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ALCOHOL FUELS POLICY

HEARINGS

BEFORE THE

SUBCOMMITTEE ON ENERGY

OF THE

JOINT ECONOMIC COMMITTEE
CONGRESS OF THE UNITED STATES

NINETY-SIXTH CONGRESS

SECOND SESSION

PART 1—Energy Self-Sufficiency for Rural America

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MONDAY, MARCH 17, 1980

CONGRESS OF THE UNITED STATES,
SUBCOMMITTEE ON ENERGY
OF THE JOINT ECONOMIC COMMITTEE,
Washington, D.C.

The subcommittee met, pursuant to notice, at 9:40 a.m., in room 5110, Dirksen Senate Office Building, Hon. George McGovern (member of the subcommittee) presiding.

Present: Senators McGovern, Percy, and Stewart; and Representative Long.

Also present: Philip B. McMartin, Mayanne Karmin, Keith B. Keener, and Ken Hughes, professional staff members; Robin Carpenter, Senator McGovern's staff; and Betty Maddox, administrative assistant.

OPENING STATEMENT OF SENATOR MCGOVERN, PRESIDING

Senator MCGOVERN. I think we will proceed with the hearing. A couple of our witnesses are not yet here, but they will come in, I am sure, during the course of the first few minutes.

The Nation's agriculture industry, I think, faces the greatest challenge ever presented to a single sector of our economy. Through the production of alcohol for use as a pure fuel and other renewable resource fuels, it is being called upon to provide the means to achieve a vast reduction in our dependence on oil, while at the same time continuing to meet the needs for food and fiber for this country and for those around the world who depend on us.

I think this challenge must and can be met. It is a matter of national embarrassment on the part of the Departments of Energy and Agriculture, in my judgment, that this challenge is not being more vigorously pursued. There is no question but that the potential for great achievement is there. It ranges from projected energy self-sufficiency for most of rural America in the next two decades to analyses that suggest that our farm and forestry sectors have the theoretical capacity to produce more than 100 billion gallons of alcohol a year, a level equal to the estimated consumption of gasoline by the Nation as a whole in 1990.

A large and widening body of expert opinion, which even the Departments of Energy and Agriculture are belatedly beginning to share, holds that production and marketing of renewable energy resource fuels is the most immediate way in which the Nation can effectively respond to the energy crisis.

Within this context, small-scale onfarm and rural community production, because of low unit costs, speed of construction, and the high efficiency levels attainable, constitutes the swiftest method of attaining initial production of significant volume. But despite the monumental need for action and the enormity of the task, the huge and favorable impact of a full-fledged renewable fuels program could have on the entire economy of the Nation, the availability of on-the-shelf technology for production and use, the enthusiastic willingness of the farm and forestry sectors, despite all of these things, the stance of the Department of Energy has been that of virtually ignoring small-scale production.

And the attitude of the Department of Agriculture, I regret to say, has been to relegate small-scale production to the level of a minor program. In effect, the Department of Energy has transferred most, if not all, of the responsibility it recognized to promote small-scale production to the Department of Agriculture. In principle, I find no fault with this decision. However, to date, the Department of Agriculture has racked up the wholly unimpressive score of seven onfarm loans, totaling $1.3 million. The figure amounts to a drop in a river of alcohol fuel that can be made to flow in rural America and is a totally inadequate response to what we ought to be doing.

While hundreds of loan requests continue to roll into the Department, USDA sits on $100 million in loan guarantees and $10 million in direct loans that are supposed to be available to launch renewable energy resource fuel production. This lack of financial assistance comes at a time when rural America's characteristic capital-shortage problems have been made desperately acute by the crushing tight money, high interest rate monetary policy being pursued by the Federal Reserve. Rural communities must now struggle with through-the-roof interest rates and the prospect of zero credit availability. In effect, farmers are being strangled in their attempts to effectively respond to the Nation's energy crisis.

What we are seeing is a Department of Energy devoted exclusively, or nearly so, to large-scale alcohol and other renewable energy resource fuels production. Many of these facilities will be operated by energy conglomerates which have no intention of allowing alcohol fuels to compete with the price of gasoline.

Plants of this size require high-quality rail service, large stores of water, and 2 to 4 years of construction time before coming on line. At best, their number and location will be severely limited.

The Department of Agriculture, on the other hand, which holds the key to small-scale onfarm and rural community production, is hamstrung by apparent internal divisions concerning its commitment to efforts that hold the promise of easily constructed, inexpensive, and highly efficient production capabilities. More than $100 million in financial assistance is earmarked within the USDA for this purpose, but less than a trickle is reaching farmers in rural communities, while oil prices continue to soar and the threat of reduced availability of foreign oil continues.

The USDA delivery system for financial, technical, and management assistance is so inadequate as to constitute something less than tokenism. In my judgment, this is an appalling situation which jeopardizes the opportunity for rural America to become energy self-sufficient.

Beyond this, we are confronted with an entirely avoidable administrative barrier which is robbing farmers and rural communities of the opportunity to own and operate the very alternative fuel production facilities that will simultaneously provide them with the means to gain energy freedom, while establishing a yardstick by which to measure the cost and availability of all renewable energy resource fuels in the Nation.

Equally important, rural America is being deprived of an important economic development tool which has the potential to launch a whole new industry and to otherwise greatly expand its business and industrial base, thereby creating hundreds of thousands of new jobs.

These circumstances demand immediate remedial action. The Departments of Energy and Agriculture must be made to commit themselves without reservation to small-scale onfarm and rural community renewable fuels production. The focus of the entire small-scale program effort must be lodged within one agency, and effective and responsive delivery of financial, technical, and management assistance must rapidly be achieved.

The purpose of this hearing is to assess the dimensions of this problem and to hear from our witnesses their recommendations as to how best to solve it in the shortest time possible.

Our first witness will be Deputy Secretary Jim Williams of the Department of Agriculture.

I am going to ask you gentlemen to summarize your oral statements in 10 minutes or less, with the understanding that your prepared statements will be made a part of the hearing record, and after that we will have an opportunity to question you.

Senator Donald Stewart of Alabama will testify this morning, and will be here later on in the session.

Congressman Long, do you have an opening statement?

Representative LONG. I have no opening statement, Senator.

Senator MCGOVERN. We are glad to have Congressman Long here this morning.

Well, Mr. Williams, you gathered from my opening statement that I am not at all satisfied with the progress that has been made to date on this whole question of small-scale alcohol fuels development which holds the prospect for resolving a significant part of our energy problem. It is not the only answer, but it is one that rural America can contribute to very substantially. Farmers in rural communities are anxious to move on it.

So, I've asked you to come here today to see if you could shed some light, first of all, on what's being done, and second, on what some of the problems are, and third, how we can do better. You can proceed in any way you see fit.

STATEMENT OF JIM WILLIAMS, DEPUTY SECRETARY, DEPARTMENT OF AGRICULTURE

Mr. WILLIAMS. Senator, I will just speak extemporaneously for a moment in response to some of your opening comments, but also to put a proper perspective on the situation as far as alcohol fuels are concerned, at least from my perspective, which is simply one person's perspective.

I came here a little over a year ago as Deputy Secretary, and in about May of last year Secretary Bergland went before congressional committees with an economic analysis of alcohol fuel, and at that time, with the pricing of unleaded gasoline, the economics were still questionable. And in fact, it appeared that we were some 17 cents a gallon away from profitable operation under that economic scenario.

Since that time, as you know, in the past 12 months, the price of imported oil has escalated slightly over 100 percent. It is now, in our opinion, economically feasible to use grains for conversion to alcohol. I personally have visited the wet corn milling process at the Archer-Daniel-Midland plant. I have seen the oil and protein removed and then the starch converted into alcohol. I am very sympathetic to the proposition that it is one small but important way that we can become less dependent upon imported oil and truly more self-sufficient in energy.

But I have to caution that while we have gone ahead with $100 million and the $3 million that you have spoken to in loan guarantees and direct lending authority in the 1980 budget, that even under today's scenario, without the windfall profits tax, without that legislation being available, that there is still no economic incentive for a farmer to convert to less than anhydrous alcohol for his own use or sale.

Now, that is a rather broad statement, but the fact is that about 85 percent of the horsepower on today's farms is diesel generated, and no one yet has come forward with an appreciable amount of diesel engine conversion for utilization of alcohol fuel. We are quite successful in alcohol use in unleaded gasoline and in gasoline combustion engines but we have not reached that kind of plateau in conversion of diesel engines. I hope that someone today will review that statement and tell me that I am all wrong, that great amounts of alcohol can be used in diesel engines. I have raised it a number of times in the presence of the Department of Energy and none of their technical people have yet to refute that statement.

The closest we have come to major utilization has been the M. & W. Gear Co. conversion that uses 1 gallon or so of water and 1 gallon of 140-proof alcohol, after the combustion and before the turbine charger, to replace from 1½ to 2 gallons of diesel in a farm tractor. That is the highest utilization that we have seen so far afforded by anybody in the diesel conversion issue.

Now, to speak directly to what I think the major concerns of any agency in the lending business has to have. That is the assurance that the recipient of that loan can, in fact, amortize the debt and pay it back. It is terribly important on large-scale operations that there be an extention beyond 1984 of the 4-cent excise tax that is in the windfall profits bill. To build a plant that takes 18 months to 2 years to complete, and to have a tax credit, excise tax credit, of 4 cents expire at the end of 1984 is not much of an incentive to the private sector to take either loan guarantees or their own money and invest it. I think that extension to 1992 is an acceptable compromise that is in the windfall profits tax legislation. That should adequately amortize the plant over a 10-year-after-construction period. We support that extension.

As for the onfarm use of alcohol, there is no tax credit comparable to that 4 cents, except that in the windfall profits tax. If you produce at less than 190 proof and more than 150 proof, you are entitled to 30 cents in your tax credit against future income taxes. That is not the same as the subsidy of 4 cents a gallon that the larger producers of anhydrous would have, but it certainly is a step in the right direction.

My final point on this particular issue would be that it is imperative that the farmer who produces this alcohol either be able to use it on his own farm in his own equipment or sell it to a neighbor who can use it, or—and, I think, most significant under the present technology—be able to convert that to anhydrous alcohol through a cooperative effort or a corporation in the community that collects product from small farm stills. The farmer should have the opportunity for patronage dividends or investment in a corporation with his product so that he can share in that 4 cents a gallon, which is a substantial subsidy that is available to our anhydrous in unleaded gasoline.

And so, I am saying to you, Senator, that as important as this subject is, we now have over $400 million in preapplications pending for the $100 million that we have set aside in the 1980 budget for Farmers Home and B. & I. lending programs, and that we are fully ready and available and anxious to move with this program. But, until the Congress completes its work on tax policy it will be very difficult for me as a former mining company executive and who has operated my own cattle and citrus operations, and sawmill and logging operations, to believe that anything is going to happen on this subject before the tax policy has been established by the Congress.

Thank you, sir.

Senator McGovern. Thank you very much, Mr. Williams.

[The prepared statement of Mr. Williams, with an attachment, follows:]

PREPARED STATEMENT OF JIM WILLIAMS

Senator McGovern and members of the subcommittee: It is a pleasure to appear before you today to discuss the Department's energy program relating to the production and use of energy from renewable biomass materials.

Before discussing the potential for renewable energy production and use I would like to put into perspective the importance of energy in agriculture, forestry and rural America by briefly discussing energy usage in those sectors.

In 1978, an estimated 13.8 quads of energy were used in agricultural and forestry production and processing, rural housing, and rural vehicular use (table 1). This represents about 18 percent of the total energy used in the U.S. Of the total energy used in agricultural production, 93 percent was derived from petroleum-based energy. In forestry and rural housing, these percentages were 51 and 71, respectively.

TABLE 1.—ENERGY USED IN AGRICULTURE, FORESTRY, AND RURAL AMERICA, 1978

Sector	Quads	Percent derived from petroleum resources	Percent of U.S. total
Agricultural production	2.5	93	3.2
Food processing	1.0	84	1.3
Forestry	2.7	51	3.5
Rural housing	3.1	71	4.0
Rural vehicular use	4.5	100	5.8
Total	13.8	82	17.8

These data indicate the significant dependency of agriculture and rural America on petroleum-based energy. Of the total 78 quads of energy used in the U.S. in 1978, about 74 percent was from petroleum products. Therefore, the rural areas are substantially more dependent on petroleum fuels than the United States as a whole.

In view of this large dependence of agriculture, forestry, and the rural sector on petroleum energy and the necessity for adequate sources of energy on a timely basis, Secretary Bergland has placed a major emphasis upon energy conservation and energy production from biomass materials. I will not address the energy conservation efforts of the USDA in this statement but will focus mainly on energy production from biomass.

ENERGY PRODUCTION POTENTIAL

Huge quantities of agricultural and forestry residues and wastes are generated each year along with the commercial production of agricultural and forest products. Some 500 million dry tons of wood are potentially available, but remain unused, each year. Plant wastes such as cereal straw, corn cobs and stalks, and sugarcane bagasse total about 400 million tons of organic solids yearly. Farm animals, many of which are raised in confinement, produce another 210 million dry tons of organic matter yearly.

Total agricultural biomass from residues and wastes constitutes well over 1 billion tons of dry matter produced annually. However, there are many environmental, ecological, economic and technical problems in use of farm and forest residues and wastes that will reduce the amount of residues that can be utilized for alternative fuel production, and much of the fuel produced would not be in liquid form. But, there is potential to produce large amounts of additional energy from agricultural and forest biomass, and much of this biomass fuel could replace current usage of oil and gas. If one-fourth of the residues and wastes were used for energy production, about 325 million barrels of oil could be produced annually (assuming 1.3 barrels of oil equivalent per ton of dry organic matter).

Another biomass energy potential is the use of agricultural commodities such as corn and grain sorghum to produce ethanol for gasohol. In the near term, agricultural commodities will be used more heavily than residues for alcohol fuels, because the technology is available and facilities can be expanded rapidly. Over time, however, we expect residues and new energy crops to be the major feedstock for alcohol fuel production.

Fuel from wood

Currently, about 35 percent of the total energy used in producing and processing forest products is from wood and forest residues. This represents about 0.9 quads of energy. Another 0.2 quads of fuelwood is used for residential heating, so that fuelwood use currently totals about 1.1 quads annually.

There is a large potential for expanded usage of wood for fuel. Total wood potentially available now in the United States, on an annual renewable basis, is roughly 9 quads in fuel-equivalent terms. Of this, some 3.8 quads (42 percent) is currently harvested and used for lumber, other manufactured wood products (2.7 quads), or for fuelwood (1.1 quads). This means that another 5.2 quads (58 percent of the total resource) which is potentially available annually is left unharvested and unused.

The economics of harvesting and using a substantial portion of this currently unused wood is becoming favorable, as the price of oil, gas, and other competitive fuels increases.

The potential for petroleum derived liquid fuel displacement is especially promising in the pulp and paper industry, which currently consumes about 2.4 quads of energy annually, most of it for process heating purposes. The industry already derives nearly a quad of its energy requirements from residues, almost all of which are of forest origin, but a substantial additional substitution potential remains. If only half of the pulp and paper industry's current level of residual and distillate fuel oil consumption were to be replaced with residues, nearly 50 million barrels of crude equivalent could be saved annually. The industry is well aware of this potential and as fuel prices increase we anticipate rapid progress in this direction.

The use of fuelwood for residential heating and for other industries and utilities (textiles, brick manufacturing, small power plants, etc.) should also expand in the short term.

Wood of course is not itself a liquid fuel unless converted, but many new applications of wood could be expected to "back out" petroleum-based liquids and natural gas. For instance, approximately 43 percent of the 1.5 quads of energy purchased by pulp and paper mills is either middle distillates or residual fuel oil, which represents roughly 4.2 billion gallons (100 million barrels) of liquid fuel. About 71 percent of the heating fuel for rural residences is petroleum based, and reliance upon middle distillates is much higher in New England, for instance, where fuelwood is potentially available as a substitute for home heating oil.

Through the National Forest System free-use fuelwood program, the number of permits issued has grown from about 64,000 in 1973 to almost 370,000 in 1978. This represents an increase in wood utilization to about 3 million tons in 1978 or the equivalent of about 8.1 million barrels of oil.

The nationwide sale of wood burning stoves numbered about 1.1 million units in 1978. This represents an increase in wood use of about 3.5 million tons which is roughly equivalent to 9.5 million barrels of crude oil. It has been estimated that an additional 1.5 million wood burning stoves were sold in the U.S. during 1979 and the wood used could be equivalent to about 12.9 million barrels of crude oil.

Two wood-fired utility plants in New England are now producing electricity for distribution to consumers. In addition, two REA member cooperatives are currently investigating the feasibility of building and operating wood-fired power plants.

While the direct combustion of wood is limited to stationary uses and therefore does not directly displace petroleum fuel in the transportation sector, the expanded use of wood promises to free up greater quantities of fuel liquids in the short term than the conversion of agricultural commodities into alcohol fuels. The 13 billion gallons of diesel and residual fuel oil used in pulp and paper plants, for example, most of which is used in stationary plants, can be compared to the 500 million gallons of fuel alcohol targeted for production during 1981. We of course need to produce the alcohol fuel, but fuelwood as replacement for fuel liquids should not be de-emphasized.

The Carter Administration has supported the energy investment tax credit and other tax incentives for the conversion of manufacturing plants to wood and other non-petroleum sources of energy, and is supporting additional loan guarantees for biomass energy production and use (including wood energy) in the pending Synfuels Bill. The Administration also supports tax credits for wood stoves. With these incentives, conversion to fuelwood should be economically attractive in an increasing number of locations.

Alcohol fuels

Both the President and Congress have emphasized the use of ethanol in near-term national energy policy. We at USDA are fully committed to focusing the resources available to the Department for production and use of fuel-grade ethanol from agricultural materials, as a part of the President's program on alcohol fuels and consistent with our other responsibilities.

The President's gasohol program established a goal fo 500 million gallons of alcohol fuel capacity to be in place in 1981. About 80 million gallons of annual on-line capacity currently exists; 420 million gallons of additional capacity is therefore necessary to reach the President's goal.

Economics.—The most important action necessary at this time to achieve the President's alcohol fuels production goals is passage of the excise tax exemption and income tax credits in the Oil Windfall Profits Tax Bill currently pending in Congress. We are hopeful that these vital incentives are given final approval quickly by Congress. The extension to at least 1992 of excise tax exemption and income tax credits, can provide a favorable climate for firms and investors considering investments in alcohol fuel plants, since they can expect these incentives to be available for most of the amortized life of a new plant.

If these and other Federal incentives are enacted in the pending Windfall Profits Tax Bill and Synfuels Bill, our calculations indicate that investment in new plant and equipment for fuel ethanol production can show an attractive financial return. Specifically, with $2.50 per bushel corn as feedstocks, a properly-managed, newly-constructed alcohol fuels plant of 40 million gallon annual capacity might be expected to yield a 20–25 percent return on equity. The basic calculations for this are contained in Attachment A to this statement.

The economic picture has improved significantly since May 4, 1979, when Secretary Bergland indicated that an additional subsidy of 17 cents per gallon of ethanol would be required to make production economically feasible, assuming about the same Federal incentives as being considered by Congress today. This resulted because of the differential inflation rates between prices of petroleum fuel and agricultural feedstock materials.

The economics of fuel alcohol production can be strengthened further by site-specific factors, particularly where the co-products of alcohol production can be increased in value or where production costs can be reduced.

For instance, the integration of an anhydrous alcohol distillery with a corn wet milling plant can result in production efficiencies and higher co-product returns (for corn oil, high-protein gluten feed, etc.). The co-location of a distillery with a cattle feedlot can allow the high-protein byproduct to be fed wet, this saving large amounts of fuel otherwise required for drying the byproduct feed. Similarly, co-location with a cooperative grain elevator can save grain handling costs, co-location with an electrical power plant can use "waste" heat from the power plant, etc.

Significant quantities of agricultural feedstocks are available for alcohol production. To meet the goal of 500 million gallons of alcohol production by 1981 established by President Carter would require less than 200 million bushels of corn and does not consider the byproducts that would be returned to animals. This is about 2.5 percent of the total 1979 record corn harvest.

The present availability of grains and other starch and sugar crops which are readily fermentable represent significant sources of biomass feedstocks for alcohol production. This should serve as a bridge until new technology will permit economic production of alcohol fuels from cellulosic biomass such as crop and woody products, either as residues or grown specifically for energy production.

We would expect minimal immediate food price impacts with the President's 500 million gallons of alcohol production goal. Other factors such as adverse weather conditions and significant changes in the levels of exports will affect commodity and food prices more than the amount of grain used for alcohol production. In the longer-run, the rate of technology advancement enabling the economic use of cellulosics as an alcohol production feedstock will be the primary criterion in moderating potential food price increases. We are pleased with progress in this technology development, but can not project when it will be available for commercial use in the U.S.

Little work has been completed, to date, concerning the economic growth implications of renewable energy resource production, mainly because our focus has been on crude oil import problems. But it is clear that the main programs contemplated in the President's January 11 anouncement will have highly favorable economic growth consequences.

For one thing, the larger distillery segment of the alcohol fuel industry as well as the wood fuels industry will tend to be more geographically dispersed than is characteristic of the traditional fuels industries. Locationally, the biomass energy industries will tend to gravitate in the direction of their raw materials in order to minimize transport costs of bulky commodities. This will diversify employment opportunities in many regions of the country that have for many decades been dependent on one or two-industry economies.

Based on the biomass alcohol projects we in USDA have seen, we would expect modern anhydrous alcohol plants to create approximately two new permanent jobs for every million gallons of annual capacity installed. This is direct distillery employment only. Thus, achievement of the President's 500 million gallons per year target for the end of 1981 should create about 650 or so new jobs in the large distilleries. Of course, substantial additional new employment will be generated in support industries and in the forest regions.

The situation with respect to the smaller on-farm stills is more complicted. Many farmers will certainly try to run their stills themselves so that alcohol production on-farm in such cases will not generate new employment. Many larger farmers, however, will hire full-time labor to operate their stills. If the installation of small distilleries generates an additional 300 new jobs during 1980–1981, the new permanent jobs directly attributable to fuel alcohol plant construction and operation would total some 1,000 by the end of 1981. Additional job creation involved in construction of large-scale distilleries, production and fabrication of steel and other indirect employment could expand the 1,000-job figure substantially.

There is an important additional factor related to employment. The failure to reduce our dependence on imported crude oil is likely to lead to severe economic dislocations in this country. From this perspective, biomass energy resource development can play a vital role in avoiding major unemployment and economic growth problems in the years ahead.

Net energy balance.—The net energy balance issue is complex. Traditional alcohol fermentation and distillation technology was developed during a period of relatively low energy prices, especially for oil and natural gas. Consequently, very little concern was expressed about the net energy balance. Besides, the industry was making alcohol mainly for beverages and the relationship between energy in and energy out was of significance only in respect to cost of production. Rapidly rising oil and natural gas prices have changed all of this, even in respect to beverage alcohol production. Research and development effort is being focused now in both the government and private sectors on the problem of reducing energy consumption in the production of fuel alcohol. We expect to see new distilleries in operation soon with net energy balances that are quite favorable. Nevertheless, we remain convinced that every effort should be made to avoid construction of alcohol stills utilizing petroleum derived fuels for process energy purposes. Even though such stills might show a positive net energy balance, we would prefer that they consumed no petroleum products at all.

There is much concern that producing alcohol fuels from farm commodities such as corn will impinge on our food supplies. It must be remembered that alcohol production only consumes starch from the corn. The protein remains for use as a livestock feed or for utilization as human food. In the wet corn milling industry the major food products are removed first and then alcohol is manufactured from the remaining starch.

There is concern as to whether cropping patterns can be altered to still provide for food and fiber supplies as well as energy. A substantial acreage shift from soybeans to corn could be visualized as alcohol fuels required more bushels of grain. The corn oil and protein would substitute in large part for soybean oil and protein. There are some differences in amino acids between corn and soybean proteins, but missing amino acids can be synthesized.

Price actions in the marketplace will bring about shifts in production patterns that will make the production of feedstocks for alcohol fuels more consistent with the continued needs of commodities for food and fiber production.

Technical aspects of small-scale production use.—The USDA recently published a technical manual, "Small-Scale Fuel Alcohol Production," that examines the state-of-the-art of small-scale ethanol production technology and provides an economic assessment of the major annual operating variables that impact on fuel alcohol price and production. Copies of the report have been provided to the Committee.

The technology is available for small-scale alcohol production facilities to be quickly assembled and brought into production. Small, pre-packaged on-farm ethanol production plants are now available and seem to be the most feasible equipment for widespread adoption. However, to date only a few pre-packaged plants have been produced and have not been adequately tested and evaluated for extended periods. But, they do offer much more operating efficiency and safety than homemade equipment.

Large on-farm and community-scale plants are becoming available, but they also are not well proven for extended periods of time. The larger units can produce anhydrous ethanol, and given sufficient distilling capacity may upgrade the lower proof alcohol to anhydrous grade that is produced from small on-farm facilities.

Currently, the bulk of the ethanol sold for gasohol use is produced in one large corn wet milling plant. Plans for construction of additional new plants have been announced, and existing idle distilleries are being reconditioned and brought back into production. Clearly, the potential is there to meet the President's goal of 500 million gallons of annual production of 1981 using existing technology.

The use of alcohol fuels on farms can present a number of problems. Anhydrous alcohol can be efficiently used as gasohol in farm automobiles and trucks without engine modification. Similarly, anhydrous ethanol can be burned in gasoline engine tractors with minor carburetion changes.

Use of straight alcohol, of less than anhydrous quality can be accomplished in farm tractors and other equipment having gasoline type engines. These can be converted at modest cost. However, most new farm equipment has diesel engines. Only small horsepower units are now sold with gasoline engines. There appears to be no feasible way to burn straight alcohol in a diesel engine today. There are conversion kits to provide a portion of the fuel as alcohol that do work rather well. One kit that costs about $900 plus installation uses 1 gallon of alcohol plus 1 gallon of water and 6 gallons of diesel fuel to perform the work of 8½ gallons of diesel fuel.

Ethanol can serve as a substitute for other farmstead energy requirements, including grain drying and heating of livestock housing. Lower proof ethanol is satisfactory for such purposes, and modification of the burners is not difficult or costly.

Financial assistance.—As a followup to the President's January 11 announcement of alcohol fuels, the Department of Agriculture on January 19 designated $100 million of Rural Business and Industry loan guarantee authority of the Farmers Home Administration to assist the construction and operation of alcohol fuel plants. In extending these loan guarantees, we will attempt to target loan guarantees on firms and persons who can take advantage of the kinds of sitespecific factors noted earlier. We are conducting assessments of opportunities for integrated operation of alcohol plants with corn milling plants, animal feedlots, grain elevators, power plants, and other such opportunities. The B&I Loan Program is based upon FmHA's rural development mission and functions without a "no credit elsewhere" clause.

FmHA is making available a demonstration program of small-scale plants to help those planning to operate fuel alcohol plants at the farm or community level. Loan guarantee assistance for small-scale ethanol production in 1980 is available through the Business and Industry loan program and through an additional $10 million in insured and guaranteed loans from FmHA's Farm Operating and Ownership Loan Programs.

In providing loan assistance for small-scale ethanol production on a broad basis, we want to make sure that it is done in a way that will provide options for use and marketing of the ethanol produced from small distilleries. Of particular concern is the extent to which it will prove technically and economically feasible to use non-anhydrous alcohol in farm tractors and other farm power equipment as mentioned earlier.

Alcohol production could become a cooperative effort. This would provide farmers an option in that they may either provide grain or other feedstock to a community plant and withdraw needed anhydrous alcohol and distillers grain byproduct for use on their farm, with the remainder being sold for profit; or they could submit farm produced lower-proof alcohol to the community plant for upgrading into anhydrous alcohol for sale or for use on the farm. The amount of product they would receive would, of course, be based on the amount of grains or feedstock they supplied to the community plant.

