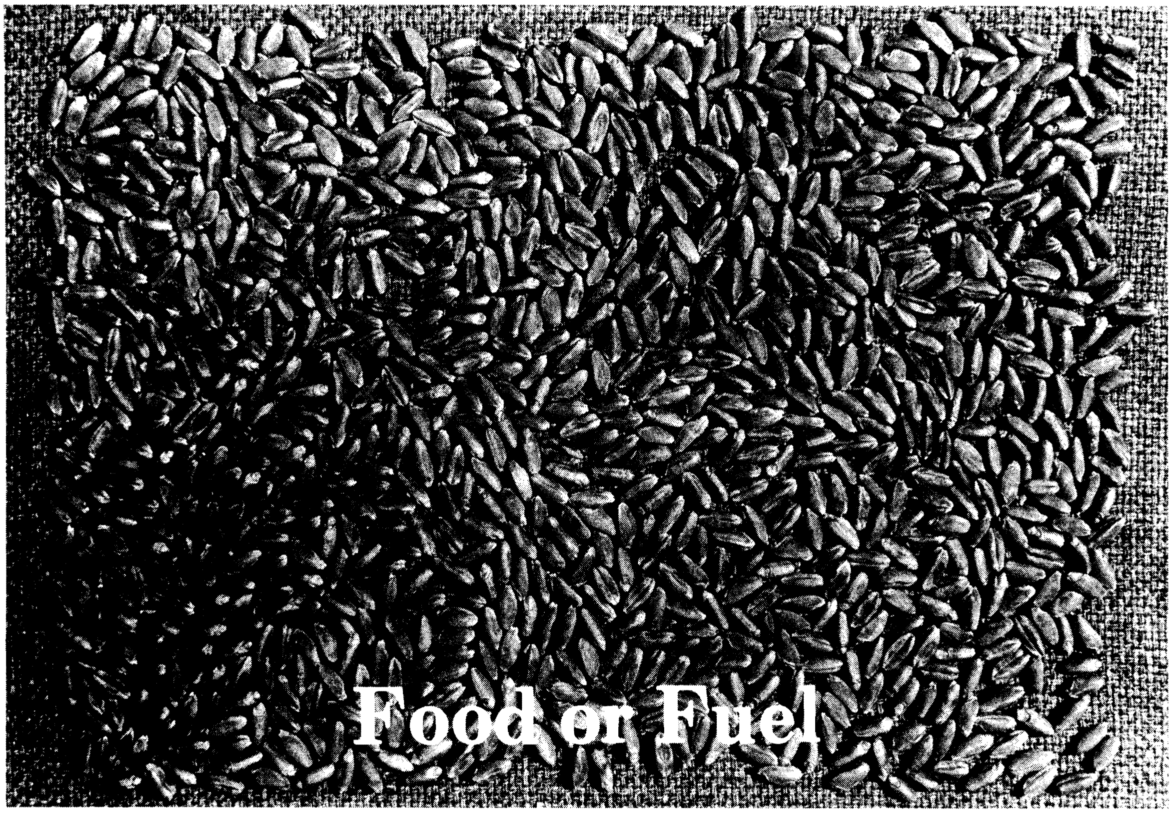

# PRODUCTION AND USE OF GRAIN ALCOHOL AS A MOTOR FUEL - AN EVALUATION

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## ABSTRACT

**The use of alcohol as a motor fuel is proposed for two reasons: the process would consume some of the surplus cereal grains; and for the conservation of fossil fuels. The process would achieve the first objective — use of surplus grains, although it is unlikely that a sufficient quantity of alcohol could be produced from grain to meet the requirements for blending on a national scale. A bushel of cereal grains can be converted to about 2.6 gallons of alcohol and this alcohol can be used in gasoline fueled engines when blended with gasoline, without alteration of the engine. The cost of the grain used for the conversion is the main determinant of the alcohol cost. The conversion of grain to alcohol and use of grain alcohol as a fuel will not conserve our fossil fuel energy resources. The overall processes associated with grain production, transportation and conversion of the grain to alcohol require far more energy than can be recovered from burning the alcohol.**

*Report on the 44th North Dakota Legislative Assembly's Senate Concurrent Resolution No. 4035 titled URGING STUDY OF GRAIN ALCOHOL AS FUEL.*

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### Introduction

The use of alcohol as a motor fuel for the internal combustion engine has been under consideration almost since the invention of the engine itself. Before the development of petroleum resources, fuel for the engine was in limited supply and alcohol was found to be a possible fuel. Over the years interest in alcohol as a motor fuel has waxed and waned as economic and sociological conditions have changed.

