However, more fuel would be required because of the lower energy content of ethanol.

Some evidence indicates that small amounts, say 10 percent, of ethanol can be mixed with diesel fuel without significant deterioration in performance despite the much lower energy content of ethanol compared to diesel fuel. One manufacturer's report indicated that a 50/50 mixture of ethanol and water was substituted for 30 percent of the diesel fuel by injection into the airstream by a turbocharger with no loss in power; however, this has not been substantiated by independent researchers. There are substantial problems in using more than 10 percent ethanol in diesel engines.

Regarding emissions from alcohol or gasohol compared to gasoline, the DOE has published the following:

> Whereas use of neat (straight) alcohol significantly reduces oxides of nitrogen emissions compared to that of gasoline under comparable conditions, the effect of 10 percent alcohol is proportionally smaller and in the realm of measurement sensitivity. The quantities of regulated emissions vary with the air fuel ratios determined by carburetor adjustment. The amount and direction of change varies for each regulated compound. The emissions effects of gasohol and other alcohol/gasoline blends can be duplicated with gasoline alone by adjusting the carburetor for leaner operation. In both cases, efficiency increases, power decreases, and there is usually degradation in driveability though none may be apparent to the average driver. Addition of alcohol to the gasoline invariably decreases CO emissions, usually decreases HC, and usually increases NO_x but may decrease it or leave it unchanged. Aldehyde emissions may be of concern because of their photochemical reactivity, but are not now considered of consequence.

The last sentence refers to the fact that gasohol results in increased emissions of aldehydes which may aggravate smog problems in some areas.

More testing needs to be done in both off-farm and on-farm settings before we will have complete knowledge of ethanol compared to either gasoline or diesel fuel. At this point, we should be wary of making a substantial commitment to the use of ethanol based on some of the claims made that its Btus are used more efficiently than Btus in gasoline or diesel fuel. In the case of on-farm alcohol production, it will be difficult to achieve the energy self-sufficiency that some farmers desire because most large farm tractors are diesel; it would be difficult and probably impossible to run most of these on straight alcohol. All of the evidence on the use of alcohol as a fuel is not yet in.

Concluding Comments

Current state and federal programs to stimulate production of ethanol, most of which will come from agricultural products or residues, could have substantial impacts on agricultural production and prices, land use and food prices. There is reason to believe that current alcohol programs are more farm programs than energy programs.

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