If this kind of profit-sharing (or fuel-sharing) arrangement is to operate to the maximum benefit of the farmers involved, the community ethanol processing and upgrading plant should be organized on a genuine cooperative basis, whereby the affiliated farmers participate in management decisions, qualify for patronage dividends or other forms of profit-sharing, and otherwise directly share in the cooperative's management and returns. For this reason, we would expect to target loan and loan guarantee assistance primarily to individual farmers and to cooperatively-organized enterprises.

The Department of Agriculture is now in the process of working out a program of financial and technical assistance to small-scale alcohol producers. Because ethanol may prove to be primarily marketable for blending with gasoline in automobiles, there ought to be facilities in place for the upgrading of lower-proof alcohol to anhydrous alcohol, prior to the widespread construction of on-farm stills with only lower-proof production capability.

For this reason, we may target much of our initial lending assistance on "community" sized plants which have excessive anhydrous production capacity, and therefore can upgrade farmer produced lower-proof alcohol, as well as produce anhydrous alcohol directly from unprocessed feedstocks.

Through March 1, 1980 the FmHA has had serious discussion with 273 possible applicants for loans or loan guarantees for constructing alcohol fuel production facilities totaling about $850 million. Of these 42 have submitted preapplication material, 25 have applied for loans, and eight others have received loans or guarantees. The eight loans or guarantees were for a total of $2.8 million to fund construction of 2.9 million gallons of annual capacity. This is about $1 per gallon of annual capacity.

We expect much more interest in the FmHA financial assistance program once Congress has enacted the excise tax and other financial incentives in the Windfall Profits Bill. Currently, there is apprehension on the part of investors many of whom have adopted a wait and see attitude.

Investment requirements for alcohol production facilities vary widely depending upon economies of scale, the feedstock being utilized for production, and the degree of processing of the distillers residue. Since alcohol production for small and community-sized facilities is relatively new, components and turn-key operations are not yet utilizing mass production techniques. Once the demand exists for a larger number of plants, we would expect investment costs to stabilize or decrease, depending on technology and other innovations.

Investment costs for small on-farm and community-sized facilities were estimated recently and appear in "Small-Scale Fuel Alcohol Production." These range from $2.45 for a small on-farm turn-key operation to $1.34 for a large on-farm non-anhydrous unit (table 2).

TABLE 2.—INVESTMENT COSTS FOR ALCOHOL PRODUCTION PLANTS

	Model plant					
	Pot still	Small on-farm	Large on-farm	Small community wet stillage	Small community DDGS	Large community DDGS
Investment cost ($1,000)	$28	$147.2	$411.8	$1,340	$1,734	$3,075
Annual capacity (1,000 gal)	16	60	360	1,000	1,000	2,000
Cost per gallon (dollars)	$1.75	$2.45	$1.14	$1.34	$1.73	$1.54

Technical assistance.—One way to rapidly expand alcohol fuels production from biomass is through adoption of a very active technical assistance program. SEA-Extension, the Cooperative Extension Service, and the State and Private Forestry component of the Forest Service are shifting resources to place much greater emphasis on energy related programs. Some additional funding to expand programs has come as pass-through funds from DOE. Cooperative Extension Service in some States received additional funding from State Energy Offices. In seven of the 10 States of the DOE-Energy Extension Service pilot program, Cooperative Extension Service operated part of the programs. In many States, CES has submitted proposals to conduct the Energy Extension Service program as it is expanded nationwide.

The energy technology transfer programs among the agencies and throughout the U.S. focus on energy conservation and the substitution of renewable for nonrenewable energy sources. We are focusing today only on the renewable energy resources, especially alcohol fuels production.

The Cooperative Extension Service is stressing information transfer on alternative forms of renewable energy sources for use on farms and in rural communities. The production and use of alcohol fuels are receiving particular emphasis because of the potential to supply motor fuel needs from local feedstocks and the creation of extra markets for agricultural products.

The Cooperative Extension Service is providing information to their county offices on the alcohol fuels program as rapidly as technical information and loan assistance information becomes available. Farmers and small businesses in rural communities are extremely interested in examining the issues and the opportunities in producing alcohol. Initial feedback from a number of States indicates that interest is more on community-based plants, rather than on individual farms, because of the advantages of maintaining quality, safety control and fewer storage problems.

Specialized training and educational materials are being developed, for Extension specialists and county agents specifically designed to assist operators of small-scale facilities in production of alcohol. For example, the USDA is distributing a new comprehensive technical manual, "Small-Scale Fuel Alcohol Production" prepared specifically for financial and technical information specialists to assist farmers and community business leaders interested in small-scale ethanol production. This manual is being distributed as well to the offices of FmHA, ASCS, Farm Credit Administration and other agencies. Extension is also distributing the DOE publication, "Fuel from Farms—A Guide to Small-Scale Ethanol Production" to its nearly 3,000 county Extension Offices this month. The USDA film, "Gasohol—Growing Some of Our Fuel" is being widely used in State and county meetings.

The Forest Service through its Cooperative Forestry program in the State and Private Forestry system is receiving considerable inquiries from cooperators in production of alcohol from wood, or the use of wood as a heat source for the production of alcohol. There are four projects for alcohol production for which FS is providing technical assistance.

There are many other projects underway that utilize wood as a renewable energy source to save millions of barrels of oil yearly. State and Private Forestry specialists are assisting producers to get the projects operational.

With passage by Congress of the excise and income tax credits that will make investments in alcohol production more favorable, we anticipate a major increase in involvement by the Cooperative Extension Service working with farmers and community producers on ethanol plant design, construction, production, safety, and government regulations to help install and keep small-scale facilities operating; and by the Forest Service to assist forest industry groups in both ethanol and methanol production.

This ends my prepared statement. I will try to answer any questions that you might have.

ATTACHMENT A

Estimated end-of-1979 economics of a 40 million gallon per year grain alcohol distillery (with Federal subsidies only)

	December 1979
Ethanol:	
Feedstock costs ($2.50/bu. corn)	$0.98
Direct costs (fuel, labor, etc.)	.26
Indirect costs (administrative, marketing, plant overhead)	.10
Capital recovery (includes 15 pct ROE) [1]	.34
Total	1.68
Less distillers' dried grain byproduct credit ($116/ton)	-.38
Subtotal	1.30
Less Federal gasoline tax credit	.40
Less other Federal incentives (investment tax credit; entitlement credit)	-.08
Net production cost per gallon of ethanol	.82
Gasoline:	
Refinery gate price on non-lead gasoline	.85
Octane credit	.10
Total	.95
Estimated profit per gallon ethanol, in addition to 15 pct ROE [2]	.13

[1] The capital recovery estimate assumes a 15-pct after-tax return on equity, 70 percent equity financing, and 12 percent cost of credit. The 13 cents estimated profit per gallon, factored into capital recovery, would yield about a 20–25-percent after-tax return on equity. Additional State subsidies would increase the rate of return.

[2] Return on equity.

Senator McGOVERN. I think we will go ahead and hear from each of the witnesses, and then we will have some questions.

Mr. Don Hertzmark is our next witness.

STATEMENT OF DONALD HERTZMARK, ECONOMIST, POLICY ANALYSIS BRANCH, SOLAR ENERGY RESEARCH INSTITUTE, GOLDEN, COLO.

Mr. HERTZMARK. Senator, I appreciate the opportunity to testify before the members of this subcommittee today on the subject of alcohol fuels.

The purpose of producing alcohol fuels from domestic sources is to reduce our overall use of conventional resources, especially imported crude oil and refined products. For this reason, it is important to have an analysis in which we are not blind to the important effects of the use of the fuels.

In our report [1] we have calculated the overall energy use of two agriculture and energy systems: One producing corn and fuel—that is, gasoline separately—and the other producing the products together. The results indicate that well-designed distilleries will show a net reduction in fossil energy use from conventional sources.

The assumptions here are conservative. We assume no use of renewable energy in the distillery itself. And yet a modern biomass food and fuel system will require 31 percent less energy to produce an array of products that is at least equivalent in value to that produced through conventional means. Each gallon of fuel alcohol produced with modern integrated techniques reduces gasoline diesel or equivalent natural gas

[1] See the report entitled "The Agricultural Sector Impacts of Making Ethanol From Grain," beginning on p. 16.

consumption by about six-tenths of a gallon. Using renewable resources at the distillery will give yet stronger results: Each gallon of fuel alcohol will reduce gasoline diesel or gas use by about 1 gallon. This means that an increase in overall production of food and feed can be accomplished while reducing conventional energy use.

It is entirely possible that a near-term production target of 1 billion gallons of ethanol annually—that is about 65,000 barrels a day—can replace 40,000 barrels of gasoline or light crude imports. As distilleries are built to run entirely on renewable resources, the replacement factor will rise to unity.

I would like to point out that we currently import about 170,000 barrels a day of gasoline, so that replacing about 40,000 barrels of that is a very significant factor in our balance of payments.

To compare ethanol to alternative liquid fuels, we have to look a the energy requirements of producing ethanol from agricultural sources versus other use for the energy that is needed to process ethanol. The issue is complicated by the array of products that can be attained from a modern ethanol distillery. The problem is quite similar to determining which refined petroleum products could be charged with the energy use of a refinery process. We don't stop to ask whether oil refineries produce a net energy output. The answer is obviously no. A fraction of the petroleum that is put into the refinery must be burned to provide the energy to separate the various fractions of crude. In fact, for every 100 gallons of gasoline that we use, at least 10 and as many as 20 gallons of oil or equivalent natural gas must be used in the refining. Again, this is shown in a table of our report.

The situation is much the same with synthetic fuels from both fossil and renewable sources. The production of fuel oil, gasoline, or methanol from coal all require that some of the energy in the coal be lost in the processing of the ultimate fuel—usually, 30 to 40 percent. When wood is processed to produce methanol, one of two alcohol fuels that can be derived from renewable resources, only 70 percent of the energy value of the wood is used, is fully transformed. This is roughly the same as for methanol from coal.

The reasoning carries over to ethanol derived from grain. Using available technologies and assuming that coal is used as the primary fuel in the distillery, obtaining ethanol from grain is at least as efficient in the use of coal as any fossil synthetic fuel that we can obtain using coal as our primary energy source.

Unlike fossil fuels, however, we recover other useful products, such as feeds and cooking oils from the production of grain alcohol. These joint products have value in human savings in ethanol energy for processing are great given the fact that process heat can come from renewable waste fuel.

Given the variety of useful byproducts that can be obtained from an ethanol distillery, it is incorrent to ascribe all of the processing energy in agricultural energy to the ethanol alone, as most studies have done. For example, a substantial amount of nitrogen fertilizer, a major energy input to corn, is required to produce a high-protein grain. It is impossible to have any kind of energy system that produces more energy than it consumes. Such schemes are in the realm of perpetual motion fantasies.

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What is entirely possible, however, is to upgrade low-quality energy resources to more useful and valuable forms. To do so requires the use of energy. The important issue is whether the production of alcohol fuels increases or decreases our use of liquid fossil fuels. And on this point, we can say that a modern fuel alcohol system will lead to an unambiguous reduction in the consumption of liquid fossil fuels.

I will address the economics of alcohol fuels now.

A second issue that has been raised with respect to alcohol fuels is that they are too costly at the present time. Too costly compared to what? Logically, this is how the situation should be viewed. Unfortunately, it seldom is. Given the multiple prices for both domestic and foreign crude oils, determining the actual costs of petroleum products is a confusing and often tricky business. The proper comparison for determining the desirability of using ethanol as a fuel is to compare its cost to the cost of other incremental resources: that is, imported oil or new domestic supplies of petroleum.

When we do this, we find that gasoline that is made from imported oil would carry a retail price of about $1.65 per gallon. Synthetic gasoline from coal is still more expensive. We can compare this to the cost of producing ethanol from corn.

At the Solar Energy Research Institute, we have analyzed the agricultural sector impact on the United States of producing alcohol fuels, and we have developed a range of wholesale prices for fuel ethanol at various production levels up to 1 billion gallons per year by 1983. That is equivalent to about 40 percent of our current gasoline imports.

A modest program of twice the current level of fuel ethanol production will result in wholesale ethanol prices of between 70 cents and $1.10 per gallon.

This compares to conservative estimates of $1.36 a gallon for gasoline from imported oil and significantly higher cost of synthetic gasoline from other feedstocks. A wide spread in the cost of ethanol produced from grain is due to the great differences in production costs for the traditional beverage techniques versus advanced technologies as continuous fermentation and vacuum distillation.

Different processes also yield different by-products, with the ones produced by the corn wet-milling techniques exceeding in value those of the beverage technique. Higher levels of alcohol production show a slight rise in the gross feedstock price; that is, the price of corn and a decline in the price of joint product feeds, distillers' grains, and glutmeal.

The lowest possible wholesale price for a 1-billion-gallon annual production level rises to about 75 cents per gallon for advanced technologies while the farm still cost increases to about $1.17 per gallon.

Several factors affect the price estimates given above. First, the use of spoiled grains as a feedstock will carry only the cost of disposal of the wet residues. Since agricultural prices have historically been more flexible both downward and upward than have other prices, it is possible to experience actual declines in feedstock prices.

A program of ethanol production more extensive than 1 or 2 billion gallons annually will require a part of the joint product feeds in diversification of our feedstock face. Because ethanol plants are much smaller than the proposed synthetic fuel plants that use coal as a feedstock, the leadtimes involved in planning and construction are far less. Existing expansion plans of ethanol show an increase of more than 100 percent over the next year.

This does not include the proliferation of small-scale stills, so that the actual rate of increase will likely be much larger than 100 percent.

A detailed report entitled "The Agricultural Sector Impacts of Making Ethanol From Grain" was written as a part of our biomass work at the Solar Energy Research Institute and is submitted for the record. We projected the short-term impacts of increased production of ethanol and its joint product feeds on the major agricultural aggregates, such as prices and farm incomes. Some of the results are summarized in a table of that report.

One: Prices of food and feeds are not affected adversely by ethanol production at levels below 1 billion gallons annually. Protein prices may even fall.

Two: Very high levels of alcohol production greater than 3 billion gallons a year annually require a diversified resource base and export of the joint product feeds.

Three: Export values for corn and soybeans remain stable and even increase slightly as alcohol production increases.

Four: Net farm income increases with ethanol production.

Five: Cotton and wheat production and prices are scarcely affected by alcohol production.

Six: Mild crop disturbances here and abroad should not affect the feasibility of ethanol production in the near future.

Seven: Carryover stocks of corn and soybeans are reduced in alcohol production scenarios. This increases the potential impact of violent disturbances in the agricultural sector in the absence of more aggressive reserve policies.

Often neglected in the light of strong support for ethanol are other biomass energy resources with equivalent energy production potential. Wood can be used for direct combustion, and it is also an excellent feedstock for gasification to methanol, ammonia or gas.

The technology of preparation, handling, and combustion has improved tremendously in recent years. Better management of small wood lots may allow farmers and other rural citizens additional income opportunities. In a similar way, technology for using straws and stokers has increased recently, too, so that they can compete with liquefied petroleum gas—LPG—in rural areas.

In summary, Senator, I do not wish to imply that alcohol fuels are a panacea for our Nation's diverse and complex energy problems. However, alcohol fuels from grains, wood, waste, and other renewable resources do afford an economically attractive opportunity in the near term to displace a significant amount of the energy we must now import from abroad.

The production technology for ethanol fuels is not perfect but it is quite efficient, both in terms of energy requirements and costs, when compared to other synthetic fuels and imported crude oil. Alcohol fuels from renewable resources fare quite well when compared to imported oil or synthetic fuels.

Senator, this concludes my testimony. I would welcome questions from members of the subcommittee.

Senator McGovern. Thank you very much, Mr. Hertzmark.

[The report entitled "The Agricultural Sector Impacts of Making Ethanol From Grain" follows:]

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THE AGRICULTURAL SECTOR IMPACTS OF MAKING ETHANOL FROM GRAIN

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NOTICE

FOREWORD

This report is the final one of a series of three on the agricultural impacts of making ethanol from grain. The previous two reports provided preliminary assessments of the issues and a detailed analysis of joint-product use. The Analysis and Applications Division of the Solar Energy Research Institute (SERI) is also sponsoring work on the direct combustion of crop residues and the cultivation of specialized energy crops. The authors wish to thank Bert Mason, Wallace Tyner, and Richard Carlson for their helpful comments.

Approved for:
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SECTION 1.0

INTRODUCTION

1.1 STATEMENT OF THE PROBLEM

The availability and cost of liquid fuels is currently the premier issue of energy policy. In this report, the role of renewable alcohol fuels as extenders of gasoline supplies in direct substitution for petroleum is considered. In addition, the potential for indirect substitution of other biomass fuels and chemicals is discussed. Questions associated with the conversion of grains to alcohol include the effects of grain diversions to ethanol on supplies and prices, the net energy output of the conversion process, and the impacts of the joint products from ethanol conversion on feed markets. In addition, the availability of land for energy crop production is briefly considered here. The work from which this report is derived represents ongoing research in the SERI biomass program.

Assuming that one of the more important goals of energy policy is a reduction in oil imports, then broader means of achieving that goal can be used than if the goal were simply to replace imported gasoline with domestic. This assumption shall serve as the statement of the problem.

One way to reduce petroleum imports is to use biomass fuels and chemicals more widely. This, however, may lead to other problems. First, the export of grain is the largest single contributor to the total value of U.S. exports. An energy policy leading to a net reduction in the value of agricultural exports would not alleviate the effect of reducing oil imports on the balance of trade since our ability to pay for oil would be reduced along with imports. A reduction in the export of grains by this country would encourage higher domestic prices for feedgrains. This translates into higher prices for beef, other meats, and wheat. An alternative to food price inflation is the possibility that large amounts of available feed joint products (distillers' grains and gluten meal) would depress the price of soybeans. This could distress the farming community, since one of the sources of popular support for producing ethanol from grain is the positive effect that farmers believe ethanol will have on grain prices.

Clearly, it is impossible for ethanol to cause both inflation and depression of agricultural prices simultaneously. The real issue concerns the agricultural system's adaptation to changes in relative quantities of corn, soybeans, and other products. The process of adaptation has three distinct components: (1) the impact of these changes on the domestic feedgrain market; (2) the impact on the high protein market; and (3) the effect of grain alcohol on the balance of agricultural trade and on the balance of energy trade. In this last area, the net energy issue assumes critical importance.

1.2 METHODOLOGY

Several different quantitative and analytical techniques were used to arrive at the results presented here. Standard econometric estimation techniques were used to establish the relationships of the ethanol feed joint products with the livestock markets and with other feeds. A detailed analysis of feeding ratios was presented in a previous companion report.* This information was put into the Agricultural Policy Simulator model (POLYSIM) to enhance the model's capability to handle large changes in the mix of products entering feed markets. The POLYSIM model is an aggregate simultaneous equation model of the agricultural sector of the U.S. economy. The driving force of the model is a supply and demand relationship for each of the crops included. This permits changes in the quantities and prices of the included crops to feed back on allocation of land and foreign sector demand. Government payments are also included in the model so that alternative types of subsidy programs can be considered. The major outputs of the model are farm income, crop prices, acreage of various crops, exports, total production, and retail meat prices.

In addition to modeling efforts, some of the standard apparatus of resource economics is used in the analysis of an optimal allocation of resources to ethanol production and to the highest value uses of that product.

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*Hartzmark, Gould. 1979. The Market for Ethanol Feed Joint Products. Golden, CO: Solar Energy Research Institute; Report No. RR-51-397.

SECTION 2.0

SUMMARY

This summary, concerns the major economic issues involved in the conversion of grain to alcohol. Again, these issues are net energy, feedstock costs and economics, joint-product markets, balance-of-trade impacts in food and energy, and the availability of land resources to grow feedstocks. This approach differs significantly from other analyses of ethanol economics and costs on assumptions about technology and market responses. As a result, conclusions presented here differ from those of many other reports on ethanol.

Perhaps the most significant difference between this analysis and that of previous studies concerns the feasibility of ethanol as an automotive fuel. The average price of gasoline in this country is currently $.65-.75 at the refinery gate, exclusive of taxes, dealer mark-up, and transportation (Oil and Gas Journal, Dec. 10, 1979). It is not average gasoline, however that is causing the havoc in our balance of payments. It is the marginal gasoline, both imported and domestic that is the true competition for ethanol as a fuel or feedstock. At a price of $30/bbl, the raw material cost alone of making unleaded gasoline from Libyan crude is about $.71/gal.* Adding tanker charges, refinery costs, and other charges, the refinery gate price of unleaded gasoline made from Libyan crude is $1.29/gal.** That, however, is not the true margin of petroleum production. Oil from domestic stripper wells has reached $31/bbl while the spot price of crude on international markets fluctuates from $45-50/bbl (Wall St. Journal, Oct. 16, 1979). At $45/bbl, the refinery gate price of unleaded gasoline comes to $1.65/gal. This implies a retail price in the neighborhood of $2.00/gal. for marginal gasoline. At the current price for corn, and using conventional technology, the cost of production of ethanol is about $1.10/gal. The wholesale price exceeds that by a wide margin because of the great demand for gasohol (OTA, 1979). If the alternative to ethanol is marginal gasoline from stripper wells, syncrude, or imports, then ethanol is less expensive.

Another point slighted in other work on ethanol is the question of substitution for petroleum via use in the petrochemical industry. Most petrochemical feedstocks come from the light fraction of the barrel. The current use of ethylene as a feedstock for synthetic ethanol production is a reversible reaction. That is, grain alcohol can be used for ethylene which in turn can be used in a multitude of chemical applications (Chemical Week, Jan. 31, 1979). The idea that the only way to replace imported oil used for liquid fuels is to obtain a direct substitute is misleading and not conducive to formulating good policies. For example, the total quantity of gasoline that can be made from imports from Iran at the past year's level is about 4.5 billion gal. per year (108 million bbl). Total imports from Iran were 196 million bbl per year, so that the remainder, mostly heavier fractions, were used for heating oil. A solar technology such as ethanol that replaces the lighter fraction of the Iranian crude will permit the U.S. to replace the total imports from a particular country by replacing only the gasoline or chemical fraction. This is because of the relative ease of replacing the heavier fractions with conservation, coal, and active or passive solar energy systems.

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*The value to be imputed to the gas-oil fraction is undoubtedly greater than $.71 ($.71 = $30.00 ÷ 42), the average cost of each gallon in the barrel. Due to difficulties in determining the correct value, we have opted for average figures.

**See Flaim (1978), updated to current prices.

Another area that has received a great deal of attention is the net energy production of ethanol relative to the fossil fuels used to produce the crop and to convert that crop to fuel and feed products. Using data derived from the whiskey distilling industry, some researchers have found that ethanol from grain is not a provider of net energy to the economy, for two reasons. First, the distillery is set up to use fuel oil (and not very efficiently). Second, almost all of the inputs to the growing of the crop itself are liquid or gaseous fossil fuels. Occasionally, the analysis is presented so that the energy content of the distillers' grain's joint product is counted along with the ethanol output. If this is done, a marginal net energy benefit may appear (U.S. DOE 1979). All of this discussion obscures several fundamental flaws in the use of the net energy argument as it has been framed with respect to alcohol fuels.

Since the same difficulty occurs in the analysis of markets for other products that are produced with ethanol, it is worth exploring the biomass refinery in some detail. A properly designed ethanol facility should be capable of turning out a variety of food, feed, and fuel products. These products include ethanol, gluten meal, cooking oil, distillers' grains, and (possibly) methane. Different grain feedstocks will yield different proportions of the various products. That is to say, by appropriate design of the processing plant and by proper purchasing of the feedstocks, the ethanol producer will have a variety of potential output mixes and associated costs. It is the job of the firm to allocate the fixed capital resources of the facility so that it can produce the various outputs at minimum cost. The analytics of this problem were presented in the appendix to an earlier paper (Hertzmark and Gould 1979). The results of that analysis show that the firm will achieve a maximum total return on the spectrum of products by achieving a minimum cost in the production of each one; i.e., by producing each product up to the point that the costs and the revenues are equal. This means that flexibility of the capital structure will be a paramount concern in a properly designed biomass refinery. The relevant economic question is identical to the relevant energy question: what is the most efficient means of producing <u>all</u> of the products that can come from this refinery? This question rearranges the usual net energy argument around the question of the final demands for potential outputs. If we ask about the most efficient means of producing all of the food, feed, and fuel products of the biomass refinery, then the answer will be far different than if we simply look at alcohol production and add in the energy value of the distillers' grains. The corn processing industry currently makes use of this type of fractionating of corn for sweetness, starch, and other products. The additional costs of a flexible plant all outweighed by its higher operating efficiencies.

Feed products and cooking oil have value because of properties—palatibility, usefulness for cooking, protein content—that are not denominated in energy units. It is germane to look at the energy requirements of producing these commodities by alternative means. But the Btu value of corn oil is by no means a clue to its value. The energy requirements of growing corn are of little help in determining its value as a feed. The most energy-intensive parts of the agronomic process come in the fertilizer requirements necessary for a high protein content in the grain. At the processing stage, there has not been a formal breakdown of the energy requirements of each of the processing steps for products other than alcohol. However, the one source that lists overall energy requirements shows that a well designed biomass refinery can be run almost entirely on waste heat from other processes within the plan or from the outside (Litterman et al. 1979; p. 27). This method of running the plant needs to be combined with two other factors. First, there is at least one distillation process that permits the coproduction of methane from the cellulose fraction of the corn grain. This quantity of methane is sufficient for about two-thirds of the process energy that is needed in vacuum distillation. Second, other biomass energy resources such as stover or residue may be used to fire boilers to cogenerate the various grades of energy needed in the refinery.

The last point introduces what is perhaps the most telling objection to net energy analysis as it has been applied to ethanol production. Energy is available in various grades from mechanical work to space heating. Simply stating the energy content of an item in Btus is an insufficient measure of its energy value. If, for example, the biomass refinery is capable of using waste heat from a power plant or an oil refinery for its process steam, and if this steam assists in producing a portable fuel capable of performing mechanical work, then the energy balance question is not meaningful. It is not considered irrational to take three units of energy from coal and transform it to one unit of electricity. Similarly, obtaining a high-quality fuel at the cost of low-grade energy does not seem an unreasonable trade-off.

Fortunately, current technologies for the conversion of grain to ethanol and other products do not need the energy quality argument to be justified on an energy production basis. According to data from the Chemapec Company, the vacuum distillation process requires only about one-fifth the energy input of the older, beverage process. Improvements upon this latter process have lowered the energy requirements of the beverage process to about the same level as the vacuum distillation method (Chambers et al. 1979).

As noted above, indirect substitution for petroleum by biomass might be more efficient than concentrating all of the biomass resources on the production of substitutes for gasoline. An analogous situation appears in the consideration of the markets for the feedstocks for alcohol production and in the markets for the joint feed products. Two detailed analyses of the economic impacts of converting corn to alcohol were performed as part of the preparation of this report and its companion on the feed market effects of gluten meal and distillers' grains (Hertzmark and Gould 1979; the POLYSIM model was used in the preparation of this report). The model used for this paper was the POLYSIM model developed by Oklahoma State University. It is a simultaneous equation, supply and demand model of the agricultural sector of the U.S. economy. After performing some econometric estimations of the price relationships of the joint products gluten meal and distillers' grains with other high protein feeds and with corn, we modified the POLYSIM model to reflect a changed composition of high protein feeds and other nutrient sources. The results stress the role of indirect substitution in feed markets. The primary focus was on the change in mix of commodities that might be precipitated by a large fuel alcohol program. Several sets of relationships are crucial to this analysis. The first concerns the corn-soybean acreage response to relative price changes in the two crops. Corn and soybeans are grown in rotation with one another in many parts of the country. Any tendency in the price of corn to rise because of the production of ethanol will be tempered by its increased value relative to soybeans. This leads to increased plantings of corn relative to soybeans. In addition, an increase in the price of corn and a fall in the price of soybeans will lead to higher exports of soybeans and lower exports of corn. A final mitigating factor will be the gluten and distillers' feed, which substitute for both corn and soybeans. The preservative of the protein content of the corn tends to shift the demand for digestible animal nutrients into forage crops. The implication of this indirect substitution is that several factors are operating that will tend to dampen the price impacts on both corn and soybeans of high levels of ethanol production (see Table 2-1). These factors are: (1) the changes in values of the joint product feeds as corn or soybean prices change; (2) the versatility of corn in a number of different uses; (3) the relative ease and speed of changing from one crop to another; and (4) the relative ease of substituting feed and meal products for one another in both domestic and export markets.