When petroleum supplies have been temporarily interrupted, as in Europe during World Wars I and II, alcohol-gasoline blends have been used to extend petroleum fuels. In the United States, a seemingly endless supply of starchy cereal grains has stimulated interest in the conversion of this starch to motor fuel by way of fermentation to alcohol. When the cereal grain market has been severely depressed to as low as a few cents per bushel, any method for diverting cereals to fuel seems most attractive.

The prices of cereal grains had remained in a depressed condition for most of the half-century prior to the dramatic upsurge in 1973. Most of this pressure on the market price was a consequence of an almost permanent oversupply of cereal grains. This oversupply resulted from a combination of factors including the decreased consumption of feed grains by draft animals as agriculture and commerce converted to electricity or petroleum-fueled engines and increasing yields of cereal grains. During most of this same half-century, gasoline products were available at the refinery for 5-8 cents per gallon. The current low prices for cereal grains have renewed interest in the use of alcohol as a motor fuel.

## Previous Studies

Numerous studies have been conducted concerning the feasibility of using alcohol or alcohol-gasoline blends as fuels for internal combustion engines. A detailed survey of these studies which reviews the literature from 1921 to 1964 was prepared by the Society of Automotive Engineers (1). An older review prepared by the United States Department of Agriculture, Bureau of Agricultural Engineering, covers the technical literature from 1907 to 1933, and includes many references to foreign publications (2). Many of the early studies on alcohol as a fuel were performed on small low-compression engines and are not entirely relevant to engines currently in use. A very extensive study of the power alcohol problem is under way at the University of Nebraska. Some preliminary results of this study have been made available in the form of progress reports (3,4).

In addition, an extensive highway test program is in progress in Nebraska in which state-owned vehicles are being operated on a blend of 10 percent alcohol in gasoline. Records are being kept of performance, fuel consumption and engine wear. A preliminary report has been prepared (5).

The United States Department of Agriculture has maintained a long-standing interest in the use of alcohol as a fuel. Since 1940 research on the improvement of the production of alcohol from cereal grains has centered at the Northern Regional Research Laboratory. Numerous reports have been prepared on the fermentation process and evaluation of alcohol as a fuel. A cost analysis of the conversion of wheat to alcohol was prepared in 1972 (6).

## Alcohol Production

Prior to 1945 nearly all of the alcohol consumed in this country for all purposes — industrial, food, beverage and medicinal — was produced by fermentation of grains or molasses. Since then synthetic alcohol produced from ethylene, a petroleum derivative, has captured nearly all of the industrial alcohol market. In some foreign countries where petroleum products are in short supply, industrial alcohol is still produced by fermentation. In the United States, government regulations require that alcohol for human consumption must be produced by fermentation. The annual production of distilled alcohol from fermentation is of the order of 100 million gallons.

The overall process for producing alcohol by fermentation has been thoroughly investigated. Information from extensive industrial and government pilot plant operations make it possible to calculate input costs and alcohol yield when grains are converted to alcohol. The overall cost of the alcohol produced is greatly influenced by the cost of raw materials (wheat, corn, etc.), plant capital, and energy to drive the process. In general, raw material cost is the major factor in determining the cost of the alcohol product. When the price of cereal grains varies, the price of fermentation alcohol varies correspondingly.

The value of cereal grains for the production of alcohol depends upon their high starch content. Corn and milo each contain about 70 percent starch. Wheat runs a little lower, especially hard red spring, hard red winter and durum types, which have higher protein contents. The yield of motor alcohol is about 2.6 gallons per bushel of wheat or 2.7 gallons per bushel of corn. Other fermentable commodities include potatoes, cane and beet sugar and molasses. In former years imported molasses was the least expensive raw material for alcohol production by fermentation.

The production of alcohol by fermentation is dependent upon the unique ability of yeasts to convert sugars to alcohol and carbon dioxide. When starchy materials are to be used, the starch is first converted to sugars (glucose, maltose) by the action of barley malt or similar substances. Yeast then utilizes the sugar for alcohol production in the fermentation process. The products of the overall fermentation process, including distillation, are alcohol, "dried distillers' grains and solubles" and carbon dioxide. When cereal grains are fermented the three products are obtained in approximately equal amounts by weight.

When fermentation of the mash is completed, the alcohol is distilled from the stillage mixture. The distillers' grains are separated by sieving or centrifuging, leaving soluble materials in solution. Normally, these soluble materials are concentrated by evaporation, the concentrate is added to the distillers' grains and the mixture dried to produce "dried distillers' grains plus solubles". The proportion of grains and solubles varies, but is about 40-45 percent grains and 55-60 percent solubles. The yield of "dried distillers' grains plus solubles" is about 20 pounds per 56 pounds of corn added to the mash. For purposes of livestock feed they are classed as high protein-low energy feedstuffs (25-28 percent protein). A recent study indicates the distillers' grains and solubles may be processed further to produce a high protein concentrate that could have value as a food supplement (7).

Carbon dioxide is given off as a gas during fermentation. It has a low market value and may be recovered for sale as "dry ice" or compressed to liquid form. The Nebraska study (3) indicates a value of $2 per ton at the fermentor.

Alcohol is obtained in the fermentation brew as a "beer" containing 8-9 percent alcohol. In order to be used for fuel the alcohol is distilled to 190 proof (95 percent), with a second distillation with benzene to recover 200 proof (100 percent) alcohol for blending with gasoline. Ordinary 190 proof alcohol does not mix with gasoline. A recent news release indicates that a product has been discovered which will allow the blending of alcohol, water and gasoline.

### Economics of Alcohol Production from Grain

Miller (6) and Scheller and Mohr (3,4) have made estimates for the conversion of cereal grains to alcohol. The cost factors summarized by Miller (6) indicated a cost of $0.242 per gallon of 200 proof alcohol, exclusive of wheat, profit, packaging and sales expenses. In that study, the value of the by-product feed grains was set at $60/ton. In the Nebraska studies (3,4), the value of the feed grains was set at $117/ton. At this higher price the income from the feed grains offset the costs of plant and operation and brought the basic conversion cost to near zero. Added to this in each case are the costs of the cereal grain and profit. The conversion cost estimates are subject to the usual variations experienced in the costs of capital, labor and energy. Since energy costs have risen sharply it is likely that the conversion costs referenced above are outdated. The overall fermentation and distillation processes require substantial amounts of energy for cooking, alcohol distllation and drying of the by-product feed grains. The energy flow and balance will be treated later.

The yield of 200 proof alcohol from cereal grains is limited by the starch content. The theoretical yield of alcohol is 0.568 pounds per pound of starch. In actual practice the yield is about 90 percent of the theoretical. This translates to about 2.6 gallons of 200 proof alcohol per bushel of hard red spring wheat (14 percent protein, 14 percent moisture). Soft wheat, corn and sorghum give slightly higher yields because of higher starch contents. The effect of wheat cost on the cost of fermentation alcohol can be estimated, assuming a yield of 2.6 gallons of alcohol per bushel of wheat:

$$\frac{\text{Cost (\$/bu)}}{\text{2.6 gal/bu.}} + \text{Conversion cost (\$/gal)} = \text{Alcohol cost/ gal.}$$

| **Wheat price/bu.** | **Grain cost** | Conversion cost (6) | **Alcohol cost*** |
|---|---|---|---|
| $1.00 | $0.38/gal | $0.242/gal | $0.622/gal |
| 2.00 | 0.76 | “ | 1.002 |
| 3.00 | 1.14 | “ | 1.382 |
| 4.00 | 1.52 | “ | 1.762 |

**Alcohol cost at distillery, not including marketing, handling, highway taxes or profit.*

The cost of alcohol produced from corn or sorghum would not be greatly different from that shown above if the prices for the grain are comparable to that for wheat. In general experience corn and sorghum sell at a lower price than wheat and are, therefore, more economical to use for alcohol production. In addition, the distiller can often use low grade or damaged grain. Even though conversion cost estimates differ considerably (3,4,6), the raw materal grain will always be a major factor in determining the price of alcohol produced by fermentation.