Several anomalies appear in Table 2-1. The first is the extreme price deterioration of distillers' grains and gluten meal at ethanol production levels, of more than 1 billion gal. yearly. One would expect export of these products to expand from current levels.

Soybean prices rise in spite of a fall in meal prices because of less acreage devoted to soybeans. The fall in meal prices will be attenuated if distillers' grains and gluten meal maintain their values through exports.

Table 2-1 PRICE EFFECTS OF ALTERNATIVE ETHANOL PROGRAMS ON SELECTED AGRICULTURAL SECTOR VARIABLES 1979-1983[a]

Variable	1979 Baseline	1983 Baseline	1983 Production (million gal./yr) 200	500	1,000	3,000
Corn						
price ($/bu)	2.48	2.47	2.50	2.53	2.59	2.74
acreage (m.ac)	69.63	75.88	75.99	76.16	76.45	77.62
exports (m.bu)	2,500.00	2,300.00	2,286.80	2,266.91	2,233.73	2,129.94
Soybeans						
price ($/bu)	6.76	7.05	7.06	7.07	7.08	7.14
acreage (m.ac)	73.42	67.54	67.44	67.28	67.04	66.02
exports (m.bu)	1,025.00	900.00	899.52	898.72	897.66	892.23
Gluten meal ($/ton)	110.26	119.41	113.32	103.78	87.79	24.09
Distillers' grains ($/ton)	122.62	132.80	125.68	114.50	95.79	21.22
Soybean meal						
price ($/ton)	185.06	200.42	197.74	193.74	187.01	160.34
exports (th.tons)	6,298.95	6,627.94	6,687.26	6,775.37	6,923.57	7,513.27
Export earnings						
Corn (M$)	6,200.00	5,681.00	5,717.00	5,735.28	5,785.36	5,836.04
Soybeans (M$)	8,094.67	7,673.37	7,672.95	7,666.61	7,650.21	7,575.20
Total (M$)	14,294.67	13,354.37	13,389.95	13,401.89	13,435.57	13,411.24
Government payments (M$)	1,727.47	1,481.87	1,479.51	1,475.93	1,469.86	1,377.54
Net farm income (M$)	31,890.25	32,732.63	33,020.63	33,456.94	34,201.94	37,360.06

[a]Source: POLYSIM

Table 2-2. ETHANOL COSTS FOR ALTERNATIVE SCENARIOS
($/gal.)

	1983 Production (million gal./yr)[a]			
	200	500	1,000	3,000[a]
Corn[b]	1.00	1.01	1.01	1.10
Credits				
Farm still[c]	.34	.34	.29	.06
Corn processor[d]	.55	.54	.51	.38
Fermentation & distillation[e]	.25-.45	.25-.45	.25-.45	.25-.45
Total[f]	.69-1.11	.72-1.12	.75-1.17	.98-1.50

[a]Considered unrealistic due to potentials for export of these commodities.

[b]Equivalent to corn at $2.49, 2.52, 2.58, 2.74/bu, respectively.

[c]Equivalent to distillers' grains at $.377, .343, .287, .064/gal. of alcohol.

[d]Equivalent to gluten meal at $.227, .208, .176, .048/gal. of alcohol and corn oil at $.336/gal.

[e].15/gal. is the cost for corn processors (vacuum distillation); .35/gal. for small-scale still.

[f]At low levels, the alcohol is essentially a by-product. This accounts for the low costs of alcohol at modest production levels.

SECTION 3.0

THE POLYSIM MODEL

3.1 DESCRIPTION

The National Agricultural Policy Simulator (POLYSIM) was initially developed by Daryll Ray at Oklahoma State University in 1972. James Richardson, Gregory Parvin, and Ray have since expanded and refined the model through cooperative agreements with the Commodity Economics Division, Economics Research Service, U.S. Department of Agriculture. Operational at Oklahoma State and in Washington, D.C., at the USDA, POLYSIM has been used extensively at both locations since 1974. The focus in Washington has been on analysis of current economic issues while the emphasis at Oklahoma State has been on longer term research.

3.1.1 Methodology

POLYSIM is a perturbation model specifically designed for analyzing the effects of alternative U.S. agricultural policies over a four-to-five year time span. The perturbations are computed around a set of baseline projections of commodity supplies, prices, and use made by the USDA. The baseline projections (usually for five years into the future) are made by commodity specialists using formal models tempered with their own experienced judgments. The projections contain explicit assumptions concerning the rates of change in population, per capita incomes, consumer preferences, export demand, technology (including crop yields and livestock gains), and other supply and demand shifters. These projections also assume a specific set of government farm programs. POLYSIM simulates the effects of policy specifications that differ from those assumed in the baseline. The model focuses on the interaction of supply and demand responses that result from specified changes in commodity prices that resulted in turn from changes in policy conditions, while holding all other supply and demand shifters equal.

Commodity supply and demand elasticities represent an important part of POLYSIM. The driving forces in the model are the initial and subsequent changes in commodity prices resulting from changes in policy conditions. The magnitude of impact is determined by direct and cross supply-and-demand elasticities.

The crop and livestock commodities included in the model are:

Crops	Livestock
Feed grains	Cattle and calves
Wheat	Hogs
Soybeans	Sheep and lambs
Cotton	Broilers and farm chickens
	Turkeys
	Eggs
	Milk

For each crop the model provides estimates of acreage, yield, production, variable production expenses, total supply, price, domestic demand, exports, carryover, cash receipts, and government payments. It also gives estimates of production, market price, and cash receipts for each of the seven livestock categories. Estimates for the various commodity variables are summed and added to exogenous data for commodities not included in the model to develop aggregate estimates of production expenses, government payments, gross income, and realized net farm income.

After the model has been set up with user-supplied information on the farm program and policy variables to be analyzed, it begins simulating for the first year by calculating production and prices for each of the seven livestock categories. The production calculations are based on percentage differences between the previous year's baseline and simulated values for the price of the product, feed grain price, and prices of competing products times the appropriate direct and cross supply elasticities. The next step is to use the production information and exogenous import and export demands to compute the amounts of livestock products available for domestic consumption. The percentage change in livestock product availability is then computed. By using farm-level direct and cross price flexibilities, the current year's price for each of the livestock categories can be estimated.

The model then begins calculations for the four crops in the crop sector. As indicated earlier, the harvested acreage for each crop is determined as a deviation from the baseline acreage, based on the percentage deviations in last year's market prices for crops from their baseline projections times the appropriate direct and cross elasticities. Yield and per-acre variable production expenses are calculated with similar equations. The total production for each crop is calculated directly as the product of the yield and harvested acreage. Total variable production expenses equal per acre expenses times the harvested acreages.

Crop prices are calculated using price flexibilities and the percentage change in crop supplies. Domestic and export demands depend upon the percentage change in prices and appropriate elasticities.

The final set of relationships in the model's simulation loop treat producer's costs, receipts, and income. Aggregate or national estimates are made for total receipts, total government payments, consumer expenditures for food, realized gross income, crop expenses, protein, feed, roughage, and nonfeed costs for livestock, total variable costs, total production costs, and realized net farm income.

3.1.2 Data Requirements

Baseline values must be available for the variables in POLYSIM. As indicated, the USDA periodically projects these values five years ahead. The necessary crop and livestock supply and demand response parameters or elasticities must be assembled for use in the model. The elasticities currently used in the model were developed in three stages. Initially, a comprehensive literature review was made to gather past estimates of the required elasticities. Secondly, many of the elasticities were reestimated, using more recent data. Finally, to make the model more useful to the USDA, ERS commodity specialists reviewed the estimates, which had been categorized by commodity groups. The final revised estimates are used as default values in the model, but users can change any of the elasticities if they have better or more recent information.

3.1.3 Uses

POLYSIM is tailored to analyze the agricultural, food cost, and government cost impacts of changes in agricultural policy instruments normally used in the United States. Analyses can be made for changes in some government variables: target prices and resulting deficiency payments, loan rates, alternative CCC buy-and-sell criteria, allotments, voluntary or mandatory set-aside acreages, per acre payment schedules for voluntary set-aside, program participation rates, and acreage or production quotas.

The effect of yield and export levels different from those in the baseline conditions can also be investigated. The policy, yield, and export levels may be changed for any one crop or combination of the four crops included in the model (feed grains, wheat, soybeans, and cotton). The model traces the effects of these changes through interrelated crop sectors, seven livestock sectors, and finally to national aggregates such as realized net farm income. The computer cost of making a simulation run is less than $2.00.

The validity of the model's results hinges on the accuracy of the baseline projections, or reference mode, used by POLYSIM, and on elasticity estimates. Both of these crucial information sets need critical evaluation and continual updating to ensure that POLYSIM draws on the best information available at each point in time.

As a descriptive model, POLYSIM cannot estimate optimum resource allocations for specific demand levels or productive capacity subject to resource constraints. Neither regional impacts nor estimates of price variations within a crop or calendar year are possible with the model. Although crop exports are endogenous, the world grain market is exogenous to the model. The model does not provide estimates of changes in farm size, farm numbers, or the organizational makeup of agriculture.

3.2 MODIFICATIONS OF THE POLYSIM MODEL FOR ETHANOL IMPACT ANALYSIS

Two specific changes were made in the POLYSIM model to account for the diversion of some corn to ethanol. The purpose of the first of these changes was to account for the removal of a sufficient quantity of corn to achieve the level of ethanol production given in each run. The second was a modification of the high protein feed sector. We assumed that each bushel of corn would make 2.5 gal. of ethanol, a conservative assumption since some other sources give the production coefficient as 2.6 or even 2.7 gal./bu (U.S. DOE 1979). Note that this is a differential of 5-10% in the amount of corn required for a certain level of ethanol production and that such a production differential would result in a decrease of an equal proportion in the joint-product feeds. As a result, the impact figures given in subsequent sections of this paper may err more on the side of overstatement than of understatement.

In a previous paper, impacts were reported on animal feed markets of a large increase in the availability of two feed products—gluten meal and distillers' grains (DDG)—that are produced along with ethanol (see Hertzmark and Gould 1979). Similar analytical techniques were used to modify the POLYSIM model in order to enhance the degree of detail on the feed market impacts of joint products. Two different estimating equations were used to obtain the cross-elasticity and price flexibility coefficients of distillers' grains and gluten meal with each other and with such other feeds as corn, soybeans, and oilseed meals. Demand elasticities for the distillers' grains and gluten meal were obtained by using the following price flexibility equations:

$$P_{DDG} = 41.3 - 1.25 \text{ (total byproduct feeds*)} + 1.28\, P_{\text{gluten meal}}$$

$$P_{\text{gluten meal}} = -13.76 - .0013 \text{ (byproduct feeds**)} + .749\, P_{DDG}$$

The arc elasticities that were obtained from the flexibility coefficients are given as:***

η (DDG, total by-products) = -.37
η (DDG, gluten meal) = .98
η (gluten meal, by-products) = -.0004
η (gluten meal, DDG) = .95

It is interesting to note that the theoretical requirement that $\eta_{xy} = \eta_{yx}$ is met for DDG and gluten meal to a high approximation. The equations that were used in POLYSIM used flexibility coefficients instead of elasticities.

Modifications were effected through changes in the types of feeds that would be necessary to satisfy the protein demands in the livestock sector. A series of demand functions for high-protein feeds was used in this part of the model so that the quantity of the protein feeds demanded and the prices of these feeds would be determined endogenously. The alternative would have been to have the demand imposed upon the model, simply parameterizing the prices of the feeds as would be done in a linear framework.

It was assumed that 50 percent of the alcohol produced would use the process that yields the distillers' grains joint-product. The other half of the alcohol would be produced using the wet milling process that yields gluten meal and cooking oil. As with the production coefficients for alcohol production, this analysis erred on the conservative side, since no export of the joint feed products was assumed. This has the effect of overstating the depressing effect of these feeds on the entire protein market as the high demand elasticities for exports of protein feeds would act as moderators of potential price declines of these products.

The supply equation for the distillers' grains and for the gluten meal were of the fixed coefficient type. As shown in a previous paper (Hertzmark and Gould), actual decision making by firms engaged in alcohol production could mimic closely the operation of the stylized multiproduct firm (presented in the appendix of that paper). Until there are more data on the actual production-possibilities that face the alcohol producer, it may be preferable to use fixed coefficients.

One of the unique features of POLYSIM is its ability to perform stochastic analysis. In this feature of the model, such variables as export demand and domestic grain yield are

*Includes soybean meal.

**Excludes soybean meal.

***The cross elasticity of demand is given by the formula:

$$\eta_{x,y} = \frac{\Delta q_x \, P_y}{\Delta P_y \, q_x}$$

allowed to vary randomly. From these variations, a frequency distribution for each of the endogenous variables in the model is obtained. Here, information about the effects on the agricultural sector of such stochastic variation was needed, when there exists a steady and inflexible demand for corn by the fuel industry. The results of this exercise will be given along with the other model results in the following sections.

SECTION 4.0

ANALYSIS AND RESULTS

4.1 FEEDSTOCK AND JOINT-PRODUCT ECONOMICS

4.1.1 The Biomass Refinery Concept

The biomass refinery concept was used in the previous section in the discussion of the net energy issue. Two main assumptions are implied by this framework. The first is that the various food, feed, and fuel outputs may be produced according to variable proportions rather than fixed proportions. The firms can respond to changes in input or output prices by altering the feedstocks and/or the products of the refinery. The usual fixed proportions model used in some other analyses (e.g., Litterman et al. 1979; U.S. DOE 1979; Tyne and Bottums 1979) is derived from the beverage industry where there is only one output that is of serious economic interest to the producing firm. It is easily shown that a highly specialized piece of capital equipment is more technically efficient than one which is flexible in terms of either inputs or outputs (Fuss and McFadden 1978; Chap. II. 4). The crucial economic questions are (1) whether receipts from a broader range of outputs can compensate for higher costs, and (2) whether higher capital costs will be matched by commensurate reductions in feedstock costs due to flexibility. In the present case, it turns out that continuous fermentation and vacuum distillation is actually less expensive than batch fermentation/atmospheric distillation since the higher capital costs of the forms are more than compensated by increased production rates (Biomass Refining Newsletter Winter 1979).

The second assumption is that future technological change on the processing side should be incorporated into these plants. The most important technology affected by this assumption is acid or enzymatic hydrolysis of cellulosic feedstocks. A properly designed ethanol facility should be able to adapt to this technology or to other cellulose conversion technologies when they become more cost competitive. The other major technological improvement that we may expect in the near future is the coupling of ethanol plants with biomass or coal gasification facilities. This latter technology will produce methanol and ammonia in a highly exothermic (heat liberating) reaction that should be sufficient to provide the process heat for a sizable ethanol distillery (Reed 1979).

A firm that has a single capital plant with which to produce a variety of products from several variable inputs will allocate these fixed resources to produce a given bundle of products at minimum cost. The analytical aspects of this situation have been given in detail in the appendix to an earlier report (Hertzmark and Gould 1979). The conclusions of that analysis carry the following implications for the biomass refinery:

1. The ability to refine alternative inputs to a common output is crucial to the economic efficiency of the refinery.
2. The switching costs that are involved in going from one input mix to another or from one set of outputs to another must be minimized in design as much as the variable and fixed costs. There will often be a trade-off between minimizing fixed costs and minimizing the switching costs (Fuss and Mcfadden 1978; 311-64).
3. The firm needs to make estimates of the demand curves for all of its potential products.

4.1.2 Feedgrains Markets

In a truly efficient market, price information is all that is necessary to properly allocate the grains and proteins to their proper uses. The POLYSIM model contains no nonprice information such as nutritional constraints. The supply and demand equations for the various grains and protein products include own prices as well as prices of other complements or substitutes. The demand and supply functions used are implicitly the results of consumer or producer optimization so that they may be fairly said to represent the end product of the sort of optimization procedure that was used in the feed simulation report.

The linear program procedure that was used to get least-cost livestock rations for the inclusion of ethanol joint products is a type widely used in the livestock industry. It is, therefore, precisely the type of nonprice information upon which economic supply and demand functions are based.* This means that the microeconomic results from the linear programming simulation should be consistent with the results of POLYSIM if, indeed, the optimization procedure used at the microeconomic level is valid. In a sense, then, the section of the model that dealt with the interconnections of feedgrains and proteins served to validate the previous microeconomic technique.

The operation of the model in the feedgrains sector is designed to capture the price, quantity, and acreage effects of alternative ethanol programs on the variables reported as part of the model. One of the more important assumptions of the model is that the production of ethanol would be divided into two basic technologies. The first is a variant of the beverage industry technique that leads to the production of 2.5 gal. of ethanol plus 18 lb of stillage (distillers' grains) from each bushel of corn. The second production technique is one that is more common to the food industry. The corn is preseparated into oil, gluten meal, and fermentable starch. This process gives the same yield of alcohol per bushel of corn but gives 3 lb of oil plus 10 lb of gluten meal. A further variation on this latter technique utilizes the fiber portion of the corn kernel as a feedstock for the production of methane.

We assumed that the production of alcohol would be evenly divided between the process that provides the distillers' grain joint product and the one that provides the gluten meal plus oil joint products. The latter technique is superior from both a technical and economic standpoint.** Unfortunately, it does not seem well suited to the small scale of on-farm production that we expect to supply a considerable portion of the ethanol. Unlike distillers' grains, gluten meal is low in fiber and already has a place in export markets.

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*The model alluded to is a cost minimization model of the form

$$\min_{x} \quad C'X$$
$$\text{s.t.} \quad A'x \geq B,$$

where c is a cost vector, A is a matrix of feed characteristics, and b is a vector of nutritional and growth constraints.

**This means that the corn processor technique is less expensive at almost all input price combinations than the beverage technique. The only exception would be one in which achieving high flow rates in the distillery was considered of small importance while energy inputs were virtually free.

Unfortunately, the authors were unable to model the effect of exporting gluten meal since foreign demand functions for the product were note available. For this reason, the estimated impacts of large ethanol production will tend to overstate the price deterioration of gluten meal and distillers' grains from what might exist with the export of the products.

The POLYSIM model accounts for changes that will take place in the corn market from the diversion of grain to alcohol production and from the addition of the joint product feeds to the protein market. Using the supply/demand relationships for corn, soybeans, protein, and land on which to grow the corn, the model simulates the decisions of farmers to plant corn, soybeans, wheat, or other crops in response to changes in the price parameters. The equations in the model relevant to determining the results on the corn market are the change in the exogenous demand for corn, additional supplies of concentrated protein, the foreign demand for corn and soybeans, and the availability of land suitable for growing additional corn. Other things being equal, an exogenous increase in the demand for corn should cause an unambiguous and sharp increase in its price.

There are, however, two demand functions for corn that are relevant for our purposes. The first is the domestic demand which has the expected, inelastic properties (see Table 4-2). The second is the foreign demand, which is much more elastic in both the short and long runs. The relatively higher foreign elasticity and the effects of time in general in increasing the elasticity of the demand curve that producers face will serve to moderate potential increases in corn prices.* In the long run, both domestic and international consumers of corn are more easily able to adjust either their livestock rations or the actual numbers of livestock in response to changes in feedgrain prices. The increase in corn prices that would accompany greater production of alcohol will thus tend to be moderated by changes in the demand for corn by other consumers. Foreign demand will have a good deal of weight in the price determination process since relatively small increases in the price of corn would trigger relatively large shifts in the quantity demanded. Since corn contains a considerable amount of protein, its value is dependent not only on its caloric content but also on the value of protein at any given time. This, in turn, depends on the conditions that prevail in the soybean market and in the market for soybean meal and similar products. A large supply of high-protein products will tend to depress the value of protein per se as an animal feed. In cost minimizing livestock rations, this will induce a greater use of these products and a fall in the demand for unprocessed grain as a feed. The remainder of the nutrition for the animals can then be obtained from a variety of low quality sources such as hay, stover, or other similar products. The supply for corn relates not only to the price of corn but to the prices of alternative products that compete for the same land base. If corn increases relative to other potential uses of the land, then there will be an increase in land used for corn. In supply-demand interaction the lags associated with changing land uses plus higher elasticities in the long run will damper demand and will reduce the overall increase in corn acreage from what one might expect on the basis of short-run price changes alone.

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*This is accomplished through a distributed lag of the form

$$D(Pt) = \eta_{sr} P_{t-1} + \lambda \eta_{lr} P_{t-z} + \cdots$$

where the t subscripts indicate time, p is price, and λ is a weighting factor for the lagged long-run elasticity.

Table 4.10 COMPARATIVE ENERGY USE FOR CONVENTIONAL AND BIOMASS REFINERY SYSTEMS

Conventional System	1000 Btu	Biomass Refinery	1000 Btu
Agricultural Energy		Agricultural Energy	
Corn (1 bu)	184	Corn (1 bu)	184.0
		Hay (17 lb)[a]	81.3
Gasoline (2 gal)[b]			
content	250		
Processing	50	Ethanol (2.5 gal.)[c,d]	120–370
Total	484	Total	385–735

Source: Chambers et al. 1979, p. 791; Pimintel et al. 1975, p. 755.

[a]According to Hertzmark and Gould (1979, p. 38) at a 10% dietary penetration, each pound of DDG in a dairy ration will replace about 1 lb of corn grain and require an additional 1 lb of alfalfa hay.

[b]Assume 1 gal. of ethanol is equivalent to .81 gal. of gasoline. This figure accounts for both the lower energy content and higher combustion efficiency of ethanol vis-a-vis gasoline. Thus, as a liquid fuel, ethanol has an energy content equivalent to 101,688 Btu/gal. (See Carlson et al. 1979; Chambers et al. 1979).

[c]The lower figure is the process energy requirement for a modern plant. The latter figure is for a beverage plant.

[d]This figure overstates the energy use of the biomass refinery relative to the conventional system since no processing of the corn is assumed for the conventional system.

√ Table 4.2. SELECTED PRICE ELASTICITIES USED IN POLYSIM

Elasticity	Short-run	Long-run
Own Prices		
Corn (domestic)	-0.420	-0.840
Corn (export)	-0.500	-2.500
Soybeans (domestic)	-0.350	-1.029
Soybeans (export)	-0.565	-2.850
Soybean meal (domestic)	-0.560	-1.647
Soybean meal (export)	-0.570	-2.900
Cross Price[a]		
Corn/soybean meal (domestic)	0.060	0.120
Grain sorghum/corn (domestic)	0.150	0.300
Distillers' grains/total byproducts	-0.370	
Guten meal/DDG	0.950	
Acreage		
Corn/own price	0.150	0.454
Corn/soybean price	-0.090	-0.273
Corn/wheat price (t-1)	-0.020	-0.061
Corn/grain sorghum price	-0.030	-0.091
Soybeans/own price	0.250	0.750
Soybeans/corn price	-0.150	-0.454
Soybeans/wheat price	-0.020	-0.061
Soybeans/cotton price	-0.030	-0.150

Source: taken from POLYSIM

[a]assume $\eta_{x,y} = \eta_{y,x}$

The substitutions just described, both direct and indirect, serve to moderate the impacts of ethanol production on the price of corn. The substitution of joint product feeds or of other high-protein products for the protein fraction of the corn and for soybean meal serves to minimize the additional land that is required even when large amounts of corn are used in alcohol production.

Another major area of concern is the effect on the soybean market. Logically, one would be hard-pressed to maintain that producing ethanol from corn would greatly increase the price of corn and depress the price of soybeans and meal simultaneously when considering the agricultural economy as a whole. There are two good reasons why this is not possible. The first is that a considerable portion of the value of corn results from the protein contained therein. Second, corn and soybeans are grown on much of the same land throughout the Midwest. Any dramatic changes in the ratio of corn to soybean prices would be mitigated by shifts out of soybeans and into corn. This will obviously slow the increases in the price of corn at the same time that it reduced the fall in soybean prices. As with the corn market, the export market for soybeans and soybean meal shows a considerably more elastic demand than does the domestic market. This allows relatively small declines in the price of soybeans to be translated into large increases in exports of both beans and meal.

4.2 ANALYSIS RESULTS

Results of the previous analysis generally follow the reasoning presented there, although some elaboration on the meaning of these results may be called for. The simulations ran from 1979-1983, inclusive, incorporating production levels of 200, 350, 500, 750, 1,000, and 3,000 million gal./yr by 1983. In each case, the build-up in alcohol production followed a steady, arithmetic progression starting with the current year. Throughout the simulations, an even split between distillers' grains and gluten meal was assumed. The stochastic runs are reported separately since analysis of those results will differ greatly from the analysis of the deterministic runs. As a caveat, we should note that these results are not intended to be perfectly accurate or predictive in a quantitive sense. Rather, they are expected to be accurate as to both the direction and the relative magnitude of the changes that alcohol production will bring to the agricultural sector.

One problem that exists in performing simulations during an inflationary era is the proper way to account for this effect. The POLYSIM model is run on a current dollar basis. Unfortunately, during a period of inflation it is very difficult to interpret the meaning of small changes in prices. This problem, known as the signal extraction problem, has been the object of some attention in recent years (see any recent advanced macroeconomic text—e.g., Dornbusch and Fischer 1978, Chap. 16). In a real world inflationary situation, small price changes may be simply the result of inflation or of expected inflation (transmitted via the futures market in grains). Minor variations in demand and supply also cause some "noise" that is difficult to interpret—e.g., is a 5% increase in the price of corn today the result of random factors, relative price increases, or simply general inflation? To answer this question one would need a variance components model, not part of the current research.* We should expect, therefore, that adjustment in the real world to a structural change in the grain markets will not be as smooth as is depicted in the POLYSIM results. What the results do indicate is that, in general, the degree to which alcohol production will be able to upset grain and protein markets is minimal. Under conditions of uncertainty, this means that a relatively small portion of the variation in grain price over the next few years can be attributed to increased alcohol production.

Looking at the model results, note that an exogenous trend of increasing demand for food and feed has been imposed on the model. This exogenous trend comes from three sources. The first is continued population and income growth in Europe and the U.S. The second is a growing list of countries whose tastes have recently come to far exceed their agricultural production capacities (e.g., Venezuela, Iran, Mexico). Lastly, as an increasing proportion of potential cropland is put under the plow, susceptibility to drought and pests requires a substantial reserve of grains. The set-aside program, then, disappears entirely. This eliminates one of the more widely touted policy alternatives to encourage the production of biomass for energy (OTA 1979, iv-v). Table 4-3 shows the summary of the exogenous trend in feed and protein demand on the other variables in the model. The most important figure in the output is that for real net farm income. This figure indicates a relative decline in the share of agriculture in overall national income if an annual growth rate of real income of 2.5% is considered the norm for the coming decade. Since this income is to be spread over an ever-decreasing number of farmers, the per-capita income in agriculture should rise at a rate faster than 0.5%. However, this figure goes a long way to explain the interest of farmers in a proposal such as ethanol that promises to raise farm income.

As Table 4-3 shows, the overall demand for protein in the livestock sector grows at an annual rate of 1.5%, and the larger part of that increase is taken up by the increased demand for soybean meal. The international demand for protein for feed has declined from record 1979 levels. This reduces the quantities of corn and soybeans entering international trade annually by 1.7% and 2.6%, respectively. Much of the decline in raw soybean exports can be accounted for by the rise in exports of soybean meal. Additional processing within this country can be considered a benefit, since it will provide the multiplier impacts that are normally associated with increases in domestic employment and economic activity. One major aspect of the development of U.S. agriculture over the next five years will be a clear and continuous reduction in government deficiency payments to agriculture if existing programs are maintained.** This primarily results from increases in wheat and soybean prices. Soybeans become a relatively less desirable crop to grow since corn, which can be grown on the same land, is often more profitable for farmers to grow.