### Use of Sprout Damaged Grain

There is a strong interest this year in diverting sprout damaged wheat into the production of alcohol. Sprouted grains may be used for alcohol production, but the value of the grain is reduced by the sprouting process. During sprouting, starch is converted to soluble sugars that are used by the embryo and seedling. During periods of extended rainfall there is an additional loss of soluble sugars by leaching. The loss may run as high as 30-40 percent of the starch originally present and the alcohol yield will be decreased accordingly. Because of this reduced yield, the value of sprout damaged grain may be good or poor, depending upon the extent of sprouting and weathering. Loss of test weight and reduced overall crop yield are good predictors for low value for alcohol production.

### Alcohol as a Motor Fuel

Practical tests of the performance of present-day high compression engines using alcohol as a motor fuel are quite limited. Pure ethanol is generally viewed as an unsuitable fuel. Most laboratory studies seem to indicate that a blend of 10 percent alcohol (200 proof) and 90 percent gasoline is the most useful formulation. The highway test underway in Nebraska (5) is probably the only extensive study of vehicle performance using present-day high compression engines. The fuel in this tudy is a 10 percent alcohol blend in standard type gasolines.

In comparing the value of alcohol and gasoline as motor fuels, it is necessary to keep in mind that all internal combustion engines, as we know them, are basically "heat engines". A fuel is burned to generate heat and pressure and the pressure is used to perform mechanical work. The value of a substance as a fuel for an engine can be judged from the caloric value of that fuel — the more calories or BTU's per unit weight or unit volume, the more valuable as a motor fuel, provided combustion is complete. A comparison of the properties of alcohol and gasoline is shown below:

**Caloric value (total heat of combustion)**

| | Gasoline (ave.) | Alcohol (200 proof) |
|---|---|---|
| BTU/lb | 21,800 | 12,800* |
| BTU/gal | 135,000 | 84,400 |

**Slightly higher and lower estimates have been reported.*

Since alcohol has a lower caloric value than gasoline, its value as a motor fuel is correspondingly diminished. Gasoline has a caloric value of 135,000 BTU/gal.; a 10 percent alcohol blend has a caloric value of 129,000 BTU/gal. (The basic value of gasoline will vary somewhat, depending upon formulation.) There is some evidence that the addition of 10 percent alcohol improves the combustion process and increases the octane value of certain gasolines, enabling a high compression engine to utilize a lower grade gasoline. Thus, part of the loss of caloric value resulting from blending alcohol into the fuel may be offset by improved combustion. At higher alcohol blends, the low caloric value is evidenced by increased fuel consumption and low power output.

Preliminary results from the Nebraska road test (5) indicate fuel consumption for vehicles powered by 10 percent alcohol blend is reduced about 5 percent to 7 percent in comparison with vehicles using no-lead fuels. The fuel cost was increased $0.087/gal. by reason of the higher cost of the alcohol. In the Nebraska test (5) the alcohol cost $1.19/gal. had $4.50 wheat been used as a source, the alcohol would probably have cost about $2.00/gal. delivered and the cost of the blend would have been increased about 0.17/gal. over a straight no-lead gasoline. For that study the basic cost of the gasoline was $0.302/gal. before taxes, transportation and profit. From purely economic point of view, the use of alcohol as a motor fuel cannot be justified even as a blend unless the price of gasoline and alcohol are about equal. Since alcohol at $1.19/gal. increases the cost of the motor fuel when used in a 10 percent blend, it would be necessary to have a very low cost source of material for fermentation in order to produce alcohol at a price comparable to gasoline. If alcohol is to be used as a fuel by itself, it would have to be available at about 62 percent of the price of gasoline, based on relative caloric values.

There are some practical problems associated with the use of pure alcohol as a motor fuel (1). These include hard starting in cold weather and low volatility. It is likely that modifications could be made to engines to permit the use of alcohol as a practical fuel. The Nebraska study, however, appears to encounter no operational problems in the use of the 10 percent alcohol blend.

### By-Product Feed Grains

The principal by-products, "distillers' dried grains" and "distillers' dried solubles" are produced in substantial amounts, about 7 to 8 pounds per gallon of alcohol. The combined annual production of these two commodities is about 400,000 tons. The market price of the feed by-products follows the price of other feedstuffs and is in the range of $110-130 per ton depending upon location. The value of distillers' dried grains and distillers' dried solubles for use as livestock feeds has been the subject of many studies (9). These materials are characterized as low energy, high fiber (8-12 percent), high protein (25-28 percent) feed supplements. Rations incorporating 10-25 percent of the by-product feeds have been developed for poultry, swine, cattle, fish and pets.

The composition of the materials varies with the grain used for the fermentation process. The nutritive value of the by-product feeds does not appear to have been improved greatly by the fermentation process. Some vitamins have been added by the yeasts, but the fermentation process has depleted the carbohydrates from the grain in the formation of alcohol, leaving a low energy residue. The combined "distillers' dried grains plus solubles" is said to be about the equivalent of good alfalfa hay when formulated into rations at the 10-25 percent level.

Because of the large amount of gasoline consumed in our society, the use of a 10 percent alcohol - 90 percent gasoline blend would create an enormous demand for alcohol in comparision with the present level of production and consumption. Along with this would come a correspondingly large increase in by-product feed grains. Gasoline consumption in the United States is approximately 100 billion gallons/year. A 10 percent blend would require 10 billion gallons of 200 proof alcohol. At 2.6 gallons of alcohol per bushel of wheat or corn, the grain consumption would be about 3.8 billion bushels/year[1]. This would create about 35 million tons of by-product distillers' dried grains and solubles (about 90 times the 1974 production!). Because of the relatively low energy value of these materials, it is unlikely that our food-feed economy could accommodate a shift of this magnitude. Extensive readjustment of feeding practices would be required. The distillers' grain by-pro-

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[1] *The 1976 United States production of wheat, corn and sorghum was about 9 billion bushels.*

ducts would be in direct competition with concentrates such as soybean, peanut, cottonseed and linseed meal, although less desirable than any of these.

### Could North Dakota do it Alone?

It is possible that a state or groupings of states could legislate for the use of alcohol-gasoline blends. The transportation and consumption of the by-product distillers' grains is a major consideration in the economy of the alcohol-gasoline motor fuel blends. The annual consumption of gasoline in North Dakota is about 405 million gallons. The production of 40 million gallons of alcohol for a 10 percent alcohol blend would produce 140,000 tons of distillers' grains which would need to fit into the marketing system. The availability of this amount of feed would be an important factor in the livestock economy. By comparison, approximately 200,000 tons of commercial feeds (all types) were sold in North Dakota in 1976.

The use of alcohol-gas blends for automobile fuels by a small region (one state) creates some problems. This would require controls on the flow of fuel to insure blending at pipeline terminals prior to distribution. The distribution of the 40 million gallons of 200 proof alcohol that would be needed for use in North Dakota would be a task and challenge of some magnitude. Present day transportation methods would suggest a separate alcohol pipeline distribution system reaching from the distillery to the gasoline pipeline terminals.

### Some Social Considerations

The distribution of large amounts of alcohol for use in motor fuels poses a serious social problem. It would probably be impossible to prevent the diversion of substantial amounts of the alcohol into beverages (to avoid payment of Federal and State taxes). Just how serious this diversion might be is unknown, but effective controls would need to be a part of any plan that would involve the use of alcohol-gasoline blends on a large scale.

The prinicipal arguements for the use of alcohol as a motor fuel are usually based on two propositions:

a. A ready market for cereal grains.
b. A source of fuel to extend petroleum and energy reserves.

It has been shown that while the production of alcohol would consume vast quantities of cereal grains (corn, wheat, milo), the conversion process produces vast amounts of high protein, low energy feedstuffs that must be worked into the economy in either animal feeds or processed further into human food supplements. The technology exists for the conversion. If the grain producer expects to receive a "good" price for his grain ($4-5/bushel), the cost of alcohol as a fuel is relatively high.

### Energetics of Alcohol Production from Grain

It may appear at first glance that use of alcohol as a motor fuel could help to extend limited petroleum resources. if this is the major justification for the use of alcohol as a motor fuel there are many problems which remain to be solved. First of all, the production fo a bushel of wheat, corn or milo involves the investment of very substantial amounts of energy in the form of natural gas, coal or petroleum used for the synthesis of fertilizer, pesticides, seed bed preparation, harvesting and transportation of the crop. Even the conversion process itself has a substantial energy requirement for grinding, mixing, distillation and drying of the by-products. The availability of cheap natural gas and petroleum fuels has made it possible to utilize many industrial processes that otherwise might not be economically feasible.

In most grain processing industries, the ratio of energy input versus the energy in the final product is almost always greater than 1 and may run as high as 15 for some foods. In other words, the processing consumes more energy than can be recovered from the product. If a process is to be developed for producing a high energy product (alcohol), it is essential that the product be capable of releasing more useful energy than was consumed in the manufacture of this high energy product (alcohol).