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*A variance components model combines cross section and time series data such that each error vector $u_i = \delta_i + \delta_t = \varepsilon_{it}$,

where δ_i is random with respect to (wrt) i (cross sections);
δ_t is random wrt time series; and
ε_{it} is completely random.

**The impacts of the embargo on sales of grain to the U.S.S.R. may change existing programs. The extent to which support programs change will depend in large measure on whether the U.S.S.R. reduces its net grain imports. If it does not, then U.S. sales to other nations should increase as simple substitution of contracts occurs.

Table 4.3 GROWTH OF SELECTED VARIABLES IN POLYSIM (Baseline Case)

Variable	Annual Growth Rate (%)
Demands	
Soybean meal feed demand	2.1
Total protein demand	1.5
Corn feed demand	1.3
Exports	
Soybeans	-2.6
Soybean meal	1.0
Corn	-1.7
Prices	
Corn gluten meal	1.6
Distillers' grains	1.6
Soybean meal	1.6
Soybeans	0.8
Corn	-0.05
Wheat	1.2
Receipts and Income	
Soybean cash receipts	2.3
Corn cash receipts	2.0
Total deficiency payments	-2.9
Net farm income	0.5
Harvested Acres	
Wheat	-0.02
Soybean	-1.7
Corn	1.7
Quantities	
Gluten meal	0.8
Distillers' grains	0.9
Cottonseed meal	-1.3

Table 4-4 shows the results of the same exercise performed for the five ethanol scenarios. The rate of growth is calculated in comparison with the base year (the first year of production). For the two low-production scenarios (350 and 500 million gallons per year by 1983), this method yields approximately accurate results. The higher production scenarios require that the initial year's production be far higher than the current level in order to have a steady linear growth trend in alcohol output. It would not be appropriate to compare the base year of one scenario with the final year of another since much of the activity of the model concerns the change from short-run to long-run impacts and elasticities. One way of getting around this difficulty would be to put in exponential growth in alcohol production. This modification will be made in subsequent uses of the model during the coming year. Results conform generally to what one would expect. The rates of growth of demand for soybean meal and corn fall relative to the baseline case, while total protein demand is enhanced. The additional gluten meal and distillers' grains are sufficient to remove the upward price trend of those two products. In addition, the growth rate of soybean meal price is reduced because of increased availability of substitutes. The income picture for farmers is enhanced primarily through the substitution of corn for soybeans on some additional acres relative to the baseline projections.

At higher alcohol production levels, the changes in growth trends identified above intensify. The demands for corn and soybeans fall off sharply while the growth rate of protein demand doubles. The trend in exports of soybeans is largely unaffected while soybean meal exports rise sharply. Exports of corn fall at a faster rate with increased ethanol production. What is essentially a minor relative price decline at the 350 and 500 million gal. levels becomes a severe deterioration at the 3,000 million gal. production level. What the table indicates is that up to 1,000 million gal. can be produced annually without seriously depreciating the value of the feed joint products. At higher production levels, there appears to be a need to promote and account for the export of at least some of these products. At 3,000 million gal. and above, export of joint products in quantities sufficient to halt the rate of decline in the price would cut into the export market for soybean meal. This would induce additional releases of soybean acres to corn in an attempt to mitigate the relative price decrease of the soybean meal. Up to the 3,000 million gal. production level, there does not appear to be any significant land use impact. At the highest level included in the simulations, the acreage of wheat falls slightly, relative to the baseline, while the rate of increase in corn acreage rises at a 25% higher level than in the baseline. Almost all of the additional acreage for the corn crop comes directly from soybean production. For at least the foreseeable future, there is apparently no need to use agricultural policy to increase the supply of land available to energy production.

The growth rates given in Tables 4-3 and 4-4 are calculated from the data that are presented in Tables 4-5 to 4-9. In considering the material presented in these tables, it is useful to note that only two quantitatively significant changes occur in the high-production scenarios. The first is that the shift away from soybeans is accelerated. The second is that the fall in government payments is accelerated over the baseline case. Both of these developments may be considered benefits of the production of alcohol; the former because it allows farmers to substitute the relatively more profitable corn crop for soybeans, and the latter because the increased income of farmers does not come at the expense of government support programs.

According to the biomass refinery concept, the cost minimizing alcohol producer would not tolerate the type of joint-product deterioration that seems to accompany higher production levels. The behavioral conditions that we have imposed on potential alcohol

Table 4.4. GROWTH OF SELECTED VARIABLES IN POLYSIM ALCOHOL SCENARIOS

	Annual Growth Rate (%) 1979-1983				
	Alcohol Production (M. gal./yr by 1983)				
Variable	350[a,f]	500[b,f]	750[c,g]	1000[d,g]	3000[d,g]
Demands					
Soybean meal	1.9	1.8	1.7	1.5	0.3
Total protein	1.8	1.9	2.1	2.3	3.7
Corn	1.0	0.9	0.8	0.6	-0.7
Exports					
Soybeans	-2.6	-2.6	-2.6	-2.7	-2.8
Soybean meal	1.3	1.4	1.6	1.8	3.2
Corn	-1.8	-1.9	-2.0	-2.1	-2.7
Prices					
Corn gluten meal	0.06	-0.6	-1.9	-3.4	-26.5
Distillers' grains	0.05	-0.8	-2.2	-3.7	-30.9
Soybean meal	1.2	1.0	0.7	0.4	-2.2
Soybeans	0.9	0.9	0.9	0.9	1.1
Corn	0.2	0.2	0.4	0.5	1.0
Wheat	1.2	1.2	1.2	1.3	1.4
Receipts and Income					
Soybean cash receipts	2.3	2.2	2.2	2.2	2.1
Corn cash receipts	2.4	2.5	2.8	3.0	4.7
Total deficiency payments	-3.0	-3.0	-3.1	-3.2	-3.7
Net farm income	0.8	1.0	1.2	1.4	3.2
Harvested Acres					
Wheat	-0.03	-0.04	-0.04	-0.05	-0.1
Soybeans	-1.7	-1.7	-1.8	-1.8	-2.1
Corn	1.8	1.8	1.8	1.9	2.2
Quantities					
Gluten meal	3.9	5.1	6.7	8.2	15.5
Distillers' grains	13.5	16.1	19.1	21.1	27.2
Cottonseed meal	-1.3	-1.3	-1.3	-1.3	-1.3

[a]1979 production = 70 million gal.

[b]1979 production = 100 million gal.

[c]1979 production = 150 million gal.

[d]1979 production = 200 million gal.

[e]1979 production = 600 million gal.

[f]Approximate range of current annual production.

[g]The growth rates in these scenarios are too low (in absolute value) since the baseline against which they are computed was not achieved this year. This implies exponential growth to achieve the 1983 production level.

producers imply two actions that they would take in order to arrest or reverse the declining value of the feed joint products. The first and most obvious is an attempt to expand the market for these products. Gluten meal is currently exported in small quantities by the United States (Agricultural Statistics 1978; p. 37). This program could be expanded with the net result that demand for the product could rise. With the distillers' grains joint product of small-scale operations, the solution to the devaluation of the stillage would involve either drying and "export" to some other consuming area within the United States or the processing of spoiled grains. In the latter situation, the protein value of the grain is virtually nil, so that the grain has a low or nonexistent market value.

The second alternative for the distillers' grains producers points to the nature of the overall solution to devalued feed products. If producers diversify the feedstocks that are used in the biomass refinery, the type of situation that appears at higher production levels should not occur. Potential alternative feedstocks for alcohol production include sugar crops, sorghum grain, potatoes, small grains, and waste products from food processing and agricultural production (e.g., cull potatoes or spoiled grain). A flexible approach to the choice of feedstocks should obviate the danger ofdevaluation of the joint products. In fact, if only the larger producers were to adopt this approach, the cross price effects on smaller producers might be sufficient to prevent a decline in the value of the distillers' grains.

The final class of results has to do with the availability of additional land for either energy or food production. As it was originally posed, the land availability issue had two parts. The first was the issue of releasing land currently in set-aside or land-retirement programs. This would make available as much as 5-10 million additional acres. The second issue involves the use of various types of marginal land for crops. It was originally proposed (see, e.g., Calvin 1979) that this land be used for growing such energy crops as Jerusalem artichokes, jojoba, guaule, and sugar crops. There are some sound theoretical and practical reasons for considering this use of marginal land to be implausible in the near future and, in some cases, for the foreseeable future.* An exhaustive study of physical land availability for additional crops was done by the USDA (Diderickson et al. 1977). This study classified potential cropland by the type of disability. Not surprisingly, most of the land that is not now in crops would require some type of capital investments in order to be brought into annual crop production. Many disabilities, such as slope, erosion, aridity, and stoniness, leave the lands in question unsuited for row crop production and intensive cultivation. Repair of one or more of these land limitations so the land can be used as an energy plantation would be both capital and energy intensive. It appears unlikely that intensive cultivation of much marginal land solely for energy purposes would be feasible with current technology. As a final point, we should note that intensive cultivation of high-cost land would create rents for the owners of better quality land, thereby driving up the cost of good agricultural land still further.**

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*Marginal land, by definition, has some deficiency that makes unit production costs for agricultural crops higher than on other, higher quality, land. One of the most serious of these production factors is that higher unit costs imply greater energy use (for irrigation or for cultivation) per unit of output. Since the concept of energy crop cultivation is in its relative infancy, studies of input/output characteristics of alternative systems should be performed as an initial feasibility test.

**The cost of production of a given crop on marginal land is the extensive margin of cultivation. The capitalized value of the greater (and lower cost) production on higher quality lands represents a rent to the owners of that land. The greater the unit cost differential between marginal and good cropland, the higher will be the prices of good land. Policies that strongly encourage cultivation of marginal lands will serve to widen this gap further.

Table 4-5. BASELINE (BSLN) AND SIMULATION (SIML) DATA FOR 200 MILLION GALLONS ANNUALLY BY 1983

	1979		1980		1981		1982		1983	
50% DDG	BSLN	SIML	BSLN	SIML	BSLN	SIML	BSLN	SIML	BSLN	SIML
Chng alcohol prd M. gal.	0	40.000	0	80.000	0	120.000	0	160.000	0	200.000
In terms of corn M. bu	0	16.000	~~80.000~~ 0	32.000	0	48.000	0	64.000	0	80.000
Corn set-aside M. ac	2.900	2.900	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Corn gltn th. tns	1,500.000	1,540.000	1,510.000	1,590.000	1,520.000	1,640.000	1,545.000	1,705.000	1,560.000	1,760.000
DDG th. tns	420.000	492.000	425.000	569.000	430.000	646.000	435.000	723.000	440.000	800.000
Cotsd meal th. tns	2,276.666	2,276.666	1,901.189	1,900.883	1,958.130	1,957.793	2,013.212	2,012.931	2,138.402	2,138.138
Prices										
Corn gltn price $/tn	110.261	109.212	112.338	110.080	117.760	114.074	120.466	115.481	119.411	113.328
DDG price $/tn	122.624	121.395	124.933	122.290	130.964	126.649	133.972	128.138	132.799	125.679
Soyb meal price $/tn	185.064	184.696	188.549	187.649	197.051	196.196	202.192	200.089	200.421	197.742
Soybean price $/bu	6.755	6.755	7.196	7.199	7.632	7.636	7.011	7.015	7.050	7.055
Corn price $/bu	2.475	2.484	2.597	2.609	2.450	2.407	2.448	2.468	2.469	2.493
Wheat price $/bu	3.233	3.234	3.434	3.435	3.266	3.268	3.414	3.416	3.425	3.428
Demands										
Soyb meal fd d th. tns	17,997.039	17,973.395	18,027.898	18,154.660	18,193.316	18,118.172	19,143.812	19,035.613	19,981.559	19,841.902
Nonsbm by-pd fed M. tns	20.010	20.122	20.933	21.156	21.897	22.233	21.168	21.616	20.991	21.551
Tot pro demand M. tns	38.007	38.096	39.141	39.311	40.090	40.351	40.312	40.651	40.972	41.392
Inc. in by-pd fed M. tns	0.0	0.112	0.0	0.224	0.0	0.336	0.0	0.448	0.0	0.560
Corn feed demand M. bu	4,200.00	4,193.301	4,299.092	4,286.547	4,399.096	4,378.633	4,449.992	4,420.508	4,474.957	4,437.734
Wheat feed demand M. bu	154.807	154.983	130.212	130.492	129.748	130.159	127.477	128.002	124.891	125.522
Exports										
Soybean exports M. bu	1,025.000	1,025.070	950.000	949.766	930.000	929.652	910.000	909.609	900.000	899.522
Corn exports M. bu	2,500.000	2,495.613	2,200.000	2,194.048	2,280.000	2,271.308	2,300.000	2,288.927	2,300.000	2,286.796
Soyb meal exp M. bu	6,298.945	6,306.309	6,230.523	6,249.133	6,187.082	6,216.910	6,427.000	6,470.742	6,627.941	6,687.262

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Table 4-5. BASELINE (BSLN) AND SIMULATION (SIML) DATA (concluded)

50% DDG	1979 BSLN	1979 SIML	1980 BSLN	1980 SIML	1981 BSLN	1981 SIML	1982 1983 BSLN	SIML	BSLN	SIML
Harvested Acres										
Wheat har acres M. ac	66.600	66.600	67.334	67.329	65.695	65.685	64.570	64.557	66.519	66.501
Soybean har acres M. ac	73.420	73.420	68.912	68.808	67.320	67.264	68.509	68.428	67.540	67.437
Corn har acres M. ac	69.630	69.030	72.133	72.171	74.280	74.340	75.235	75.325	75.878	75.993
Cotton har acres M. ac	13.163	13.163	10.844	10.842	11.010	11.008	11.124	11.122	11.593	11.591
Receipts and Income										
Soybean cash rec M$	13,008.859	13,005.953	14,218.328	14,214.055	14,771.250	14,788.078	14,880.387	14,881.145	14,569.203	14,561.074
Corn cash receipts M$	9,892.867	9,909.621	10,867.363	10,917.172	11,075.609	11,153.348	10,881.852	10,986.809	10,955.074	11,086.734
Total crop cash rec M$	56,541.191	56,557.838	60,067.387	60,117.121	61,596.141	61,674.605	62,698.477	62,804.551	63,461.230	63,593.277
Total live cash rec M$	65,691.937	65,691.937	67,817.750	67,894.437	72,392.750	72,488.062	74,606.312	74,810.437	76,691.125	78,806.002
Tot liv & crop rec M$	484.999	484.999	489.998	488.098	497.362	497.371	506.364	506.384	516.686	516.719
Corn deficiency pay M$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total def payments M$	572.068	570.905	713.748	712.480	810.009	808.725	470.811	468.274	495.878	493.510
Total govt payments M$	1,727.470	1,726.303	2,178.578	2,177.313	1,623.740	1,619.556	1,255.319	1,252.781	1,481.872	1,479.510
Net farm income M$	31,890.250	31,882.375	33,394.500	33,503.812	35,199.562	35,340.625	33,853.500	34,082.250	32,732.625	33,020.625

Table 4-6. BASELINE (BSLN) AND SIMULATION (SIML) DATA FOR 350 MILLION GALLONS ANNUALLY BY 1983

50% DDG	1979 BSLN	1979 SIML	1980 BSLN	1980 SIML	1981 BSLN	1981 SIML	1982 BSLN	1982 SIML	1983 BSLN	1983 SIML
Chug alcohol prd M. gal.	0	70.000	0	140.000	0	210.000	0	280.000	0	350.000
In terms of corn M. bu	0	28.000	0	56.000	0	84.000	0	112.000	0	140.000
Corn set-aside M. ac	2.900	2.900	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Corn gltn th. tns	1,500.000	1,570.000	1,510.000	1,650.000	1,520.000	1,730.000	1,545.000	1,825.000	1,560.000	1,910.000
DDG th. tns	420.000	546.000	425.000	677.000	430.000	808.000	435.000	939.000	440.000	1,070.000
Cotsd meal th. tns	2,276.666	2,276.606	1,901.189	1,900.655	1,958.130	1,957.546	2,013.212	2,012.674	2,138.402	2,137.844
Prices										
Corn gltn price $/tn	110.261	108.212	112.338	108.161	117.760	111.062	120.466	111.478	119.411	108.547
DDG price $/tn	122.624	120.225	124.933	120.045	130.964	123.123	133.972	123.453	132.709	120.084
Soyb meal price $/tn	185.064	184.412	188.549	186.045	197.651	195.054	202.192	198.514	200.421	195.727
Soybean price $/bu	6.755	6.754	7.196	7.202	7.632	7.640	7.011	7.018	7.050	7.059
Corn price $/bu	2.475	2.491	2.597	2.618	2.450	2.470	2.448	2.483	2.469	2.510
Wheat price $/bu	3.233	3.234	3.434	3.436	3.266	3.269	3.414	3.418	3.425	3.430
Demands										
Soyb meal fd d th. tns	17,097.039	17,955.535	18,207.898	18,114.582	18,193.316	18,062.809	10,143.812	18,956.602	19,081.559	19,736.539
Nonsbm by-pd fed M. tns	20.010	20.206	20.933	21.324	21.897	22.485	21.168	21.951	20.991	21.970
Tot pro demand M. tns	38.007	38.162	39.141	39.439	40.090	40.547	40.312	40.908	40.972	41.707
Inc. in by-pd fed M. tns	0.0	0.196	0.0	0.391	0.0	0.587	0.0	0.783	0.0	0.979
Corn feed demand M. bu	4,200.000	4,188.250	4,299.992	4,276.305	4,399.996	4,362.434	4,449.992	4,398.309	4,474.957	4,409.590
Wheat feed demand M. bu	154.807	155,113	130.212	130.700	129.748	130.462	127.477	128.391	124.891	125.989
Exports										
Soybean exports M. bu	1,025.000	1,025.124	950.000	949.602	930.000	929.403	910.000	909.326	900.000	899.184
Corn exports M. bu	2,500.000	2,492.305	2,200.000	2,189.526	2,280.000	2,264.750	2,300.000	2,280.607	2,300.000	2,276.845
Soyb meal exp M. bu	6,298.945	6,311.789	6,230.523	6,263.031	6,187.082	6,239.578	6,427.000	6,504.160	6,627.941	6,731.371

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Table 4-6. BASELINE (BSLN) AND SIMULATION (SIML) DATA (concluded)

50% DDG	1979		1980		1981		1982		1983	
	BSLN	SIML	BSLN	SIML	BSLN	SIML	BSLN	SIML	BSLN	SIML
Harvested Acres										
Wheat har acres M. ac	66.600	66.600	67.334	67.325	65.695	65.677	64.570	64.547	66.519	66.488
Soybean har acres M. ac	73.420	73.420	68.912	68.837	67.320	67.223	68.509	68.309	67.540	67.300
Corn har acres M. ac	69.630	69.630	72.133	72.199	74.280	74.385	75.235	75.392	75.878	76.079
Cotton har acres M. ac	13.163	13.163	10.844	10.841	11.010	11.006	11.124	11.121	11.593	11.589
Receipts and Income										
Soybean cash rec M$	13,006.859	13,005.309	14,216.328	14,212.523	14,771.250	14,766.043	14,886.387	14,877.359	14,589.262	14,654.805
Corn cash receipts M$	9,892.867	9,922.055	10,867.363	10,954.078	11,075.609	11,210.891	10,881.852	11,064.777	10,955.074	11,184.637
Total crop cash rec M$	56,541.191	56,570.187	60,067.387	60,154.078	01,596.141	61,732.934	62,698.477	62,883.359	63,401.230	63,691.215
Total live cash rec M$	65,691.937	65,691.937	67,817.750	67,951.437	72,392.750	72,558.250	74,686.312	74,916.937	78,601.125	76,005.750
Tot liv & crop rec M$	484.999	484.999	489.998	489.998	497.362	497.379	506.364	500.400	516.688	516.746
Corn deficiency pay M$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total def payments M$	572.068	570.131	713.746	711.601	810.009	803.856	470.811	466.397	495.878	491.698
Total govt payments M$	1,727.470	1,725.533	2,178.578	2,176.433	1,623.740	1,616.487	1,255.319	1,250.905	1,481.873	1,477.692
Net farm income M$	31,890.250	31,877.250	33,394.500	33,587.312	35,199.562	35,458.812	33,853.500	34,253.312	32,732.625	33,237.037

Table 4-7. BASELINE (BSLN) AND SIMULATION (SIML) DATA FOR 500 MILLION GALLONS ANNUALLY BY 1983

50% DDG	1979 BSLN	1979 SIML	1980 BSLN	1980 SIML	1981 BSLN	1981 SIML	1982 BSLN	1982 SIML	1903 BSLN	1903 SIML
Chng alcohol prd M. gal.	0.0	100.000	0	200.000	0	300.000	0	400.000	0	500.000
In terms of corn M. bu	0.0	40.000	0	80.000	0	120.000	0	160.000	0	200.000
Corn set-aside M. ac	2.900	2.900	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Corn gltn th. tns	1,500.000	1,600.000	1,510.000	1,710.000	1,520.000	1,820.000	1,545.000	1,945.000	1,560.000	2,060.000
DDG th. tns	420.000	600.000	425.000	785.000	430.000	970.000	435.000	1,155.000	440.000	1,340.000
Cotsd meal th. tns	2,276.666	2,276.666	1,901.189	1,900.423	1,958.130	1,957.274	2,013.212	2,012.407	2,138.402	2,137.663
Prices										
Corn gltn price $/tn	110.261	107.209	112.338	106.241	117.760	108.054	120.466	107.495	119.411	103.775
DDG price $/tn	122.624	119.051	124.933	117.797	130.964	119.603	133.972	118.700	132.799	114.497
Soyb meal price $/tn	185.064	184.114	188.549	186.244	197.651	193.945	202.192	196.941	200.421	193.735
Soybean price $/bu	6.755	6.753	7.196	7.204	7.632	7.643	7.011	7.011	7.055	7.065
Corn price $/bu	2.475	2.497	2.597	2.627	2.450	2.491	2.448	2.498	2.469	2.528
Wheat price $/bu	3.233	3.234	3.434	3.436	3.266	3.270	3.414	3.420	3.425	3.432
Demands										
Soyb meal fd d th. tns	17,997.039	17,937.395	18,207.898	18,075.508	18,193.316	18,007.305	19,143.812	18,876.379	10,981.559	19,630.824
Nonsbm by-pd fed M. tns	20.010	20.290	20.933	21.492	21.897	22.736	21.168	22.287	20.991	22.390
Tot pro demand M. tns	38.007	38.228	39.141	39.567	40.090	40.744	40.312	41.164	40.972	42.021
Inc. in by-pd fed M. tns	0.0	0.280	0.0	0.559	0.0	0.839	0.0	1.119	0.0	1.399
Corn feed demand M. bu	4,200.000	4,183.199	4,209.992	4,266.141	4,399.996	4,346.148	4,449.992	4,376.098	4,474.957	4,381.477
Wheat feed demand M. bu	154.807	155.244	130.212	130.909	129.748	130.765	127.477	128.779	124.891	126.457
Exports										
Soybean exports M. bu	1,025.000	1,025.179	950.000	949.438	930.000	929.153	910.000	909.046	900.000	898.715
Corn exports M. bu	2,500.000	2,489.014	2,200.000	2,185.046	2,280.000	2,258.144	2,300.000	2,272.320	2,300.000	2,266.905
Soyb meal exp M. bu	6,298.945	6,317.168	6,230.523	6,277.289	6,187.082	6,262.176	6,427.000	6,537.113	6,627.941	6,775.367

Table 4-7. BASELINE (BSLN) AND SIMULATION (SIML) DATA (concluded)

50% DDG	1979		1980		1981		1982		1983	
	BSLN	SIML	BSLN	SIML	BSLN	SIML	BSLN	SIML	BSLN	SIML
Harvested Acres										
Wheat har acres M. ac	66.600	66.600	67.334	67.321	65.695	65.670	64.570	64.537	66.510	66.475
Soybean har acres M. ac	73.420	73.420	68.912	68.806	67.320	67.181	68.509	68.310	67.540	67.284
Corn har acres M. ac	69.630	69.630	72.133	72.227	74.260	74.430	75.235	75.459	75.878	76.164
Cotton har acres M. ac	13.163	13.163	10.844	10.840	11.010	11.005	11.124	11.119	11.593	11.587
Receipts and Income										
Soybean cash rec M$	13,006.859	13,004.711	14,216.328	14,210.965	14,771.250	14,763.727	14,886.387	14,873.359	14,569.262	14,550.355
Corn cash receipts M$	9,892.867	9,934.547	10,867.363	10,991.230	11,075.009	11,268.574	10,881.852	11,142.465	10,955.074	11,282.625
Total crop cash rec M$	56,541.191	58,582.672	60,067.387	60,191.301	61,596.141	61,791.199	62,608.477	62,961.833	63,461.230	63,701.152
Total live cash rec M$	65,601.937	65,601.937	67,817.750	68,008.687	72,392.750	72,629.000	74,666.312	75,022.187	76,691.125	77,124.562
Tot liv & crop rec M$	484.999	484.909	489.998	489.998	497.362	497.386	506.304	506.417	516.686	516.774
Corn deficiency pay M$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total def payments M$	572.068	569.299	713.746	710.673	810.909	800.525	470.811	464.417	495.878	469.936
Total govt payments M$	1,727.470	1,724.701	2,178.578	2,175.505	1,623.740	1,613.356	1,255.319	1,248.924	1,481.872	1,475.929
Net farm income M$	31,890.250	31,872.687	33,394.500	33,671.000	35,199.562	35,571.365	33,853.500	34,424.187	32,732.625	33,456.937

Table 4-8. BASELINE (BSLN) AND SIMULATION (SIML) DATA FOR 750 MILLION GALLONS ANNUALLY BY 1983

	1979		1980		1981		1982		1983	
50% DDG	BSLN	SIML	BSLN	SIML	BSLN	SIML	BSLN	SIML	BSLN	SIML
Chng alcohol prd M. gal.	0	150.000	0	300.000	0	450.000	0	600.000	0	750.000
In terms of corn M. bu	0	60.000	0	120.000	0	180.000	0	240.000	0	300.000
Corn set-aside M. ac	2.900	2.900	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Corn gltn th. tns	1,500.000	1,650.000	1,510.000	1,810.000	1,520.000	1,970.000	1,545.000	2,145.000	1,560.000	2,310.000
DDG th. tns	420.000	690.000	425.000	965.000	430.000	1,240.000	435.000	1,515.000	440.000	1,789.999
Cotsd meal th. tns	2,276.666	2,276.666	1,901.189	1,900.038	1,058.130	1,056.825	2,013.212	2,012.071	2,138.402	2,137.260
Prices										
Corn gltn price $/tn	110.261	105.540	112.388	103.037	117.760	103.055	120.468	100.877	119.411	95.794
DDG price $/tn	122.264	117.098	124.933	114.047	130.964	113.752	133.972	111.044	132.709	105.157
Soyb meal price $/tn	185.064	183.642	188.549	185.118	197.651	192.136	202.192	194.334	200.421	190.410
Soybean price $/bu	6.755	6.752	7.196	7.208	7.632	7.648	7.011	7.027	7.050	7.072
Corn price $/bu	2.475	2.508	2.597	2.642	2.450	2.511	2.448	2.522	2.409	2.558
Wheat price $/bu	3.233	3.235	3.434	3.438	3.260	3.272	3.414	3.423	3.425	3.436
Demands										
Soyb meal fd d th. tns	17,997.039	17,907.629	18,207.898	18,009.464	18,193.316	17,913.832	19,143.812	18,741.336	19,981.559	19,455.770
Nonsbm by-pd fed M. tns	20.010	20.430	20.933	21.771	21.897	23.156	21.168	22.847	20.991	23.090
Tot pro demand M. tns	38.007	38.338	39.141	39.781	40.090	41.070	40.312	41.588	40.972	42.545
Inc. in by-pd fed M. tns	0.0	0.420	0.0	0.839	0.0	1.259	0.0	1.679	0.0	2.099
Corn feed demand M. bu	4,200.000	4,174.824	4,299.992	4,249.109	4,399.996	4,319.210	4,449.992	4,339.086	4,474.057	4,334.676
Wheat feed demand M. bu	154.807	155.464	130.212	131.257	129.748	131.270	127.477	120.429	124.891	127.237
Exports										
Soybean exports M. bu	1,025.000	1,025.268	950.000	949.147	930.000	928.732	910.000	908.578	900.000	898.071
Corn exports M. bu	2,500.000	2,483.535	2,200.000	2,177.494	2,280.000	2,247.219	2,300.000	2,258.417	2,300.000	2,250.312
Soyb meal exp M. bu	6,298.945	6,326.305	6,230.523	6,300.746	6,187.082	6,299.406	6,427.000	6,591.660	6,627.941	6,849.227

Table 4-8. BASELINE (BSLN) AND SIMULATION (SIML) DATA (concluded)

50% DDG	1979		1980		1981		1982		1983	
	BSLN	SIML	BSLN	SIML	BSLN	SIML	BSLN	SIML	BSLN	SIML
Harvested Acres										
Wheat har acres M. ac	66.600	66.600	67.334	67.314	65.695	65.657	64.570	64.521	66.519	66.453
Soybean har acres M. ac	73.420	73.420	68.912	68.752	67.320	67.112	68.509	68.211	67.540	67.156
Corn har acres M. ac	69.630	69.630	72.133	72.275	74.280	74.505	75.235	75.570	75.878	76.307
Cotton har acres M. ac	13.163	13.163	10.844	10.837	11.010	11.002	11.124	11.116	11.593	11.584
Receipts and Income										
Soybean cash rec M$	13,006.859	13,003.633	14,216.328	14,208.164	14,771.250	14,758.605	14,888.387	14,866.508	14,569.202	14,548.600
Corn cash receipts M$	9,892.867	9,955.539	10,867.363	11,053.258	11,075.609	11,364.809	10,881.852	11,272.957	10,855.074	11,447.340
Total crop cash rec M$	58,541.191	58,603.629	60,087.387	60,253.359	61,596.141	61,888.203	62,698.477	63,003.316	63,481.230	63,956.707
Total live cash rec M$	65,691.937	65,691.937	67,817.750	68,104.750	72,392.750	72,745.750	74,066.312	75,107.750	76,691.125	77,340.375
Tot liv & crop rec M$	484.999	484.999	489.998	489.998	497.362	497.399	506.364	506.445	516.686	516.819
Corn deficiency pay M$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total def payments M$	572.068	567.788	713.746	709.073	810.909	795.303	470.811	461.238	495.878	486.066
Total govt payments M$	1,727.470	1,723.190	2,178.578	2,173.905	1,623.740	1,608.134	1,255.319	1,245.746	1,481.872	1,472.959
Net farm income M$	31,890.250	31,803.875	33,394.500	33,810.625	35,199.582	35,757.125	33,853.500	34,711.562	32,732.625	33,826.500

Table 4-9. BASELINE (BSLN) AND SIMULATION (SIML) DATA FOR 1,000 MILLION GALLONS ANNUALLY BY 1983

	1979		1980		1981		1982		1983	
50% DDG	BSLN	SIML	BSLN	SIML	BSLN	SIML	BSLN	SIML	BSLN	SIML
Chng alcohol prd M. gal.	0	200.000	0	400.000	0	600.000	0	800.000	0	1000.000
In terms of corn M. bu	0	80.000	0	160.000	0	240.000	0	320.000	0	400.000
Corn set-aside M. ac	2.900	2.900	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Corn gltn th. tns	1,500.000	1,700.000	1,510.000	1,910.000	1,520.000	2,120.000	1,545.000	2,345.000	1,560.000	2,560.000
DDG th. tns	420.000	780.000	425.000	1,145.000	430.000	1,510.000	435.000	1,875.000	440.000	2,239.999
Cotsd meal th. tns	2,276.666	2,276.666	1,901.189	1,899.657	1,958.130	1,956.371	2,013.212	2,011.690	2,138.402	2,136.775
Prices										
Corn gltn price $/tn	110.261	103.877	112.338	99.848	117.760	98.046	120.466	94.257	119.411	87.790
DDG price $/tn	122.624	115.151	124.933	110.314	130.964	107.888	133.972	103.295	132.709	95.788
Soyb meal price $/tn	185.084	183.171	188.549	183.957	197.651	190.274	202.192	119.722	200.421	187.008
Soybean price $/bu	6.755	6.751	7.196	7.212	7.632	7.653	7.011	7.035	7.050	7.076
Corn price $/bu	2.475	2.519	2.597	2.657	2.450	2.532	2.448	2.547	2.469	2.588
Wheat price $/bu	3.233	3.235	3.434	3.439	3.266	3.274	3.414	3.425	3.425	3.439
Demands										
Soyb meal fd d th. tns	17,997.039	17,887.887	18,207.898	17,942.824	18,193.316	17,821.512	19,143.812	18,605.719	19,981.559	19,282.363
Nonsbm by-pd fed M. tns	20.010	20.570	20.933	22.051	21.897	23.575	21.168	23.406	20.991	23.789
Tot pro demand M. tns	38.007	38.448	39.141	39.994	40.090	41.397	40.312	42.012	40.972	43.072
Inc. in by-pd fed M. tns	0.0	0.560	0.0	1.118	0.0	1.678	0.0	2.238	0.0	2.798
Corn feed demand M. bu	4,200.000	4,166.414	4,299.992	4,232.137	4,309.996	4,292.176	4,449.992	4,302.098	4,474.957	4,287.715
Wheat feed demand M. bu	154.807	155.682	130.212	131.605	129.748	131.776	127.477	130.076	124.891	128.017
Exports										
Soybean exports M. bu	1,025.000	1,025.356	950.000	948.870	930.000	928.309	910.000	907.006	900.000	897.656
Corn exports M. bu	2,500.000	2,478.028	2,200.000	2,169.995	2,280.000	2,236.245	2,300.000	2,244.594	2,300.000	2,233.728
Soyb meal exp M. bu	6,298.045	6,335.445	6,230.523	6,323.957	6,187.082	6,337.270	6427.000	6,645.984	6,627.941	6,923.574

Table 4-9. BASELINE (BSLN) AND SIMULATION (SIML) DATA (concluded)

50% DDG	1979 BSLN	1979 SIML	1980 BSLN	1980 SIML	1981 BSLN	1981 SIML	1982 BSLN	1982 SIML	1983 BSLN	1983 SIML
Harvested Acres										
Wheat har acres M. ac	66.600	66.600	67.334	67.307	65.605	65.645	64.570	64.505	66.519	66.431
Soybean har acres M. ac	73.420	73.420	68.912	68.699	67.320	67.043	68.509	68.113	67.540	67.036
Corn har acres M. ac	69.630	69.630	72.133	72.322	74.280	74.560	75.235	75.681	75.878	76.447
Cotton har acres M. ac	13.163	13.163	10.844	10.835	11.010	10.999	11.124	11.113	11.503	11.580
Receipts and Income										
Soybean cash rec M$	13,006.859	13,002.543	14,218.328	14,205.523	14,771.250	14,755.898	14,886.387	14,862.914	14,569.262	14,531.523
Corn cash receipts M$	9,892.867	9,976.324	10,867.363	11,115.195	11,075.609	11,461.502	10,881.852	11,403.797	10,955.074	11,612.309
Total crop cash rec M$	56,541.191	56,624.277	60,067.387	60,315.322	61,598.141	61,986.031	62,698.477	63,228.363	63,461.230	64,123.066
Total live cash rec M$	65,691.937	65,691.937	67,817.750	68,199.812	72,392.750	72,862.875	74,666.312	75,373.500	76,001.125	77,553.625
Tot lv & crop rec M$	484.999	484.999	489.998	489.098	497.362	497.411	506.364	506.474	516.686	516.864
Corn deficiency pay M$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total def payments M$	572.068	566.454	713.746	707.540	810.009	790.115	470.811	458.075	495.878	483.864
Total govt payments M$	1,727.470	1,721.857	2,178.578	2,172.372	1,823.740	1,802.946	1,255.310	1,242.583	1,481.872	1,469.857
Net farm income M$	31,890.250	31,855.500	33,394.500	33,951.125	35,109.582	35,047.875	33,853.500	35,007.062	32,732.625	34,201.937

Table 4-10. BASELINE (BSLN) AND SIMULATION (SIML) DATA FOR 3,000 MILLION GALLONS ANNUALLY BY 1983

50% DDG	1979		1980		1981		1982		1983	
	BSLN	SIML	BSLN	SIML	BSLN	SIML	BSLN	SIML	BSLN	SIML
Chng alcohol prd M. gal.	0	600.000	0	1200.000	0	1800.000	0	2400.000	0	3000.000
In terms of corn M. bu	0	240.000	0	480.000	0	720.000	0	960.000	0	1200.000
Corn set-aside M. ac	2.900	2.900	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Corn gltn th. tns	1,500.000	2,100.000	1,510.000	2,710.000	1,520.000	3,319.999	1,545.000	3,945.000	1,560.000	4,560.000
DDG th. tns	420.000	1,500.000	425.000	2,585.000	430.000	3,670.000	435.000	4,754.996	440.000	5,839.996
Cotsd meal th. tns	2,276.666	2,276.666	1,901.189	1,896.592	1,958.130	1,954.066	2,013.212	2,006.339	2,138.402	2,132.907
Prices										
Corn gltn price $/tn	110.261	90.518	112.338	74.294	117.760	57.586	120.466	41.874	119.411	24.085
DDG price $/tn	122.624	90.514	124.933	60.404	130.964	60.531	133.972	41.984	132.799	21.224
Soyb meal price $/tn	185.064	179.402	188.549	174.813	197.651	175.575	202.192	170.648	200.421	160.344
Soybean price $/bu	6.755	6.743	7.196	7.244	7.632	7.676	7.011	7.113	7.050	7.135
Corn price $/bu	2.475	2.606	2.597	2.748	2.450	2.743	2.448	2.747	2.469	2.741
Wheat price $/bu	3.233	3.238	3.434	3.447	3.266	3.289	3.414	3.450	3.425	3.468
Demands										
Soyb meal fd d th. tns	17,997.039	17,639.973	18,207.898	17,411.984	18,193.316	17,103.203	19,143.812	17,489.687	19,981.550	17,877.437
Nonsbm by-pd fed M. tns	20.010	21.690	20.933	24.288	21.897	26.933	21.168	27.881	20.991	29.385
Tot pro demand M. tns	38.007	39.330	39.141	41.700	40.090	44.036	40.312	45.371	40.972	47.263
Inc. in by-pd fed M. tns	0.0	1.680	0.0	3.355	0.0	5.036	0.0	6.713	0.0	8.394
Corn feed demand M. bu	4,200.000	4,099.266	4,299.992	4,112.261	4,399.996	4,045.426	4,449.992	3,983.548	4,474.957	3,949.558
Wheat feed demand M. bu	154.807	157.432	130.212	133.922	129.748	136.470	127.477	135.593	124.891	133.110
Exports										
Soybean exports M. bu	1,025.000	1,026.069	950.000	946.601	930.000	926.314	910.000	901.807	900.000	892.229
Corn exports M. bu	2,500.000	2,434.083	2,200.000	2,119.924	2,280.000	2,125.000	2,300.000	2,127.401	2,300.000	2,129.941
Soyb meal exp M. bu	6,298.945	6,408.582	6,230.523	6,510.586	6,187.082	6,635.820	6,427.000	7,086.898	6,627.941	7,513.270

Table 4-10. BASELINE (BSLN) AND SIMULATION (SIML) DATA (concluded)

50% DDG	1979		1980		1981		1982		1983	
	BSLN	SIML	BSLN	SIML	BSLN	SIML	BSLN	SIML	BSLN	SIML
Harvested Acres										
Wheat har acres M. ac	66.600	66.600	67.334	67.254	65.695	65.504	64.570	64.353	68.519	68.236
Soybean har acres M. ac	73.420	73.420	68.912	68.273	67.320	66.812	68.509	67.112	67.540	66.025
Corn har acres M. ac	69.630	69.630	72.133	72.700	74.260	75.049	75.235	76.763	75.878	77.617
Cotton har acres M. ac	13.163	13.163	10.844	10.817	11.010	10.983	11.124	11.070	11.593	11.549
Receipts and Income										
Soybean cash rec M$	13,006.859	12,893.875	14,216.328	14,183.473	14,771.250	14,718.922	14,886.387	14,815.086	14,569.282	14,466.539
Corn cash receipts M$	9,892.867	10,143.371	10,367.363	11,553.102	11,075.809	12,250.105	10,881.852	12,508.059	10,955.074	12,837.527
Total crop cash rec M$	56,541.191	56,700.629	60,067.387	60,750.785	61,696.141	62,777.066	62,698.477	64,440.766	63,461.230	65,365.809
Total live cash rec M$	65,691.937	65,691.937	67,817.750	68,958.562	72,392.750	73,518.000	74,606.312	77,274.375	76,601.125	79,148.000
Tot liv & crop rec M$	484.909	484.909	489.998	489.998	497.382	497.516	500.364	506.656	516.686	517.271
Corn deficiency pay M$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total def payments M$	572.068	555.147	713.746	607.119	810.909	747.364	470.811	420.995	495.878	462.112
Total govt payments M$	1,727.470	1,710.550	2,178.578	2,139.638	1,623.740	1,528.031	1,255.319	1,177.430	1,481.872	1,377.535
Net farm income M$	31,890.250	31,705.375	33,394.500	35,115.687	35,119.562	37,058.687	33,853.600	38,136.312	32,732.625	37,360.062

The more likely alternative for the marginal potential croplands is that they will be used to grow forage crops. Such crops as alfalfa hay can be grown under a wide variety of soil and climate conditions. The cultivational requirements may be tailored to suit the expected yield in a particular area so that the crop may return the best achievable rate of return for the farmer. Contrasting this to the rigid requirements of many row crops, it appears that the forage crop option would make more sense economically for both the farmer and for the economy as a whole. The results of the simulations for this paper and for the previous one clearly show that there are benefits to flexibility in an agricultural system. These benefits are difficult or impossible to quantify in any straightforward sense. However, the stochastic simulations presented in the next section will provide some insight into the economic benefits of flexibility.

With respect to the quantitative significance of the ethanol-induced price increase for corn, it is useful to note that the normal spread between spot prices and one-year contracts for corn is several times greater than the ethanol-induced increases in corn prices in the low production scenario. And even in the highest production scenario, the price differential attributable to ethanol is less than the one-year spot market-future market price differential. The normal approach to an analytical comparison of alternative policies is the with-and-without test—i.e., to look at the relevant variables with the project under way and to look at them again, disregarding the project. The figures of merit to compare in this case are the baseline and simulation figures for the final year of the model runs, 1983. For soybean and wheat prices, we find the baseline and simulation figures that are scarcely different from one another regardless of the level of alcohol output. For corn, the result is an increase of about 11% in 1983 for the 3,000 million gal. figure versus the baseline figure. The most dramatic impacts show up in the protein market figures. Under a maximum alcohol production scenario, the price of gluten meal declines by 80% over the 1983 baseline price. Distillers' grains show an 84% decrease while soybean meal falls by 20% over the baseline price. Given the unlikelihood of achieving such a large production figure over a short period of time, and considering the options available to producers that were not included in the model, we feel that the drastic impacts indicated by this scenario are unlikely.

Export values of corn and soybeans remain approximately constant throughout the baseline and alcohol production scenarios. The quantity of corn exported declines by as much as 7.4% over the baseline case, while soybeans remain approximately constant. The inelasticity of the demand curve for corn is sufficient to increase the total revenues from corn exports in each scenario. Revenues from soybean exports increase slightly. The most dramatic effect is the increase in exports of soybean meal (up to 13% higher in the 3 billion gal. scenario). The demand for soybean meal is more elastic than for either soybeans or corn. Since the short-run demand is still inelastic, total revenue falls.

On the income side, the increase in corn prices relative to wheat and soybeans provides an inducement for farmers to grow more corn. In the high production scenario, this shows up as an increase of 17% for corn cash receipts in the scenario versus the baseline level for 1983. Net farm income increases by about 14% in the high production scenario.

A look at these same variables for the 1,000 million gal. scenario reveals much less dramatic impacts with respect to the baseline case. Gluten meal and distillers' grains prices declined by 26% and 28%, respectively. Soybean meal falls by 7% and corn prices rise by 5%. The income effects are also less dramatic. Corn cash receipts increase by 6% , while farm income in general rises by about 5%.

In the lower production scenarios, the impacts of the additional ethanol production, though evident, would in all likelihood be at or below the limit of statistical detection. The vast majority of the price or income changes are below 5%. The amount of corn that would be diverted to ethanol production in the low production scenarios is much less than the normal yearly fluctuations that result from planting decisions, weather, and random variations in demand.

Figures 4-1 to 4-14 display the same information as Tables 4-5 to 4-10.

4.3 STOCHASTIC RESULTS

The results of the POLYSIM model when crop yields are allowed to vary randomly are presented in this section. One of the questions that often surround the use of agriculture as a source of liquid energy is the problem of the unpredictability of yields, both in this country and abroad. The prospect of a large part of the U.S. energy supply being dependent on the vagaries of harvest figures here and abroad is disquieting to those who remember the upset to the domestic food economy that was occasioned by the Russian wheat deal, the loss of the Peruvian anchovy, and sharp fluctuations in domestic corn yields in the period 1971-73. To help determine the extent to which alcohol could be a futher destabilizing factor in the agricultural sector, a series of simulation runs around the 500 million gal. scenario were designed that would provide this information. The stochastic runs generated 300 different values for the yield data. This is a sufficient number of values to give some evidence on the likelihood of a "worst case" outlier with respect to crop prices and quantities. In particular, the likelihood that additional demand for corn as an energy feedstock would prove destabilizing under conditions of low domestic yields for corn and soybeans was investigated.

As in the case of the deterministic runs, the 500 million gal. figure was not enough alcohol production to significantly destabilize the agricultural sector variables of interest in this analysis. Final year (1983) results are thus quite similar to those of the deterministic run.

The stochastic analysis produced two general results. First, the variability of several important indicators shows an increase over the five-year period. That is, the variances increase over the simulation period, indicating a tendency toward greater instability. Second, the prices for corn, soybeans, and soybean meal are biased upward from the deterministic results.* For the latter reason, both net farm income and total crop receipts are higher in the stochastic runs than in the deterministic runs. The variables showing an increased deviation over the five-year period include prices, domestic demand, and exports of corn. Other factors apparently destabilized by ethanol production are the two income variables and domestic demand for soybean meal.

The interim results (1980-82) show even greater variability than the two boundary years. Presumably this is because of the difference between short- and long-run elasticities. The lower short-run values will be more destabilizing, though the variability comes down as the higher, long-run elasticities come to dominate the interactions in the model.

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*This comes from a biasing of the distribution due to the existence of loan rates and support prices that limit the downward movements of prices.

Table 4-11. STOCHASTIC SIMULATION RESULTS FOR SELECTED VARIABLES, 1979 AND 1983

Variable	Value					
	Stochastic[a]				Deterministic	
	Baseline		Simulation			
	1979	1983	1979	1983	1979	1983
Corn price	2.499	2.513	2.525	2.593	2.497	2.528
($/bu)	(.130)	(.141)	(0.129)	(0.143)		
Corn feed demand	4,185.215	4,404.648	4,165.211	4,280.387	4,183.199	4,381.477
(M. bu)	(96.431)	(124.667)	(96.028)	(134.461)		
Corn exports	2,491.482	2,307.742	2,491.471	2,307.742	2,489.014	2,266.905
(M. bu)	(119.213)	(130.990)	(119.203)	(130.990)		
Soybean price	6.938	7.328	6.935	7.359	6.753	7.065
($/bu)	(.708)	(.710)	(0.708)	(0.715)		
Soybean exports	1,025.060	903.866	1,027.107	903.851	1,025.179	898.715
(M. bu)	(56.523)	(53.812)	(56.521)	(53.825)		
Soybean meal domestic demand	17,857.816	19,627.254	17,806.523	19,259.250	17,937.395	19,630.824
(th. tons)	(472.667)	(546.853)	(457.996)	(514.883)		
Soybean meal exports	6,249.555	6,544.543	6,268.582	6,690.359	6,317.168	6,775.367
(th. tons)	(167.930)	(167.212)	(168.761)	(155.964)		
Soybean meal price	185.064	200.421	186.629	195.453	184.114	193.735
($/ton)			(8.699)	(8.190)		
Total crop receipts	56,731.586	64,345.742	56,780.145	64,828.102	56,582.672	63,791.152
(M$)	(631.865)	(1,308.001)	(632.029)	(1,329.470)		
Net farm income	31,996.672	33,810.734	31,990.789	34,695.859	31,872.787	33,456.937
(M$)	(515.268)	(2059.132)	(533.635)	(2,063.725)		
Soybeans—end of year stocks	146.877	146.014	147.194	136.558		
(M. bu)	(59.392)	(50.193)				
Corn—end of year stocks	1,057.930	1,249.958	1,027.941	1,169.918		
(M. bu)	(96.554)	(174.601)				

[a]Standard deviations in parenthesis.

Table 4.12 EXTREME VALUES OF SELECTED VARIABLES IN STOCHASTIC SIMULATIONS

Variable	1979		1983	
	Minimum	Maximum	Minimum	Maximum
Corn price ($/bu)	2.239	2.750	2.252	3.053
Corn feed demand (M. bu)	3,972.225	4,373.734	3,869.979	4,601.832
Corn exports (M. bu)	2,200.711	2,797.249	1,909.987	2,711.054
Soybean price ($/bu)	5.595	9.032	6.071	9.402
Soybean exports (M. bu)	860.732	1,181.159	728.771	1,088.988
Soybean meal domestic demand (th. tons)	16,257.277	18,555.707	17,563.121	20,349.867
Soybean meal exports (th. tons)	5,703.230	6,565.438	6,066.785	6,986.434
Soybean meal price ($/ton)	171.327	215.769	181.323	227.720
Total crop receipts (M$)	54,967.356	59,994.195	61,231.633	69,209.125
Net farm income (M$)	30,628.250	34,761.438	29,760.125	41,214.688

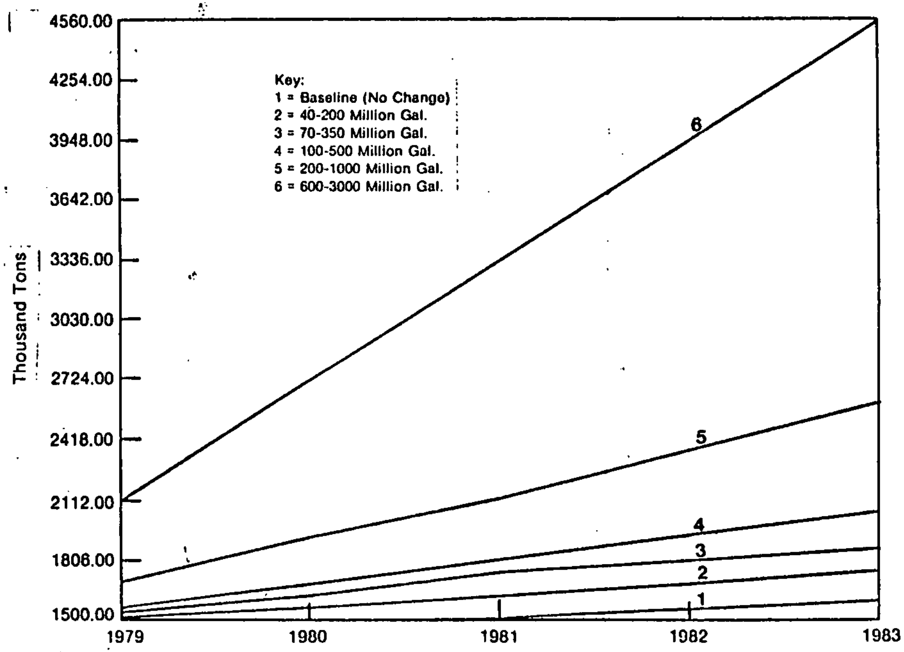

Figure 4-1. Corn Gluten Meal Fed

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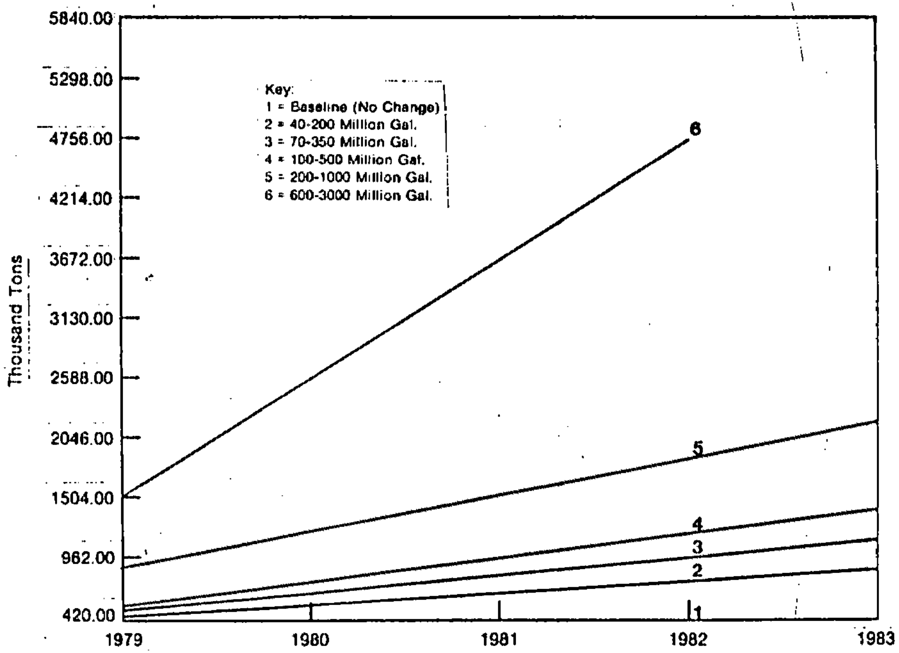