In the case of the production of alcohol by fermentation of grains an estimate of the energy inputs has been made (8). A summary of the utilities inputs is given in Table I. The overall flow of energy is estimated in Table II.

**Table I. Utilities summary for conversion of corn to alcohol1/**

| | Requirements | |
|---|---|---|
| | Per hour | Per gallon of 200 proof alcohol |
| Steam — 50 psig | 200,600 lb | 109.2 lb |
| 15 psig | 72,500 lb | |
| Electricity | 700 kw | 0.28 Kwh |
| Coal (10,000 BTU/lb) | 4,680 lb | 1.87 lb |

*1/Source: See Reference 8. The plant was designed to produce 20 million gallons of 200 proof alcohol per year, or about 2,500 gallons per hour and would require about 900 bushels of corn per hour.*

In addition to the process energy, the production and transportation of a bushel of cereal grain in our "energy-intensive" agriculture requires substantial energy inputs, usually as fossil fuels (gas, coal, petroleum). For example, the production of one bushel of

**Table II. Energy requirements to operate the plant described in Table I.**

| | Estimated energy to product | Estimated energy input/gal |
|---|---|---|
| Steam total: | | |
| 109.2 lb /gal[1] | 1,400 BTU/lb | 152,880 BTU |
| Electricity: | | |
| 0.28 Kwh/gal[1] | 11,00 BTU/Kwh | 3,080 BTU |
| Coal: | | |
| 1.87 lbs /gal[1] | 10,000 BTU/lb | 18,700 BTU |
| | Total process energy/gal. | 174,660 BTU |

[1] *From Table I.*

wheat requires 3-4 pounds of nitrogen, much of which comes from synthetic processes. The synthesis of 1 pound of anhydrous ammonia requires a little over 1 pound of petroleum products or natural gas. Add to this the fuel consumed in tillage, harvesting, drying, transportation, manufacture of pesticides and chemical fertilizers, and the total energy input to produce a bushel of cereal grains approaches 0.8 to 1.0 gallon of pertroleum products or products derived from coal. The caloric value of these inputs must be added to the process inputs detailed above. Assuming 1 gallon of pertroleum/bushel of grain, the energy input per gallon of alcohol may be calculated as follows:

$$\frac{(1\ \text{gal. petroleum/bu.}) \times (135{,}000\ \text{BTU/gal})}{2.6\ \text{gal. alcohol/bushel of grain}} = 51{,}923\ \text{BTU input/gal. of alcohol output}$$

The sum of production energy and process energy (Table II) is estimated to be 226,580 BTU/gallon of alcohol. The heat of combustion of 1 gallon of alcohol yields only 84,400 BTU/gallon. It is obvious that the investment in energy far exceeds the output.

It should be noted that not all of the energy of a crop of wheat or other cereal is contained in the alcohol produced by fermentation. The distillers' feed grains and the crop residues left in the fields together yield more energy on combustion than does the alcohol produced from the grain. No really efficient method has been devised for using these commodities for fuels on a large scale. Scheller (personal communication) has made an estimate of the caloric value of a Nebraska corn crop used for alcohol production. He estimates that about 30 + percent of the caloric value is in the alcohol, 18 percent in the distillers' grains and byproducts and 50 + percent in the corn stalks and corn cobs. The relative values for a wheat crop would not be greatly different. The energy content of the distillers' grains would eventually be used by livestock, but a satisfactory ratio of energy input/energy output is not secured unless the crop residues (straw, stalks, cobs, etc.) are collected and used for fuel or another higher value purpose. While at first glance it may appear that agricultural commodities could provide a renewable energy resource, the production, collection, transportation and processing of these materials involve energy expenditures that often equal or exceed the useful energy that can be recovered when the commodities are used as a fuel.

In primitive societies, the energy balance was more favorable because primitive man invested little more than his own energy and energy from the sun to produce and process his crops. Wastes were returned directly to the soil which produced the crop. In technological societies, fossil fuels have been used to replace the energy of man and beast. Materials that were waste for primitive man, to be cast back on the soil, may become intolerable pollutants when accumulated by factories and cities. Dispersal and decontamination of the wastes from processing plants involves yet another expenditure of energy.