Figure 4-2. Dried Distillers' Grains Fed

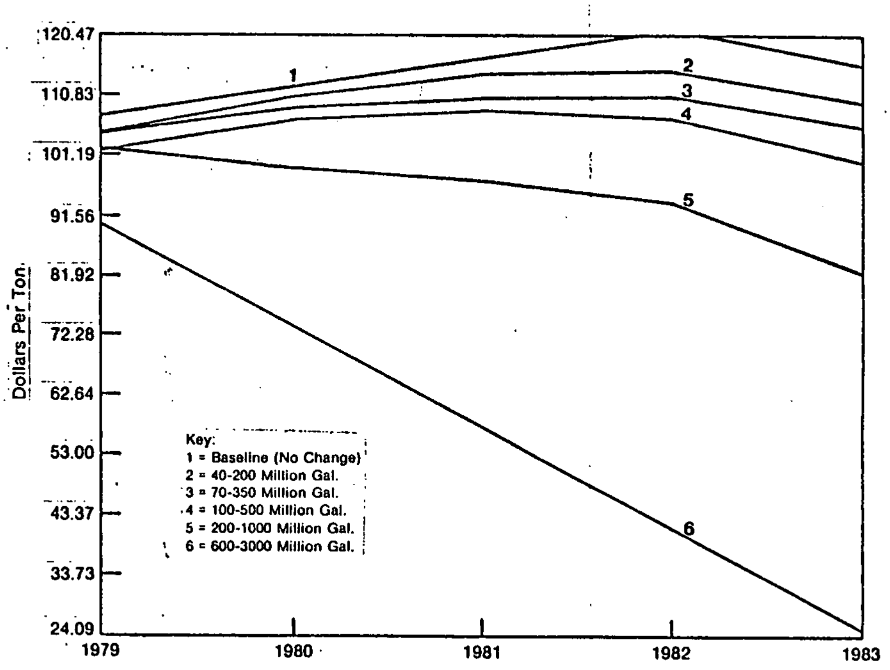

Figure 4-3. Corn Gluten Meal Price

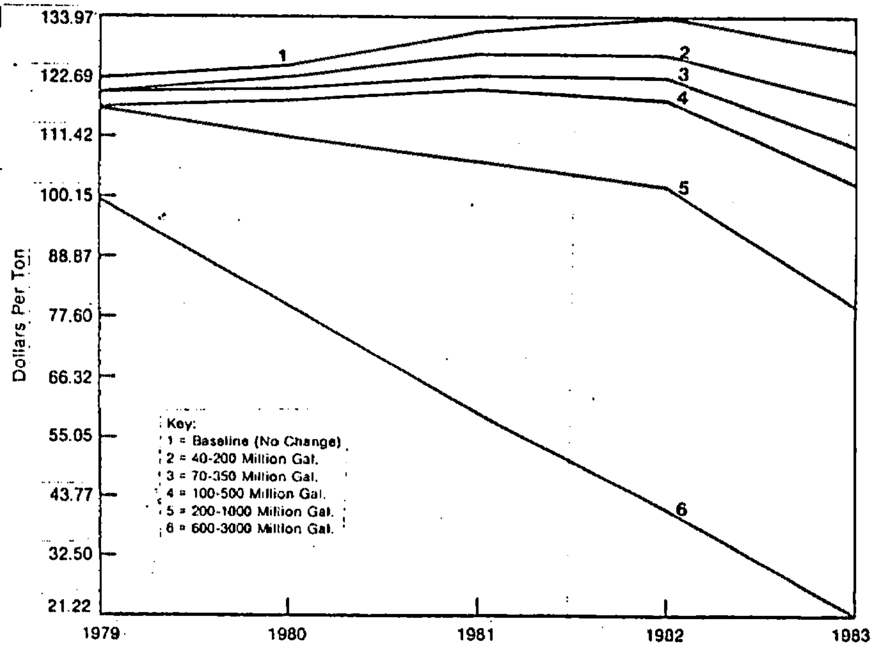

Figure 4-4. Dried Distillers' Grains Price

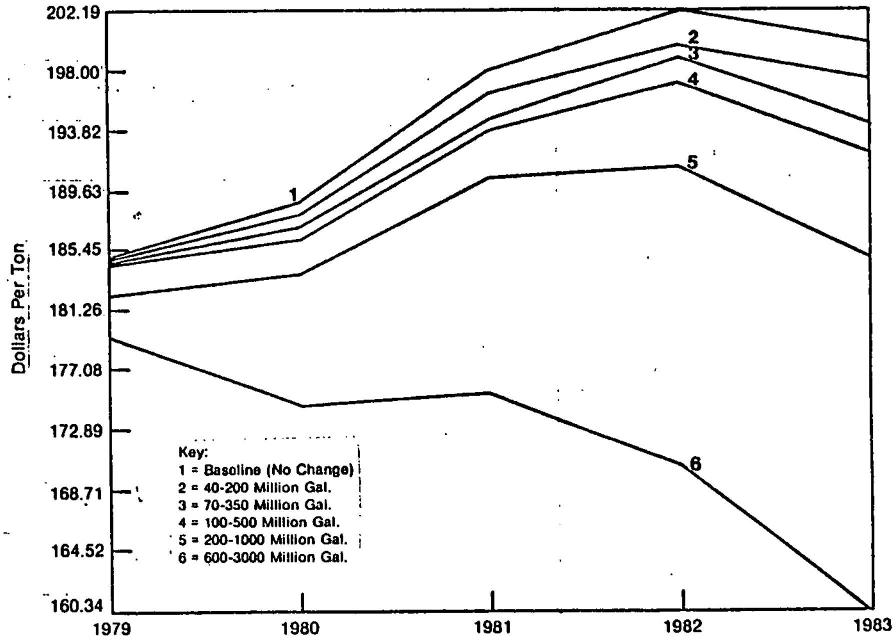

Figure 4-5. Soybean Meal Price

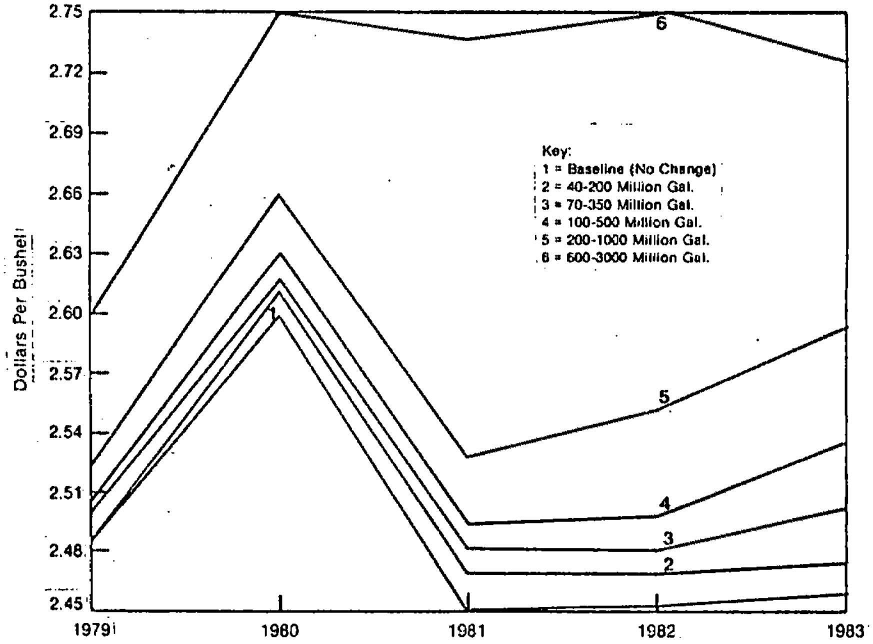

Figure 4-6.. Corn Price

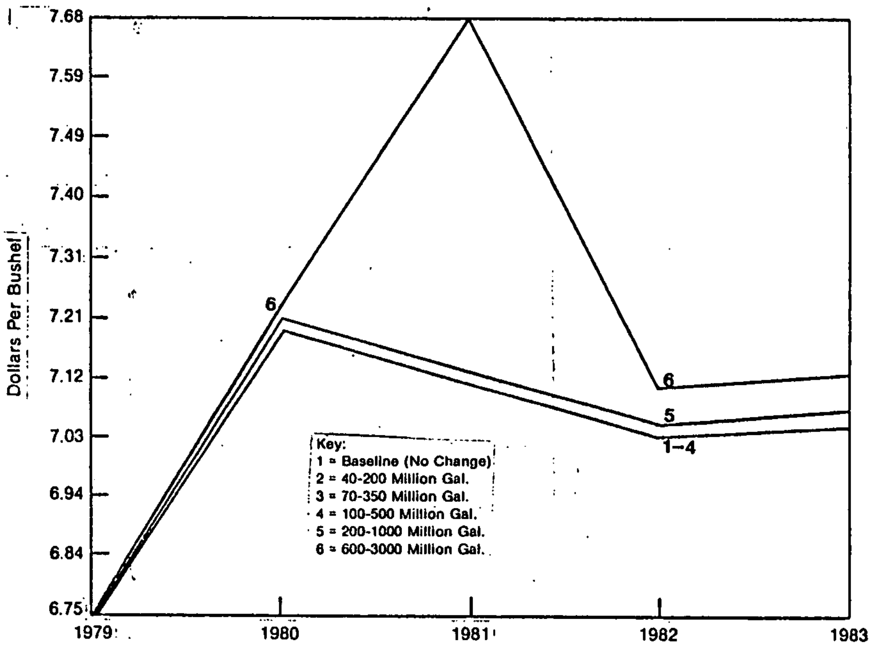

Figure 4-7. Soybean Price

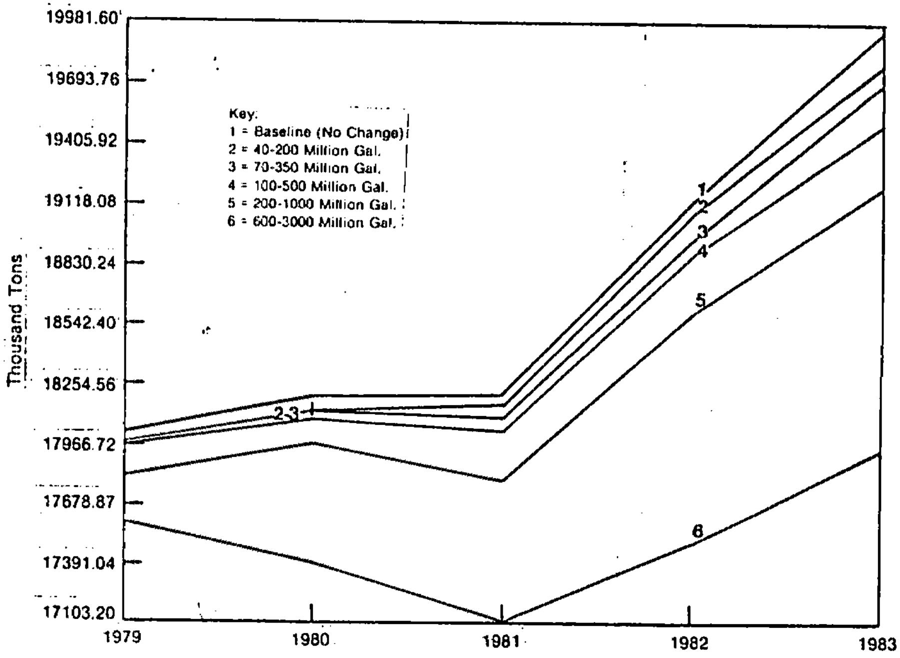

Figure 4-8. Soybean Meal Fed

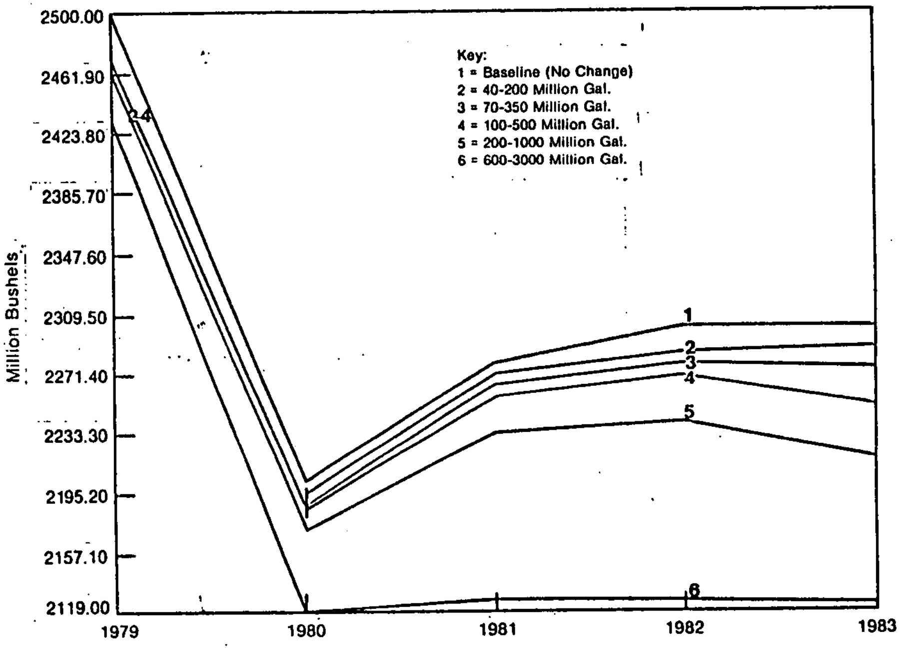

Figure 4-9. Corn Exports

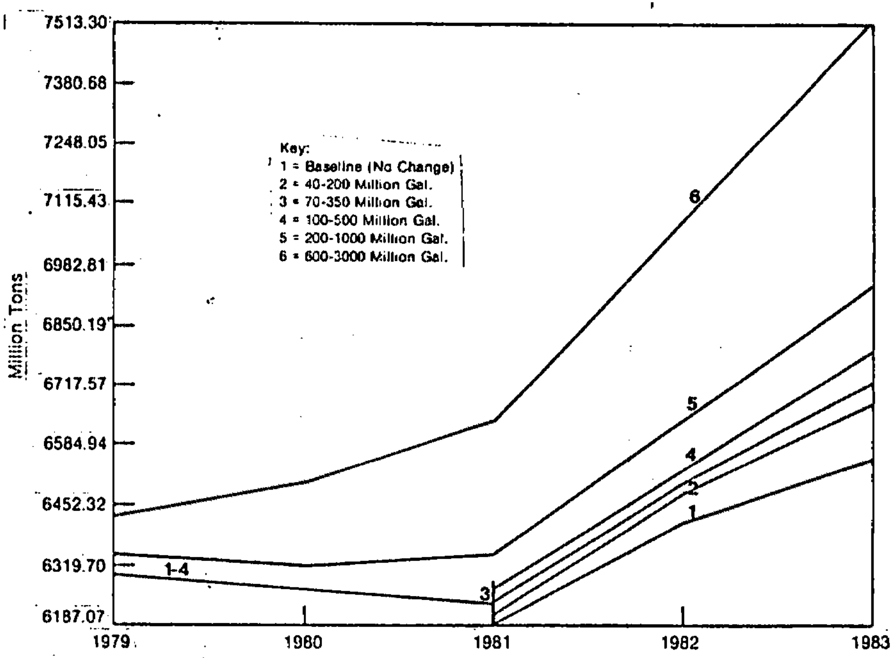

Figure 4-10. Soybean Meal Exports

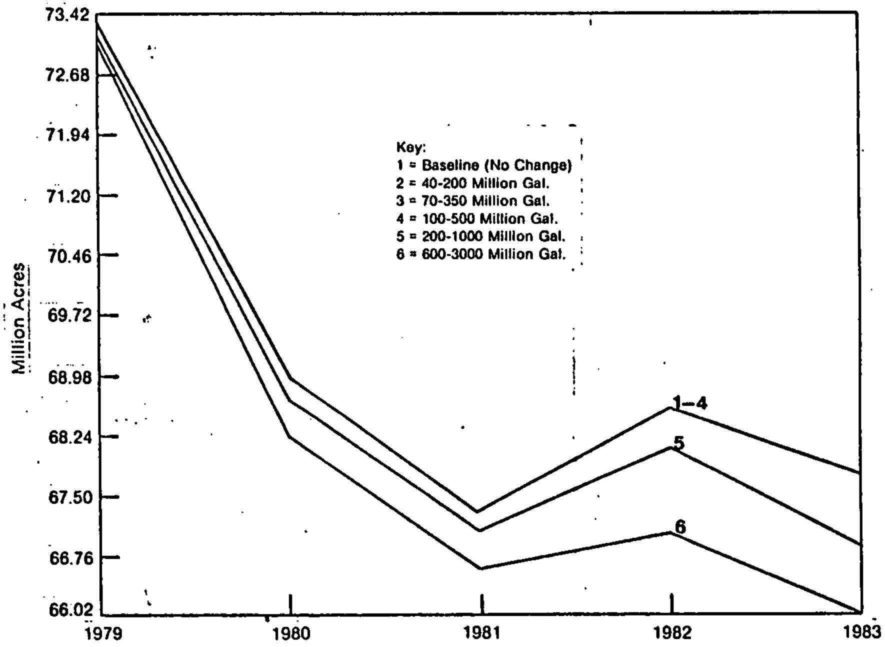

Figure 4-11. Soybean Harvested Acreage

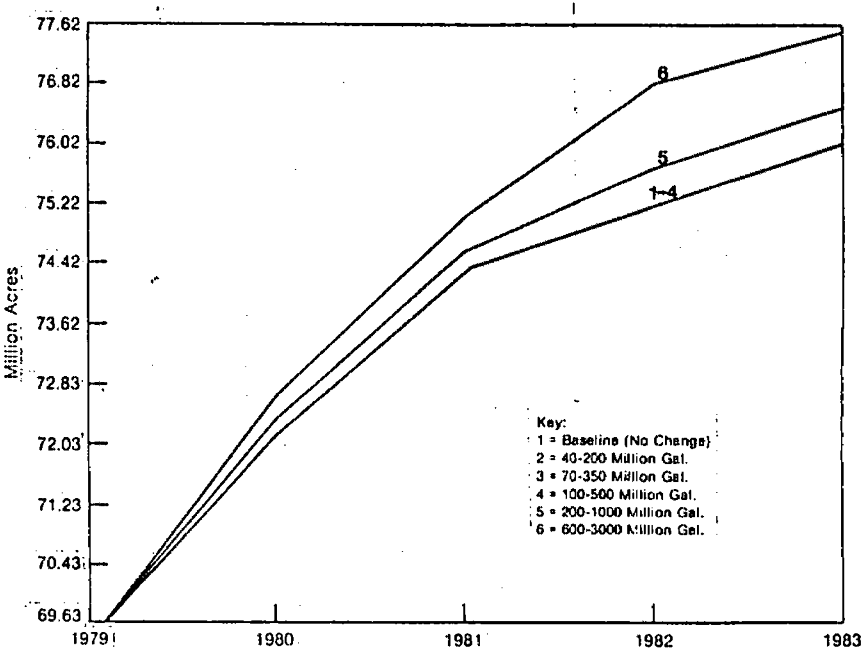

Figure 4-12. Corn Harvested Acres

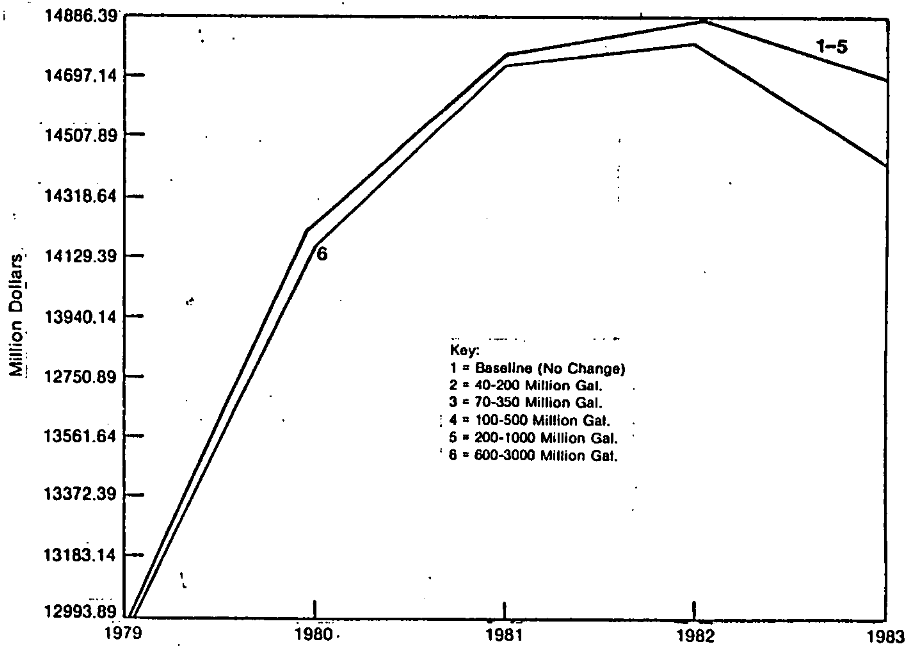

Figure 4-13. Soybean Cash Receipts

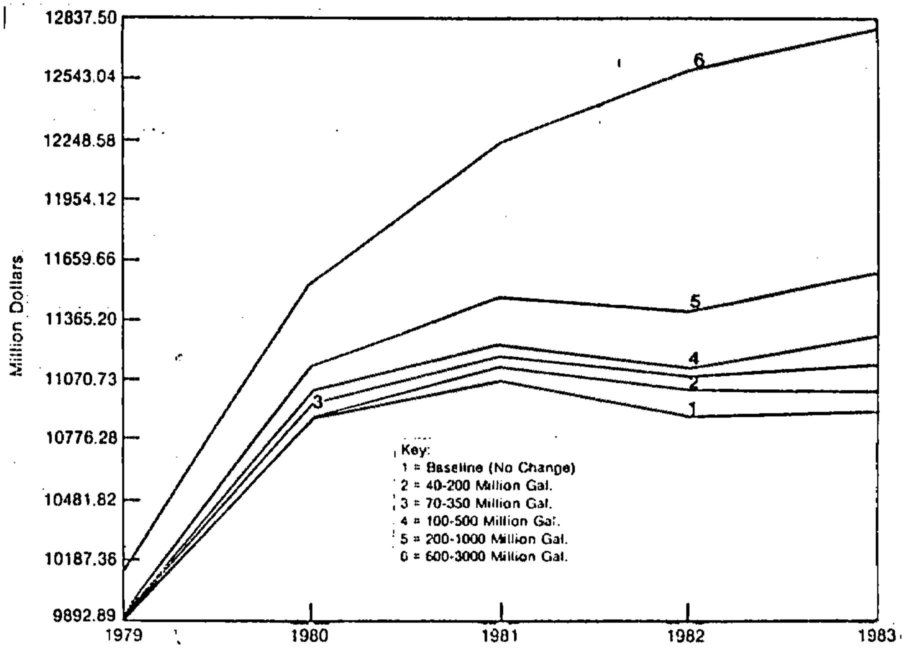

Figure 4-14. Corn Cash Receipts

SECTION 5.0

CONCLUSIONS

5.1 SUMMARY OF RESULTS

The analysis and results presented in this report attempt to address in detail the critical issues surrounding the economic feasibility of obtaining motor fuels from grains. Properly applied economic methodology could lead to answers that differ significantly from conventional wisdom with respect to agricultural sector impacts and to the economic desirability of making alcohol fuels. This work focuses on the short run—up to five years—because of the short-run nature of the POLYSIM model itself. In addition, longer time periods are subject to structural changes within the agricultural sector that would vitiate much of the value of an elasticity model.

The major conclusion of this study is that the amount of alcohol that can be produced from grains over the next five years is not sufficient to cause serious upsets in the agricultural sector or to food prices. The binding constraint on alcohol production will be distillation capacity, not feedstocks. In general, the deflationary effects of joint feed products outweigh the inflationary effects on corn and wheat prices of high levels of alcohol production. From a logical perspective, this result is unremarkable and unsurprising. Any increase in the processing of a commodity that permits the least valuable portion of the commodity (the starch) to be converted to a useful product (such as fuel) while leaving the other portions of the commodity in a more useful form than they were previously, must increase the value of that commodity relative to others. The net result of this is an increase in the rate of growth of income in agriculture from near stagnation to something less than the rate of growth trend of the economy as a whole. From the standpoint of income distribution, alcohol production will encourage a production shift that will slow the relative erosion of agriculture's share of the national product.

Secondary results of our study include the following:

- The cost of providing high-protein products to livestock will fall. This could mitigate the inflationary impacts on meat prices of increased corn costs and the rebuilding of depleted herds.
- The agricultural sector in the United States is sufficiently flexible to absorb large production requirements for fuels and chemicals to be produced jointly with food.
- Policies that encourage the growth of energy crops in marginal lands should be scrutinized carefully. Study results indicate that maintenance of the flexibility inherent in current agricultural practices can result in the provision of large amounts of energy to the economy.
- Marginal gasoline is the true competition for fermentation ethanol. The use of average cost pricing of gasoline has obscured such viable alternatives as alcohol fuels.
- The release of lands currently in agricultural set-asides will not be necessary to promote greater production of grain. The current state of demand is sufficient to entirely eliminate that program over the next two years.

- Mild crop disturbances here and abroad should not affect the feasibility of ethanol production in the near future. The extent to which the production of ethanol would adversely affect either wheat or corn supplies is almost negligible.
- Carryover stocks of corn and soybeans are reduced under alcohol production scenarios. This will increase the impact of violent disturbances in the agricultural sector.
- Inefficient fermentation technology and low prices for joint products will make ethanol from grain costly, even relative to marginal gasoline.
- As greater production of alcohol leads to increases in corn prices relative to joint-product prices, the cost of alcohol will rise more quickly than that of corn.

5.2 LIMITATIONS

There are several important limitations in this study, which readers or those who wish to draw policy conclusions from these results should note. With respect to the analysis that preceded the modifications of the POLYSIM model, the omission of the vegetable oils markets represents a potential distortion of the impacts of growing additional corn. In particular, mills' demand for soybeans can be expected to decline if there are an additional 400-plus million lb of oil as a joint product of fermentation. This could be expected to exert further downward pressure on soybean prices and, consequently, on the desirability of soybeans as a crop.

The production increments will most likely be exponential. There are several implications here for the results of the model. First, more volatility can be expected as the growth curve for ethanol production enters its vertical portion. Second, large-scale programs could possibly exert sufficient pressure on some parts of the agricultural sector to change the elasticity figures that form the basis of the POLYSIM model.

Again, POLYSIM is a short-run model, thus, more accurate in its output than some others. Unfortunately, many interesting policy questions have longer time horizons than are covered in this analysis. At this stage of the modeling effort, however, it is not a serious limitation. Accurate, short-term results are preferred to courageous but useless long-term projections.

Many of the important questions about ethanol production are regional. These are not addressed here. The problem of building an interregional model that is both accurate at the regional level and plausible at the national level involves types of behavior presumed by the modeler. This study does not assume optimizing behavior for the economy as a whole. Regional modeling is difficult, then, since the finer the resolution of the model, the more reasonable optimizing assumptions become.

The lack of regional resolution may blind us to important production shifts that may permit greater levels of overall production of biomass for both food and energy. One of the more obvious cases of this is the rapid increase in sunflower production in the Northern Plains. This crop will augment both protein and oil supplies to a great degree, and might make the use of other lands for sugar crop production more feasible than is now the case. Unfortunately, it is difficult to project a regional phenomena in a national model.

SECTION 6.0

REFERENCES

American Petroleum Institute. Basic Petroleum Data Book. Washington, D.C.: API.

Annual Survey of Manufacturers. 1976. Fuels and Electric Energy Consumed. Washington, D.C.: U.S. Department of Commerce, Bureau of the Census.

Buchele, W. F.; Marley, S. J. 1978. "Energy Production from Crop Residue." Proceedings of the Soil Conservation Society of America Meetings. Denver, CO: August.

Chambers, R.S.; Herendeen, R.A.; Joyce, J.J.; Penner, P.S. 1979. "Gasohol: Does it or Doesn't it Produce Positive Net Energy?" Science Vol. 206, November 16; pp. 789-795.

Chemapec, Inc. 1978. "Industrial Alcohol by Continuous Fermentation and Vacuum Distillation with Low Energy Consumption." Woodbury, NY.

Chemical Week. Jan. 31, 1979.

The Conference Board. 1974. Energy Consumption in Manufacturing. Cambridge, MA: Ballinger; pp. 301-320.

Dvoskin, D.; Heady, E.O. 1977. "Economic and Environmental Impacts of the Energy Crisis on Agricultural Production." In William Lockeretz, ed., Agriculture and Energy. New York, NY: Academic Press.

Energy Daily. 1978. Vol. 6, no. 178; September 14.

Energy Daily. 1978. Vol. 6, no. 180; September 18.

Farthing, D. C.; Kliebenstein, J. B. 1979. "Impacts of Fuel Pricing and Nonprice Allocation Scenarios on High and Low Risk Crop Producers." Meetings of the American Agricultural Economics Association. Pullman, WA: July 29—August 1.

Ferguson, C.E. 1969. The Neoclassical Theory of Production and Distribution. Cambridge, U.K.: The University Press.

Flaim, S. J.; Mount, T.D. 1978. Federal Income Taxation of the United States Petroleum Industry and the Depletion of Domestic Reserves. Golden, CO: Solar Energy Research Institute; Report No. TR-52-041.

Forster, D. L.; Rask, N. 1977. "Changes in Fertilizer Usage and Crop Production Under Scarce Energy Supplies." In William Lockeretz, ed., Agriculture and Energy. New York, NY: Academic Press.

Fuss, M.; McFadden, D. 1978. Production Economics: A Dual Approach to Theory and Applications. Amsterdam: North Holland.

Hertzmark, D. I. 1979. A Proposition on Energy Analysis and Economic Efficiency. Golden, CO: Solar Energy Research Institute; Report No. TR-51-332.

Hertzmark, D. I.; Gould, B. 1979. The Market for Ethanol Feed Joint Products. Golden, CO: Solar Energy Research Institute; Report No. RR-51-357.

International Petroleum Finance. 1979. Vol. 2, No. 19; October 8.

Kalter, R. J.; Vogely, W. A., eds. 1976. Energy Supply and Government Policy. Ithaca, NY: Cornell University Press.

Litterman, M.; Eidman, V.; Jensen, H. 1978. Economics of Gasohol. University of Minnesota: Department of Agricultural and Applied Economics, Economic Report ER78-10; December.

Mensah, E. K.; Miranowski, J. A. 1979. "Derived Demand for Energy in Agriculture: Effects of Price, Substitution, and Technology." Meetings of the American Agricultural Economics Association; Pullman, WA: July 29—August 1.

Office of Technology Assessment. 1979. Gasohol: A Technical Memorandum. Washington, D.C.: OTA; September.

Oil and Gas Journal. 1979. Vol. 77, No. 28; July 9; p. 4.

Oil and Gas Journal. 1979. Vol. 77, No. 42; October 14; p. 219.

Pimentel, D.; Dritchilo, W.; Krummel, J.; Kutzman, J. 1975. "Energy and Land Constraints in Food Production." Science. Vol. 190; November 21; pp. 754-761.

Rask, N.; Forster, D. L. 1977. "Corn Tillage Systems—Will Energy Costs Determine the Choice?" In William Lockeretz, ed., Agriculture and Energy. New York, NY: Academic Press.

Scheller, W. A.; Mohr, B. J. 1977. "Gasoline Does, Too, Mix with Alcohol." Chemtech. October; pp. 616-23.

Sladek, T. A. 1978. "Ethanol Motor Fuels and Gasohol." Mineral Industries Bulletin. Golden, CO: Colorado School of Mines; May.

Tyner, W. E.; Bottum, J. C. 1979. Agricultural Energy Production Economic and Policy Issues. West Lafayette, IN: Department of Agricultural Economics, Purdue University. Station Bulletin No. 240; September.

U.S. Department of Agriculture. 1979. Agricultural Statistics—1978. Washington, D.C.: U.S. Government Printing Office.

U.S. Department of Energy. 1979. The Report of the Alcohol Fuels Policy Review. DOE/PE-0012; June.

Weisz, P. B.; Marshall, J. F. 1979. "High-Grade Fuels from Biomass Farming: Potentials and Constraints." Science. Vol. 206; October 5; pp. 24-29.

APPENDIX

ENERGY ANALYSIS

The issue of whether alcohol fuel does or does not produce net energy output has been an important one in previous analyses of the feasibility of using alcohol fuels (U.S. DOE 1979; Chambers et al. 1979). The two analyses cited will not be replicated here. It is clear from their results that conventional distillation technology, using feedstocks derived from energy-intensive agriculture, at best will be only slightly positive and more likely will be negative. Small changes in assumptions about whether the stillage is to be included as an output or a negative input, what type of cultivation practices are used, and the fate of the straw or stover are sufficient to draw the energy balance from positive to negative or vice versa. In one sense, the entire debate is otiose since any refined energy product, from gasoline to electricity, will turn out to have a negative balance when computed on the basis of outputs divided by inputs. In fact, any fuel possessing a ratio in excess of unity would have fair claim to be a perpetual motion machine of the first type.*

As an alternative to this debate, we need to concentrate on three different aspects of the energy balance question. The first one is the most obvious: alternatives to conventional distillation technologies. The second is the question of the quality of the energy used in various stages of processing and growing. The third is a more comprehensive view of the energy requirements of alternative ways of producing all of the potential outputs of a biomass energy refinery producing both food/feed and energy outputs.

One of the better known alternatives to conventional distillation technology is vacuum distillation. This process is used by the Chemapec Company, a Swiss Architecture and Engineering (A&E) firm. Two aspects of the process are of interest. The first is the preseparation of corn into starch, oil, and feed. The cellulose fraction is removed later and is anaerobically digested to provide some of the process energy. The external energy requirements of the process appear to be about 30,000 Btus per gallon of ethanol produced (Chemapec 1978). The cellulose fraction of the grain is used to provide about .4 m^3 of methane (10 ft^3) per bushel of corn processed. This provides a substantial fraction of the total process energy that is required since the vacuum distillation process is less energy-intensive to begin with. The second interesting feature is that there appears to be a clear process distinction between beverage alcohol and power alcohol. The specification sheet for the two processes indicates that considerably fewer contaminants are found in the beverage alcohol. Allowing such contaminants as esters, aldehydes, methanol, and fusel oils to remain in the alcohol should result in lower production costs for this alcohol compared with one that is distilled to beverage standards regardless of its ultimate disposition.

*Pauli (1973; p.7) defines a perpetual motion machine of the first type as one that can produce heat energy from nothing. The first law of thermodynamics states, inter alia, that during a cycling process heat can be transformed only into work or vice versa. The second law states that this cycling process is finite since each transformation causes entropy (unavailable work) to increase.

On a straight energy in/energy out basis, there is no refined energy product that can claim to have an energy efficiency ratio greater than unity.* The most obvious reason for this is that the energy value of the feedstock must always be greater than the energy content of the refined product, in the case of fuels. The important question here, then, must center on the quality of the products that are produced with given feedstocks and auxiliary inputs. An alcohol distillery fueled by coal may indeed have a poor energy balance if we really believe that scores of more than one are possible in our energy balance ratings. However, we must inquire as to the potentials for coal to produce a premium liquid fuel or some other type of transportation fuel in order for the comparison with other alternatives to be proper. Recent reports on the thermal efficiency of the South African synthetic fuel plant indicate that the energy out/energy in ratio is on the order of 0.35 for an output that consists mostly of light fractions of synthetic crude oil suitable for refining to gasoline. The work of Chambers et al. (1979) indicates that the net energy loss will never drop as low as the figure for fossil synthetic fuels or for electricity (p. 793). Since we apparently have no qualms about the production of electricity or fossil synthetic fuels, at least on the basis of net energy, then the policy basis of the entire discussion appears to be nonexistent. An earlier paper shows that the stress on simple Btu accounting is often misleading in terms of results and can serve to misdirect the proper debate on energy efficiency (Hertzmark 1979). A more sound basis for the argument is to consider the thermodynamic efficiency of alternative production schemes. Most of the process energy that is required for the fermentation of grain and the distillation of mash to pure alcohol is relatively low-temperature heat or steam. At the present time, well organized markets do not exist for low-grade energy. It is understandable, therefore, that there has been little attention paid to the possibilities of using either the thermal effluent from electric power generation or that from chemical process factories as major heat sources for the production of fuel alcohol. Counting the Btus in and out of a plant that makes use of its "waste" heat is not necessary if the alternative use of this heat is simply to become additional thermal effluent. The importance of properly using the entire heat potential of energy resources is reflected in debates about various externalities of energy use, such as heat, CO_2, sulphur, etc. Some people in the field are now properly sensitized to effluents other than the thermal kind and consider limitations on these effluents to be policy objectives. Thermal effluents are a resource valuable in low-temperature applications and otherwise a nuisance. Of course, once the concept of thermodynamic matching of sources and uses of energy is taken more seriously, there may be some competition for these thermal effluents.** At the present time we may conclude that this energy source is available at approximately zero cost;*** the energy balance is moot and minor.

The final aspect of energy analysis that deserves attention is a novel approach to the entire issue of energy analysis of alcohol fuels. As shown previously (Hertzmark and Gould 1979), the diversion of corn grain to ethanol and joint products leads to a series of indirect substitutions in the livestock sector of the agricultural economy. One of the most striking of these is that additional use of corn grain in the livestock sector becomes unnecessary because of substitutions of various hays for the carbohydrate portion of the

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*Id.

**Awareness of the cost savings possible by cascading energy from its highest thermodynamic grade (mechanical work) to an ambient state may well serve to induce firms to locate proximate to sources of "waste" or low quality heat.

***Excluding the piping and heat exchanges which are needed for any energy source.

grain. This suggests that one measure of efficiency in energy use would be a comparison of the energy requirements of various types for two alternative food and fuel systems. The first is simply the present system, and the second is a biomass refinery with associated forage crop production.

The two alternative production systems are shown in Sec. 4.0 (Table 4-1). The first is a conventional corn production system with an additional 2 gallons of gasoline to provide a fuel production equivalence with the alternative biomass refinery system. Using results from the previous study of the uses for the feed joint products, calculations show that a 10% dietary penetration of distillers' grains, there would be an increase of about 1:1 in the consumption of such other feeds as alfalfa hay. This means that for each reduction in the quantity of corn grain that is fed into the ration, there will be an almost matching increase in the quantity of forages that are fed to the livestock. Also, process energy is required to preseparate the grain and to distill the alcohol. There is no need to account for the energy value of the corn grain itself since this is simply one form of stored solar energy. For the two systems producing identical food and fuel outputs, the biomass refinery system will be more efficient in its use of fuel if modern technologies are used in the processing stage. Additionally, the use of beverage alcohol technology does not appear wise from an energy standpoint. These figures are conservative in that there was no processing energy assumed in the conventional system.* In addition, we used the energy requirements for producing gasoline from high grade petroleum rather than from marginal deposits or from syncrude.** For the use of modern distillation technology, the

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*A more complete comparison would presume dry milling of corn in the conventional system also. One of the major economic outputs of the biomass refinery is corn oil. The conventional system does not produce the same economic value, although it has the same calorie value as the biomass refinery.

**Analytically, the indirect substitution argument is easily shown. Let y be a vector of energy sources, r a vector of costs, M a matrix of input coefficients, and Z a vector of output requirements. The resource constraints are represented by the inequality $y \leq Y$. To minimize the overall cost of production we solve

$$\begin{aligned} \min_{y} \quad & r'y \\ \text{s.t.} \quad & M'y \geq Z, \\ & y \leq Y. \\ & Y \geq 0 \ (i = 1, 2, \ldots, n). \end{aligned}$$

A change in relative costs will change the components of the vector r. Suppose that the matrix M shows more than one way to produce several of the outputs Z_1. In particular, suppose that Z_1 is electricity, Z_2 gasoline, and Z_3 high pressure steam. Now suppose that Y_1 (solar) substitutes for Y_2 (petroleum) in producing Z_2 due to an increase in r_2/r_1. Assume that r_2 increases relative to r_3 (coal price). This incudes an additional substitution in Z_1 of coal for oil. Now, however, additional coal demand in Z_1 causes r_3 to rise relative to r_1. This induces penetration of both Y_1 and Y_2 in Z_3. This is a simple explanation for a complex dynamic process. In a dynamic model, analogous results could be obtained provided that the appropriate elasticities of substitution are greater than unity. The royalty terms for the two exhaustible resources serve to limit the supply elasticity for both coal and oil. One approach that is useful here is the recursive approach of Day (1973). After each solution, a recursion equation would modify r of M according to resource exhaustion criteria or technological change criteria. The series of solutions generates a time path for the choice variables Y and solution values.

implications of this exercise are clear: there will be an unambiguous reduction in the use of fossil energy for a food/fuel system that produces fuels and foods from the same biological and industrial plant.

Senator McGOVERN. Senator Percy wanted to note one of the witnesses who is going to appear before our subcommittee today. Senator Percy.

STATEMENT OF HON. CHARLES H. PERCY, A U.S. SENATOR FROM THE STATE OF ILLINOIS

Senator PERCY. Senator, I would ask unanimous consent that my comments do not interrupt the continuity of the present witnesses and that they precede the testimony to be given by Mr. Al Mavis. I just wanted to express my appreciation to all of you. As a former member of the Joint Economic Committee, I commend the chairman on calling these hearings, and would particularly like to welcome Al Mavis who in Illinois we call Mr. Gasohol. Due to his efforts, I think, Illinois is competing now to be in the forefront of all States in gasohol production. The largest single plant in the country, turning out more gasohol than any place else, is an indicator. We are also well underway now to work on the smaller plant concept.

As he will aptly point out, the problems are very deep and the interests—we have to approach this as we did REA a long time ago. Senator McGovern is familiar with the progress that was made there. That was a fundamental program based upon low interest loans for long term and this is what really is needed. I think the quality of our witnesses and particularly my distinguished friend from Illinois will help shed a lot of light on this program.

I hope that through our combined efforts we are going to raise this to a very, very high priority. I commend you again, Senator, for convening this hearing and for testimony that you are going to have, from Mr. Mavis as well as from your other witnesses. Thank you.

Senator McGOVERN. Thank you, Senator Percy. Mr. Carlson, we will hear from you and then we will have some questions for Messrs. Williams and Hertzmark.

STATEMENT OF RICHARD CARLSON, RESEARCH ASSOCIATE AND ECONOMIST, CENTER FOR THE BIOLOGY OF NATURAL SYSTEMS, WASHINGTON UNIVERSITY, ST. LOUIS, MO.

Mr. CARLSON. It is a pleasure to appear before you this morning, Senator.

Just to follow up on what Mr. Hertzmark has said, I agree completely with all of his remarks. I have studied very carefully the recent reports put out by his group, and I just want to point out before launching into our own analysis that the analysis conducted at SERI is very complementary to what we are attempting at CBNS.

Mr. Hertzmark has taken the shortrun potential into consideration in his analysis, whereas at CBNS we are interested primarily in the longrun potential of any sort of technological change in the agricultural sector which is necessary for renewable resource fuel production.

Now, since such a wide range of opinion presently exists as to how much energy can be produced through renewable resources within agriculture, we first need to examine what the sources of this discrepancy are. Although a lot of numbers are thrown around, one of the major sources for discrepancy is in the choice of the analytical framework or the basic assumptions which go into the analysis.

In the last few years, two general types of analysis have been put forth with regard to assessing how much energy could be produced by biomass fuels from agriculture.

One of the strategies could best be defined as the energy farm approach, where the researcher simply attempts to find some unconventional crop that will maximize biomass production per acre, without taking into consideration all of the possible implications for agriculture, in terms of feed production or price. This research approach has severe limitations, one of which is that areas suited for extremely high biomass production, such as the areas where sugarcane is presently grown, are very limited, and such areas can have only a minor impact on the national liquid fuels market. The second limitation, of course, is that the substitution of energy farm techniques for conventional agricultural techniques runs into very severe limitations in terms of the rising price of food.

In contrast to this approach, another major approach taken by recent studies has been of just the opposite sort: To fully recognize the importance of maintaining food production at reasonable prices, both for domestic consumption and for export. Now, this approach simply tries to make the best use of what are now regarded as surplus resources in the agricultural resource base. Analysis has been done of the possibility of utilizing animal manure for either methane generation or direct combustion, and of crop residues and food processing residues for energy production.

While each of these categories can make a significant contribution, they are inherently limited in how much energy can be produced, because they are either dependent upon the final demand for foods, which limits the amount of food processing waste or animal manure, or the conflict with soil protection in the case of residues. This approach of utilizing surplus resources assumes that the agricultural technology is going to remain the same, and is simply trying to pick up a few surplus resources for energy conversion from around the margins of the system.

Now, in contrast to both of these approaches, the work done at our Natural Systems Center has focused on how to best integrate food production with energy production on the farm. We recognize the limitations in both of the above approaches, so that what we have tried to do is to analyze what changes would be necessary on the farm, in terms of crop substitutions, crop management practices, livestock feeding practices, the type of residue harvest, the type of soil protection policies and so on, which would best maximize renewable resource fuel production.

There are several ways that we have found of increasing biomass production on farms. Basically, most agricultural cropland in this country is used for the production of nutrients for livestock production. This means that the current agricultural system is optimized in terms of its carbon and nitrogen balance which provides the essential nutrients of carbohydrates and protein for livestock rations.

So taking this requirement as a starting point, we have sought to find a new type of cropping system and a new type of livestock feeding system which can change this overall carbon to nitrogen balance in such a way as to augment the total supply of carbon which can then be taken off through bioconversion process for alcohol production or methane production, and still leave the requisite amounts of carbon and nitrogen which are essential for livestock production and for food exports.

The types of considerations that we have looked into in detail are the substitution of new high carbon-producing crops such as sugar beets, which in addition to providing substantial amounts of alcohol fuel per acre, could also provide relatively large amounts of livestock feed per acre. So in essence, you are getting two crops in one, both a food crop and fuel crop, from the same land.

Another type of substitution stems from the fact that since the residue byproducts from alcohol conversion are relatively high in protein, we could substitute high-carbon-producing crops for land which is presently used to produce protein from soybeans. So we have allowed for substitution of corn oil and high-protein corn stillage from grain alcohol distilleries for soybean oil and soybean meal.

Third, the substitution effects which I have just mentioned also indirectly induce a third type of possible change, and that is greater reliance on low quality carbohydrates from forage production. Our present forage production capability is greatly underutilized. It would be expensive in terms of more resource inputs, but we could gain much more additional forage output by more intensively cultivating the pastures and haylands of this country.

Another consideration that we have taken into account is how to decrease the amount of residue that could be left on the land in order to make use of this residue material to provide the process heat needs of an alcohol fuel plant without increasing soil erosion. And in fact, we have found methods by which soil erosion could be greatly reduced at the same time as we take off more residue from the land. This basically involves the switch to conservation tillage practices which now exist.

I see my time is about up, so I will conclude by turning to one of the recent empirical projections that we have made, based on these considerations, which is summarized in table 2 of my prepared statement.

Also, in table 2, taking into account all of the above considerations with fairly conservative assumptions, we see that the energy output-input ratio is very much larger than what is generally shown in such studies, ranging from 2.7 to 6.3 depending on how much alcohol fuel we produce; either 18 billion gallons in the restricted case, or 27 billion gallons in the other case.

These higher ratios are due to three factors. One is taking into account the oil substitution value of ethanol when used as a replacement for gasoline, which is about 1½ times its energy content. Second, they take into account the crop shifts; and finally, the minimization of fossil fuel use in distilleries. These results have several implications for on-farm or small-scale community alcohol production, the largest of which is that the promotion of such small-scale efforts needs to take into account the system considerations; simultaneously looking at ways to change the crop mix, change the residue harvest practices, and to change cultivation practices in order to preserve the soil.

That concludes my statement.

Senator McGovern. Thank you, Mr. Carlson.

[The prepared statement of Mr. Carlson follows:]

Prepared Statement of Richard Carlson

INTEGRATED FOOD-ENERGY PRODUCTION ANALYSIS

Senator McGovern and members of the subcommittee: Many attempts have been made in recent years to determine how much biomass energy could be produced from agricultural sources. An incredibly wide range of opinion exists as to how much renewable energy can be attained at reasonable cost from agriculture. The source of much of the discrepancy lies in the choice of analytical framework or basic assumptions which impinge upon the scope of the research effort. In order to understand better how CBNS is able to develop very optimistic estimates of the energy potential from agriculture—on the order of several quadrillion Btu's (quads) or tens of billions of ethanol annually—I will describe two methodological approaches which typify most agricultural energy production studies, and then contrast their assumptions with those of the CBNS systems integration approach before going into the details of new production arrangements. These two common strategies (some studies involve both) may be termed the "energy farm" approach and the "surplus resource" approach.

The energy farm strategy seeks to identify very high-yielding crops from conventional or exotic plant species in order to minimize costs per unit of biomass harvested. In this way it is believed that super biomass species which can bid land away from food production may be identified. This research strategy completely ignores food output and price impacts with its (usually implicit) goal of eliminating food in the competition for agricultural resources. Typically, such studies conclude that optimal climatic conditions for attaining super biomass yields at minimum cost limit the growing of energy crops to the limited areas suitable for sugar cane cultivation.

In polar opposition to the energy farm approach, the surplus resource approach fully recognizes the negative repercussions for consumers and the environment of interfering with the food production system. The strategy implied by the surplus resource approach is to minimize all possible perturbations to the food system and its ecological base. Research is focused on the identification of idle land or biomass wastes which may be used for production of energy. This straightforward approach for avoiding possible conflicts between food and energy production concludes that the economic potential for energy production from three types of surplus resources is quite limited.

First, most of the "surplus" idle or potential cropland that some analysts have heavily relied upon are disappearing under the plow to meet growing foreign demand for food. Since 1974 over 40 million additional acres have been planted to row crops, primarily soybeans and wheat.

Secondly, the highly inelastic U.S. demand for food in its final forms implies that the small potential energy contributions from coverting recoverable livestock manures and food processing wastes into energy (less than one quad each) cannot be augmented. These are important renewable energy sources, however, which are already proving economical along with their additional benefits of reducing water pollution.

Finally, the utilization of crop residues has attracted some attention, but problems of protecting the soil from wind and water erosion, retaining essential soil nutrients, and maintaining the tilth (permeability) of the soil in order to maximize water infiltration and microbial activity are highlighted. The ample evidence of ever worsening soil quality and erosion is often used to argue against the removal of any more crop biomass, even if the short run costs make energy conversion economically feasible.

In contrast to both of these polar research strategies—the one aiming to divert production away from food through product substitution, and the other attempting to avoid disruption of food production altogether—the approach used at CBNS has been to integrate energy production with food production through whatever transformations in the agricultural sector are required to maximize the net energy contribution of agriculture while simultaneously maintaining desired levels of food output and protecting the environment. This integrated systems analysis strategy leads naturally to two related research concerns—increasing biomass production and decreasing land residue requirements—based upon the view that many productivity-enhancing innovations stem from production reorganization through flexibility in the choice of existing production technologies, rather than the invention of new individual processes.

Increasing biomass production

Most harvested agricultural biomass is used for the support of livestock. Since proper livestock nutrition is based primarily upon adequate levels of carbohydrate and protein intake, while biological conversion of fermentable biomass into ethanol only removes carbon—the chief constituent of carbohydrates—energy production can be maximized without disturbing livestock production by constructing a new crop system which maximizes carbon production, converting excess carbon into ethanol, while maintaining nitrogen (the source of protein) production at the previous level.

Some surplus carbon is now produced, mainly in the form of cellulosic crop residues which have low digestibility and can only be fed to cattle and sheep. But overall, the current crop system is essentially optimized in its C/N (carbon/nitrogen) ratio. The limiting element to livestock production has always been nitrogen, which requires either energy-intensive nitrogen fertilization of crops such as corn (most of the nitrogen is in the grain), or leguminous crops such as soybeans. An alternative crop system which produces no more than the requisite amount of nitrogen should theoretically enable considerable excess carbon production with little additional expense for nitrogen fertilizer or other agricultural inputs.

The rising demand for ethanol as a high-octane unleaded gasoline substitute serves as a catalyst, inducing three types of livestock feed crop substitution. First, high-yielding crops such as sugarbeets (twice the biomass yield of corn) which are not grown just for livestock feed since the roots, which account for half of the total biomass are relatively unpalatable in their raw form, can be processed into ethanol and also provide residues sufficiently palatable and nutritious for feeding. This triggering effect through processing is very analogous to the case of soybeans, which are also relatively unpalatable as a raw forage crop. This explains why soybeans were an insignificant crop before the technology for processing them was developed shortly before World War II.

Secondly, relatively low-yielding soybean land (one third of corn grain yield) can be replaced with higher-yielding crops through the substitution of corn oil and high-protein stillage from ethanol conversion.

Thirdly, the higher value of fermentable carbohydrates (grain and sugar crops) relative to protein signaled by the rising demand for alcohol allows for greater low-quality carbohydrate production through intensified forage crop production and more livestock feeding of grain straw and stover.

Decreasing land residue requirements

In order to increase the economic and energy efficiency of ethanol production from agriculture, the use of fossil fuels for process heat in distilleries needs to be minimized. This requires serious consideration of the environmental feasibility of utilizing additional crop residues. Although soil erosion is a serious and worsening problem, it does not necessarily follow that no more crop residues can be removed from the land. First, the changes in crop mix induced by ethanol production will probably result in somewhat more residue production, allowing more to be harvested with the same amount left on the land. Secondly, if more forage production is forthcoming from an increased carbohydrate price, hilly and marginal land can be better protected from soil erosion. Thirdly, and most importantly, numerous studies have shown that conservation tillage practices (i.e., a primary tillage tool other than the moldboard plow) allow considerable residue removal while greatly reducing soil erosion from that of conventional land preparation. Conservation tillage need not also imply liquid fuel-saving minimum tillage, although this may by an added benefit.

Since residue removal for providing distillery heat costs little in additional farming energy inputs (including additional inorganic fertilizer energy), it offers a substantial pay-off in net energy gained by ethanol production.

Sample ethanol-food production systems

A computerized optimization technique (linear programming) was used by CBNS to model a simple, aggregate integrated food-energy system for maximizing ethanol production while maintaining food production and preserving the soil. The results of this model are only meant to be suggestive of fruitful lines of research to illustrate the conceptual scheme. But even if later validation of the energy production potential turns out to be considerably less, the magnitude of energy production suggested by this exercise warrants its reporting after only this preliminary research.

The model is based on U.S. average 1973–77 crop yields (considerably lower than for more recent years), 1977 crop acreage, and 1977 domestic and foreign food demands. From 1977 to 1979, crop acreage increased by roughly 20 million acres, but this in turn was offset by larger crop export demands, so that the results are not affected either way. Ethanol production was allowed to come from corn, milo, small grains, and sugarbeets. Corn oil from ethanol production was allowed to substitute for soybean oil; the extra processing energy for corn oil production assumed to be offset by less soybean processing. Livestock rations were required to meet dry matter, crude fiber, digestible protein, and metabolizeable energy requirements. Crop residue harvest for cattle feed and distillery process heat was limited. Distillery process heat was assumed to be 40,000 Btu per gallon of ethanol, and in addition the distillery electricity requirement was assumed to be one kwh or 10,000 Btu of fossil fuel per gallon.

The results from three sets of assumptions are summarized in Tables 1 and 2. Table 1 shows how crop production shifts so as to accommodate the same livestock and grain production along with ethanol production. Restrictive assumptions were made to prevent corn grain acreage from expanding beyond 70 million acres, and to prevent hay and pasture production from falling through the possible feeding of large amounts of sugarbeet tops in both cases. Slightly less than 30 percent of soybean oil is substituted with corn oil in the two alternative systems. The "restricted" sugarbeet alternative prevents sugarbeet acreage from exceeding 35 million acres, while the "unrestricted" sugarbeet system limits beet production to 57 million acres due to domestic and export food production constraints.

In Table 2 an aggregate energy balance for all fossil fuels is presented for each of the two ethanol production systems. In noticeable contrast to traditional grain ethanol net energy calculations, the energy output/input ratio here considerably exceeds the break-even point. This is due to three factors. The first is the assignment of 130,000 Btu per gallon of ethanol output based on its estimated fossil fuel replacement value when substituted for high-octane unleaded gasoline. This value of 1.5 times the energy content of ethanol reflects its approximately 20 percent higher thermal efficiency than gasoline when used in internal combustion engines designed for optimal performance with ethanol, and the considerable refinery energy loss of 27 percent associated with the production of gasoline. The second factor is the series of crop substitutions and ethanol joint feed products which attenuate additional energy expenditures in food production. Of course, the more ethanol production is increased, the more farming energy expenditure is needed at the margin of ethanol output. Finally, the third factor contributing a high energy gain ratio is the minimization of fossil fuel in ethanol production to only the amount used to generate electricity, plus the fossil fuel farming energy to harvest and transport crop residues for distillery process heat requirements.

In summary, Tables 1 and 2 illustrate the great importance of attempting to design a new argicultural system for integrated production of both food and energy. The proper economic comparison for evaluating the worth of ethanol production from agriculture is between the present system for producing food only, and a new system of crop production and livestock feeding which has equivalent food output. Economic evaluations based on a single farm or individual ethanol distilleries fail to account for the wide range of direct and indirect substitutions in the agricultural and petroleum sectors induced by ethanol production.