There are many goals that justify the use of energy intensive processes. In these processes either the energy is available at a low cost as in the case of fossil fuels or the product has a very high value. Alcohol, when consumed as a beverage, has a high cultural value for many persons. On the other hand, alcohol as a motor fuel has no special features that would justify the investment of large amounts of energy, unless the energy is inexpensive or renewable.

The collection of crop residues for use as fuel for processing plants, factories and homes does not appear to be a tenable proposition, largely because these are bulky materials of low energy content when compared to fossil fuels. The practice of using these materials on the farm which allows for convenient recycling of minerals is in all probability their best use.

Lignite coal is an inexpensive source of energy and could be used to provide the large energy requirements to operate a distillery. An even lower cost form of energy could be made available by use of the exhaust steam from electric generating plants. This heat is eventually transferred to the environment as waste heat but could be used to good advantage if diverted into a distillery or other industry which can utilize low-pressure steam.

The coupling of large steam-powered thermo-electric generating plants with various industrial processes has been advocated on many occasions for the efficient utilization of our fossil fuel resources. It is likely, however, that it would be far more efficient to convert lignite coal directly to liquid and gaseous fuels rather than to use lignite as an energy source to produce and process crops that are intended to be used as fuels. The use of lignite or other fossil fuel for the production of food is entirely another matter.

Finally, the conservation of petroleum resources by substituting alcohol for all or part of our gasoline needs is not even a halfhearted or token effort. Gasoline consumption accounts for less than half of our petroleum consumption. If alcohol were to be added to the extent of 10 percent of all petroleum fuels, including diesel fuels, heating fuels and aircraft fuels (most of which is not even feasible) the demand for alcohol would greatly exceed any possible level of production of the necessary cereal grains. This action would seriously deprive our food and feed-stuffs of essential caloric value. Furthermore, a 10 percent replacement would extend fuel reserves only 10 percent, assuming that no petroleum-type products are used for the production of the cereal grains or alcohol. This would mean that if we have a 25-year reserve of petroleum, the use of alcohol would extend this to 27.5 years. This is not a real solution!

### Energy and the Technological Society

No rational solution has been demonstrated that will permit our society to continue to consume fossil fuel energy reserves (natural gas, petroleum, coal) without coming to an end of these reserves. Unless the surface of the earth contains vastly more oil and gas than has generally been reported, some alternate source of energy must be found. Because of the high energy input needed for mechanized production of high yielding crops, it is not feasible to depend upon agricultural production to provide for the energy needs of a technological society. The technological society is dependent upon ever increasing levels of energy inputs. Unless society comes to grips with this central issue and adjusts its energy consumption or develops alternate energy sources — solar, fusion, tides, winds and every other possibility — society will run out of gas, oil and coal, whether in this century or another.

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**Guest Column Continued from Page 2.**

and seed cleaning plants. In short, just about everything a farming or ranching enterprise involves. And, the work at branch stations is in the hands of a limited number of people who are expected to be multi-proficient.

It has been my observation that research at branch stations attracts a special kind of person — part time farmer, part time livestockman, part time mechanic, part time extension specialist, part time public relations man and full time agricultural scientist. And, it has been my good fortune, for over a quarter century, to be associated with this special group of men. I have found them in the past, and continue to find new additions to the staff, to be knowledgeable, capable, imaginative, ingenious, self-reliant and dedicated people, well aware of their responsibilities as North Dakota State University's representatives in their home localities. Unfortunately, sometimes part of this talent goes to waste because branch stations are located at considerable distances from the University and the inconvenience of distance makes involvement awkward and impractical.

Branch station personnel can easily relate to General Amos Halftrack, commander of Camp Swampy in the Beetle Bailey comic strip, who waits in vain for a word, any kind of word, from the Pentagon. We get to feeling like orphans at times, and with some justification perhaps, when one considers that over the past 30 years, to my knowledge, a full complement of The Board of Higher Education has never visited the Dickinson station, and on only a couple of occasions have we had the pleasure of showing part of the Board around. Perhaps it is unfair to pick on the Board only, in this regard. As a matter of fact, often if someone does stop by it's if they are on the way to somewhere else and we only get to pass the time of day.

The branch station people have in the past, and continue to make a solid contribution to the collective knowledge that makes North Dakota's agriculture the great enterprise that it is. We're not only on the team — we're on the first team. We think you could do worse than recognize the branch stations as the real assets that they are to the Land Grant University system.