TABLE 1.—1977 LAND USE AND ALTERNATIVE ETHANOL PRODUCTION LEVELS

[In million acres]

Land use	No sugar beets [1]	Restricted sugar beets	Unrestricted sugar beets
Corn grain	70	70	70
Sorghum grain	14	5	5
Wheat	66	57	57
Barley and oats	23	29	7
Soybeans	53	43	42
Corn and sorghum silage	11	0	0
Sugar beets	0	35	57
Hay	60	60	60
Pasture	83	83	83
Total	380	380	380
Ethanol production (billion gallons)	0	18	27

[1] Source: USDA, Agricultural Statistics (1978).

TABLE 2.—1977 AGRICULTURAL ENERGY FLOW WITH ALTERNATIVE ETHANOL PRODUCTION LEVELS

[In quadrillion Btu]

Energy flow	No sugar beets	Restricted sugar beets	Unrestricted sugar beets
Energy output [1]		2.34	3.50
Energy input [2]	1.55	1.92	2.18
Net energy gain from ethanol production [3]		1.97	2.87
Energy output/input from ethanol production [4]		6.3	5.6

[1] Assumes 130,000 Btu petroleum replaced per gallon of ethanol, based on 20 percent greater thermal efficiency (miles/Btu) and a 27 percent refinery energy loss associated with gasoline production.

[2] Includes fossil fuel in food and ethanol production.

[3] Energy output minus additional energy input.

[4] Energy output divided by additional energy input.

Senator McGOVERN. Mr. Williams, I wanted to just clarify one point that you made, where you say you don't see the economic incentives yet to use alcohol fuels in the diesel engines. Is that a current analysis or is that based on earlier costs of diesel fuel? Diesel fuel is up to—what? $1.15 or $1.20 a gallon?

Mr. WILLIAMS. No, sir, my reference to that has nothing to do with economics. It is just that the farmer, if he is going to be self-sufficient in energy and he's going to put in a still, he has got to be able to use the alcohol in place of the diesel. That is the purpose of it.

Up until now, we have not seen anybody come forward with any conversion to the 85 percent of the horsepower on the conventional farms in America today, that replace substantial amounts of diesel with alcohol.

Senator McGOVERN. You're talking now about pure alcohol as against gasohol?

Mr. WILLIAMS. I am talking about the use of diesel on farms and the elimination of that use by producing your own alcohol. For instance, Senator, I wish that were not the case, but I have not yet been able to find anybody who tells me you can use diesel engines converted to alcohol fuel.

Senator McGOVERN. That was the point I was trying to get at. You're talking about the burning of pure alcohol as over against gasohol.

Mr. WILLIAMS. Well, even in gasohol, Senator, you cannot use the same proportions of alcohol in the diesel engine that you can in a gasoline. For instance, in Brazil, I'm told now they are up to 20 percent utilization of alcohol in their gasohol.

Senator McGOVERN. That's what I understand.

Mr. WILLIAMS. They are at the same time absolutely unable to get their trucks, their buses, and their tractors to use diesel in any substantial quantities, and in fact are importing crude oil in order to make enough diesel for that sector of their economy to continue to operate. So, there is a very serious problem of utilization of alcohol in diesel engines with present technology.

Now, they have gone a step further and simply said they were going to convert half of their automobiles to straight alcohol usage by 1985 and 100 percent of all automobiles would be alcohol fueled in 1990. They still have not yet solved their problem—nor have we—of the use of alcohol in substantial quantities in diesel engines.

Senator McGOVERN. Mr. Carlson, do you want to comment on that?

Mr. CARLSON. I would like to take a stab at it.

First of all: In reference to Mr. Williams' initial remark that fuel use on—liquid fuel use on farms is 75 percent diesel presently, that is true for field crop production, but I believe the overall liquid fuel use on farms, when you take into account the energy used in the farm automobile, the farm pickup and the farm truck, is more nearly half the total. So about half comes from gasoline and half from diesel.

Second: although research hasn't really gotten underway, it does seem possible to modify farm tractors slightly in order to utilize the method of dual fueling, if you take into account the requirement of the diesel fuel in order to keep the engine running properly. It will also allow significant amounts of alcohol to be introduced into the engine, and early estimates have shown that up to 80 percent of the fuel requirement for the tractor could come from alcohol.

Senator McGOVERN. Well, we had representatives of the Post Alpine Co. visiting in South Dakota a few weeks ago. They are the company that pioneered in the development of that alcohol fuels technology in Brazil. They testified that with a mixture of 20 percent ethanol and 80 percent regular fuel, that diesel engines will operate fine on that; and in fact, are, in Brazil.

Is your information to the contrary on that, Mr. Secretary?

Mr. WILLIAMS. Well, the information I got came from a congressman who recently returned from Brazil and talked about the subject. That was Congressman Ottinger—he was the one that pointed out to me the severe problem they were having in the use of any substantial quantities in diesel equivalents, whether it be trucks, buses, or tractors, and that they were, in fact, importing.

Senator McGOVERN. Well, I think that is a discrepancy we need to nail down, because we have a written testimony on record now from the engineers of the firm that developed that technology in Brazil. They started off with the 10-percent mixture, but they say you can carry it up to 20 percent without any notable falloff in efficiency.

I think, Mr. Middaugh, you were at that hearing, heard that testimony; am I correct on that?

Mr. MIDDAUGH. That is correct.

Senator McGOVERN. In any event, those are the kinds of questions I think we need to nail down, because there does seem to be discrepancy depending upon who one is talking to. Obviously this is a new technology but this Austrian company has been in the business a long time. I think they may be the biggest in the world, in terms of developing alcohol-based fuels. And that was their testimony.

Mr. WILLIAMS. Senator, I would not want to in any way imply that we are not going to make alcohol fuel loans. We are. We do think it is important that when the farmer comes in to make the loan that you point out to him that in order to use any kind of credit, if the windfall profits tax passes, to amortize the debt, you're going to have to be able to use the substantial quantities of the fuel, or sell it.

The only market that is a sure market today is unleaded gasoline, and that is anhydrous.

Senator McGOVERN. Well, let me just get into some of these larger questions. Now, you state in your prepared statement that the President has set a national production goal of 500 million gallons of alcohol a year by the end of 1981. Has the Department of Agriculture set its own interim goals for production and use assistance as part of its obligation in reaching that goal?

Mr. WILLIAMS. Yes, sir. Senator, as a matter of fact, before the President's decision was made we asked for $100 million in loan guarantee authority for alcohol fuel, plus the $10 million for onfarm in the 1980 fiscal year. That started last October.

We have now pending some $400-plus million of preapplication notice to us, but most all of that is tentative. I have to preface by saying that it is totally dependent from an economic standpoint on having a tax policy passed by the Congress. The people that want to borrow money or get loan guarantees want to know what the tax policy is before they actually break ground and start this process.

Senator MCGOVERN. Well now, I understand that that is moving along through the conference, that it is expected that maybe the bill will clear the conference in the next week or so. If it does contain in its final form that kind of tax incentive, are you going to be prepared then to move on these loan guarantees?

Mr. WILLIAMS. Yes, sir. We have put together a package that is being sent out to every Farmers Home Administration district and county and State office, and we are prepared to immediately start processing loans. We predicated it only on one further point: We do ask that DOE have the technical feasibility of plant design in their shop, and they will sign off once that has been done. When a prototype is established, we won't go back to DOE from further advance on that prototype. We are not in our agency trying to analyze the technical feasibility of plant design, we think that is more appropriately done by DOE. That is part of a cooperative effort, and that is the only part of the program that is cooperative.

Senator MCGOVERN. Do you have a production target, though, in mind in terms of the 1980–81 period? I mean, if the President says we're going to achieve 500 million gallons production by the end of 1981, that is a very short timespan. I just wonder whether you have any specific other than money authority, which may or may not be used. Do you have any production goals in mind that you would like to see achieved by the small-scale production that has been assigned to you?

As I understand it, DOE is the lead agency in terms of the larger plants, but they have turned over to the USDA responsibility for the smaller community-sized and the onfarm plants. What I'm trying to get at, do you have a production goal in mind? What percentage of that 500 million gallons, roughly, is going to be in small-scale plants, or are we going to have 10 50-million-gallon plants to achieve the 500 millon goal?

Mr. WILLIAMS. No, sir. What I would prefer to do is to fund every one of the small-scale operations that we can possibly fund. I would like to see it done in this way. That is to fund it with the clear understanding that if a secondary market is not able to put fuel utilization on the farm or through sales to his neighbors, that in fact it can go into a cooperative anhydrous community-based unit. We would like to see that the anhydrous capacity of these community-based or cooperative-based operations is great enough to absorb that excess production from small-scale onfarms, so that those farmers will have an opportunity to produce anhydrous and in a patronage dividend sort of a way, similar to any other commodity that is in a co-op or a corporation.

We will not in any way hesitate to utilize all of the authority that we have. The windfall profits tax has not yet addressed the issue of what size operation loans would be made for, either in DOE or the USDA, or the total volume of that lending authority.

It has been talked to in terms of $300 to $350 million a year, but that is in addition to what we have already allocated in B. & I. for 1980 of $100 million.

Senator McGOVERN. Well, Mr. Williams, one of the frustrations all of us are running into when we talk to farmers and community leaders who are interested in this field, they are convinced it is feasible, as you know, and I know you get around the country enough to know that there are few subjects that have come along in recent years that farmers and small business people and small town people are more interested in than they are in alcohol fuels. They are convinced it is one way to break our dependence on high cost, uncertain supplies from overseas, and they wanted part of the action.

Could you work out a procedure where, on a monthly basis, you give us a report on the loans that you have cleared, either the guaranteed loans or the direct loans, so we know what is going on, and indicate to us where those States are, where you've made the loans and the size of the loans? It would seem to me this would be a matter that it would be rather simple to get for us, and what the production, roughly the production totals will be from the kind of loans you are making, and also, to give us some indication of what the USDA is providing in the way of technical and management assistance.

I mean, if this is what I think it is, an opportunity to not only assist farmers but assist the whole country on its energy requirements, it seems to me we need a little better public reporting procedure on how we're going about it. Otherwise, it seems to me we're going to set the stage for a lot of disillusionment in the field.

I appreciate the fact that you want to be careful about not getting into things that aren't economically feasible. There is a growing body of opinion from an awful lot of thoughtful individuals that have worked in this field, and we have the experience in Brazil, we have the experience of some of these private operations, kind of do-it-yourself operations that are developing, and there is a growing conviction on the part of people out across rural America that this concept can be made to work.

Could you supply us that kind of monthly information?

Mr. WILLIAMS. Yes, sir, we would be happy to do that, Senator.

Senator McGOVERN. Well, I personally would feel a lot better about it.

Mr. WILLIAMS. What we would like to do is send you immediately the preapplications and all of the inquiries we have had up until now and the status of those inquiries.

Senator McGOVERN. I think that Congressman Long and Senator Stewart and others who are interested in this field would be interested in seeing that information. Then it would give us some idea of what is going on and what the problems are.

Congressman Long.

Representative LONG. Yes, thank you, Senator.

Mr. Secretary, pursuing the Senator's line of discussion, through March 1, 1980—and I'm reading from your statement now—the Farmers Home Administration had had serious discussions with 273 possible applicants for loans or loan guarantees for constructing alcohol fuel production facilities totaling about $850 million. Of these, 42 have submitted preapplication material, 25 have applied for loans, and 8 others have received loans or guarantees.

The eight loans or guarantees were for a total of $2.8 million to fund construction of 2.9 million gallons of annual capacity. This is about $1 per gallon of annual capacity. Is that a reasonable figure on loans, $1 per gallon of annual capacity for the loan or grant?

Mr. WILLIAMS. I would suspect that that is a low figure. I think that the larger scale operations will have a higher capital intensity than the small scale, that doesn't dry the residue and has the ability to feed directly to livestock on the farm. In capital outlay, I would think that the dollar a gallon is going to be a low number.

Representative LONG. As you go into the more sophisticated technological processes, that capital investment figure is also likely to rise, is it not?

Mr. WILLIAMS. Yes, sir. That is the loan guarantee portion that we are talking about and not the total equity of the corporation.

Representative LONG. Yes; earlier these might have also had, particularly if you all had funded it, they might very well have had a substantial amount of capital on the other side, I would think.

Mr. WILLIAMS. Yes, sir, the loan guarantee is up to a 90-percent loan guarantee.

The question then falls on how much equity is required for cash flow in the amortization of that total debt. In some instance, it may be 10 percent because of no land acquisition required for onfarm, or even a cooperative may have the capacity in its own system that would not have to have additional land requirements for the addition of an alcohol unit. So each case has to be looked at.

Then, of course, as we point out in the testimony, you can take advantage of your existing materials handling equipment, your rail facilities or transportation facilities. You can certainly cut the capital requirement if you convert to something that has waste heat generation capacity. There are a number of things that all play a part of that total capital outlay.

Representative LONG. Do you see any short-range conflicts between the historical responsibility of the Department of Agriculture in the production of food and fiber for the peoples of the world and the production of food and fiber for making energy?

Mr. WILLIAMS. No, sir, I don't. We have made that determination through Secretary Bergland, and he has simply made further evidence under the 1977 act that one of the legitimate uses of grain for all set-aside and diversion, all programmatic decisions, will be the use for alcohol fuel.

I would want to point out that we have not seen a scenario that goes beyond 1985 that doesn't begin to move in a much different direction that what we now have, which is alcohol fuel primarily grain-based. To follow up on the use of residue, the use of woody cellulose material, are all possible and all feasible.

At this point, the one thing that has kept cellulose conversion from moving ahead has been the inability of the enzymes to break down lignin, which is part of the cellulose, some one-third of the cellulose. I I hope that that research project that DOE has been involved in with Mr. Tsao at Purdue will make some major breakthrough by the end of the contract this year, but up until now we do not have enzymes that break down the lignin portion of the cellulose.

Representative LONG. I would gather from a perusal of your prepared statement that one of the reasons you feel that is so important is because you have there a major source of raw materials all over the United States, not now being used for any other purpose, and, consequently, could make a material contribution here.

Mr. WILLIAMS. And has a much lower cost per ton for conversion purposes. It involves the research that the other gentlemen have spoken to today about cropping patterns, raising crops specifically that are more easily identifiable for multipurpose, both protein a wells as fuel. It does in fact require some further breakthrough in order to utilize for woody products cellulose conversion.

Representative LONG. Are you at all optimistic as to what the scientist are going to be able to do in that regard?

Mr. WILLIAMS. I am personally very optimistic about it. It is a major initiative that we have going on, both at Madison, Wis., with the Forest Service Laboratory there, and with the Peoria, Ill., laboratory, agricultural research center, and joint work that we have going on with an exchange of scientists with the University of Arkansas, as well as Peoria, trying to get the very best information we can on this subject.

Also, we've been involved at Auburn University with their technologists, but at this point we simply do not have an enzyme that breaks down cellulose.

Representative LONG. What do you mean by this:

> While the direct combustion of wood is limited to stationary uses and therefore it does not directly displace petroleum fuel in the transportation sector, the expanded use of wood promises to free up greater quantities of fuel liquids in the short term than the conversion of agricultural commodities into alcohol fuels.

Mr. WILLIAMS. The volume of what is known as unmarketable wood is simply a tremendous volume of material, and woodlot management and the idea that Senator Stewart and Senator Talmadge have been working on of using wood to eliminate oil or natural gas for boiler fires is in fact the displacement of liquid petroleum, and that is where we're trying to come from. The potential for that displacement is, of course, a very large number; much larger at the present time than we think it will be from grain.

Representative LONG. Did I understand you to say that in the immediate future you would expect that the use of wood as a furnished fuel would displace probably more than would the alcohol fuels made from grain?

Mr. WILLIAMS. Yes, sir, that is correct. That comes from two major reasons. One is the use of wood already by the forest products industries who are in the materials handling business, bring in wood and often can use what is waste wood for heat conversion that in essence eliminates the use of another type process, where if it were coal it would not be elimination of liquid petroleum, but fossil fuel. It if were oil or natural gas, then it would have a direct displacement. We're also setting a contract on Wednesday of this week with Guarantee Fuels of North Carolina, who have just come up with some $600,000 of capital for a project that will make hardwoods into fuel pellets, and that will then be sold to a textile mill who must stop using oil and natural gas.

They're being pushed into coal, and with the tremendous capital requirements for scrubbing the waste stack gases, under EPA guidelines, they have chosen to opt for going into wood pellets, which would fire the boiler rather than coal.

We are optimistic that that is a way for the future. There are some people coming in tomorrow from Florida, that happens to be my home State, who have been doing a considerable amount of work in both sugarcane bagasse as well as waste wood, which is a rather prolific material in a large part of Florida. We are a very large timber State, but like Georgia and some other Southeastern States, about half of all the wood volume in some of those States is not presently marketable timber.

So the use of that unmarketable wood in converting the forests to species that are marketable or energy-related, with woodlot management, would make an awful lot of sense to us.

Representative LONG. I had no idea that it was anywhere near as big as that. Of course, we in America tend to get caught up in these technological things, like making alcohol and using it for gasoline. But you are saying that in the immediate future more fuel is going to be displaced by the use of wood per se than by alcohol fuels made from grain?

Mr. WILLIAMS. In total Btu's, that is the analysis that we've made, Congressman Long.

Mr. HERTZMARK. Excuse me, Senator. I would like to answer a previous question. Mr. Williams stated that right now we didn't have the capacity to convert cellulose products to alcohol. The University of Arkansas in Fayetteville is continuing development on a process that was developed by the Gulf Chemical Co. to convert cellulose products, primarily newspaper, to alcohol. They have had a pilot plant operating for several years that actually does produce fuel grade alcohol as an output. So I just wanted to clarify that one point.

Mr. WILLIAMS. Yes, sir. That has been true. I went down and I saw that one also. When you ask them to, if they have the ability to deal with lignin, they do not. They simply take the lignin after it doesn't break down and then they dry that and use it for boiler fuel for their operation. It looks optimistic, but if you tell anybody that there are commercial cellulose conversion plants in operation today, I have not yet seen one.

Representative LONG. The 500 million gallons per year target for the year 1981, do you all expect to be able to meet that?

Mr. WILLIAMS. Yes, sir, we do. The original goal was to meet that goal in 1980. That did not seem feasible. We think 1981 is feasible, and in our own shop, if the preapplications are processed, that is some $400 million that there is immediate interest in. In addition to those, there are others. At the present time, there is about 80 million gallons a year being produced. The Archer-Daniel-Midland plant at Decatur, Ill., is producing about 50 million of that in the current year, and they have announced intentions to go to Cedar Rapids, Iowa, with another operation that will be in about a 40-million-gallon range.

We think it is achievable, and in fact with the proper timing of the windfall profits tax and the initiative from all of us in Government, I think that we can go further than that. The question is how much construction can be accomplished and online by the end of 1981.

Representative LONG. Thank you, Senator.

Senator McGOVERN. Thank you, Congressman Long.

Before I yield to Senator Stewart, Mr. Williams, there is just one additional point I wanted to raise here, and then I think Senator Stewart has a brief statement and also some questions.

A group of my constituents in Scotland, S. Dak., have put together the main part of a small-scale gasohol plant. They have raised about $150,000 locally and they have got a lot of the labor and the technical and legal services donated. In any event, they have been told repeatedly by both the Department of Agriculture and the Department of Energy that assistance would be available to help them complete that plant. They need another $100,000, maybe $150,000 in loan money to finish that plant, which will have a production capability of about 1 million gallons a year.

When they go to the local offices of the Department they are told the money is not available.

Mr. WILLIAMS. That is probably true, Senator, and it is because of the policies that I've discussed with you up until this point. What we are looking for is to go this month with all of the information we have to every FmHA county office, to analyse and to turn over to their prospective customers an analysis sheet of about seven pages, and they run through it and determine whether or not they in fact want to proceed, because of the economics.

It is an economic analysis, but we are prepared on April 1 to go into finalizing these loans. I would caution you, I don't mean to come before the Congress and in any way be critical, but we need a tax policy in order for this situation in 1981 to be consummated.

Senator McGOVERN. But if we assume that the House and the Senate is going to sign off on that windfall profits tax in the next couple of weeks and we do have that provision in there in the excise tax waiver, then do you think you will be in a position to make some loans?

Mr. WILLIAMS. Yes, sir, for $110 million worth we are ready to go. If the windfall profits tax takes us beyond that, we will be able to deal with those additional dollars.

Senator McGOVERN. Well, look at that one in Scottland, S. Dak. They have been working on it for a long time.

Mr. WILLIAMS. I will personally review it, Senator. I do a lot of these sorts of things and I will be glad to look at that one.

Senator McGOVERN. Welcome, Senator Stewart.

STATEMENT OF HON. DONALD W. STEWART, A U.S. SENATOR FROM THE STATE OF ALABAMA

Senator STEWART. First, Senator McGovern, I want to commend you for having this hearing. I know that there are some of us who are new to this particular battle but you have provided tremendous leadership in this area since 1972. You have been talking about alcohol fuel since that time, and have made a believer out of me and a lot of other people in the Senate and in the House, and I think Congress has moved ahead because of the leadership of people like you and Birch Bayh and others. I want to commend you for it.

Also, I want to thank you for giving me the opportunity to ask some questions of Mr. Williams and to submit a prepared statement for the record.

Senator McGOVERN. Thank you, Senator Stewart. Without objection, your prepared statement will be made a part of the hearing record at this point.

[The prepared statement of Senator Stewart follows:]

PREPARED STATEMENT OF HON. DONALD W. STEWART

Senator McGovern, it is indeed a pleasure to appear before you today as you address a very important issue in the overall energy picture. For decades our Government has had a terribly irresponsible energy policy. We have allowed our Nation to become dependent on a small cartel of oil-producing nations and a small oligopoly of multinational energy conglomerates. If we have learned nothing over the past few years, surely we should have learned that all of our energy eggs should not be placed in one basket. We should no longer be dependent on a small group of producers for any essential supply of energy, whether that group be the Exxons and Mobils or whether it be the Saudi Arabias and the Nigerias.

If we are ever to achieve our energy independence, Senator, and avoid further international confrontation which threaten the peace of the entire world, we must move to a diversified energy supply. While the large energy producers certainly will have a major role in this supply, our Government must develop policies that insure small producers are also included.

In this decentralization of the energy production of this country, rural America must have a strong role. Rather than being a drain on the energy supply of this country, rural America can become a contributor to our energy production. This can only happen, however, if we adopt the correct governmental policies.

Unfortunately, I have a great deal of doubt as to whether the correct policies will be adopted. The administration has made a major policy statement on alcohol fuels, for example. They say that they are committed to an alcohol fuels policy. They talk about the role of small-scale technology in that policy. Yet, when it comes to specifics, I find that I can not get agreement from the Carter administration on how to implement their program. I have worked for months with both the Department of Energy and the Department of Agriculture to try to develop a workable alcohol fuels policy for America, a policy that will have both small-scale and commercial-scale production, and, let me tell you what I have run into. Some people at USDA understand the problem and are doing all they can to reach a responsible solution. I could ask for no one more fair nor sincere than Jim Williams. Though he has been frustrated at every turn, Jim has done admirable work to form a consensus policy. Unfortunately, other people at USDA seem to spend more time fighting alcohol fuels than trying to make them work.

The agricultural community obviously must have a strong role to play in an alcohol fuels industry, and, if we are to reach that community, USDA must play a major role. If we tell the farmers of America to go to the Department of Energy for help in developing the capability to produce alcohol fuels, we will be making a major mistake. DOE has no way to reach the farmers of America; they have no financing capability, and most importantly, they do not have a desire to develop a small-scale on-farm production capability for alcohol fuels or any other renewable resources.

When I make this charge, I do not make it idly. Several weeks ago, I held hearings in the Small Business Committee to find out what share of DOE solar funding went to small businesses. What I found out, Senator, was shocking. Even though solar energy is clearly suited to small-scale and decentralized technology, these hearings revealed that more than 95 percent of the solar research and development funds of DOE are going to large corporations. These corporations include many who have vested interests in proving that solar energy is not practical. Many companies who get large amounts of funding are companies that have issued public statements questioning the viability of solar energy. Yet, DOE continues to give the money to these Doubting Thomases.

If we are to have innovation and creative development of a decentralized renewable energy industry, it is critical that all of the funding not go to the energy conglomerates that have a stranglehold on our Nation today. I don't know about the rest of you, but I don't want Exxon controlling the solar industry or Texaco controlling the alcohol fuels industry.

If we are to avoid such a result, Senator, the Carter administration is going to have to get together and develop a strong policy, with enthusiastic agreement from USDA, DOE, and the White House. As for the specifics of what that policy should be, I believe we have the basis for a responsible program in titles II and

III of S. 932, the omnibus energy bill. These two titles have agreed that the smaller and on-farm alcohol fuel programs would be based in USDA, with the larger projects handled from an Office of Alcohol Fuels in the Department of Energy. The core of such a program in USDA should be loan guarantees to get the necessary financing for today's technology. However, it is also essential that the Agricultural Extension Service be given funding to provide necessary financial and technical information to the agricultural community. The last thing we want is farmers buying stills from fly-by-night operators. USDA is in a position to assist the farmers in operation of their facilities.

Another key element of the program needs to be research funding and authority for USDA. As you well know, Senator, there are other advances in technology, particularly in the cellulosic conversion area, that would enable alcohol to play an even greater role in America's energy future. Though the Department of Energy is also involved in this research, I am convinced that many unique energy needs of rural America can only be answered with assistance from USDA. Quite frankly, I do not believe the mentality at DOE is directed toward the most effective use of solar energy to dry crops or what is the best crop rotation in Alabama or South Dakota for a farm co-op that is producing alcohol for its members use.

I do not believe that DOE should be excluded from involvement in renewable energy sources. They do have an important role to play. I would only suggest, Senator, that they do have an inherent bias towards the idea that "big is better." Title III of the energy bill gives DOE the authority it needs in the area of alcohol fuels and I am hopeful that authority will be well used.

However, I am very concerned that many key elements of title II and perhaps even title III may be lost in conference if we do not mobilize our forces to combat those who disagree with us. To do this, we need the strong and open support of the White House, DOE, and USDA for the alcohol fuel provisions of S. 932. We also need unity from the Senate, in resisting any House efforts to remove any essential elements from the program. Knowing of your long and untiring efforts in this area, Mr. Chairman, I know you will do your part. I just sincerely hope that our allies will not be complacent. A strong and effective program can only come from concerted efforts by all. Thank you.

Senator STEWART. Mr. Williams, let me ask you this: Have you all reached the memorandum or signed the memorandum of understanding between the Department of Energy and the Department of Agriculture that we have discussed previously on prior occasions?

Mr. WILLIAMS. I would like to be able to tell you that the issue has been resolved. The fact of the matter is I met with the Deputy Secretary of Energy about 2½ weeks ago, and he asked me to put in memorandum form what I thought we had agreed to. I did, and it had to do principally with three things, Senator, and I, for the life of me, don't know why we can't get an agreement.

The three things, simply, are this: That the Department of Agriculture, because we are the lead agency in the food and fiber policy, would like to have some say about the total estimated use of grains or other feedstocks for alcohol fuel; and that even if the lending program were in other agencies, that if it impacts on food and fiber policy, we would like to know what their plans are so we can build it into our scenario or setaside or no setaside, diversion or no diversion.

We also agreed that DOE ought to have technical feasibility analysis capability on any plan; that is not something that the USDA has the expertise, nor do we think is needs to be duplicated in USDA.

So, those two, I think, are relatively simple.

The third component, which just blows our minds every time we talk about this subject, is that I am unwilling for USDA to be restricted to less than about $15 million in loan guarantee or plant size, for this simple reason: I am convinced that until we do use substantial quantities of alcohol and diesel tractors, that farmers ought to be in a position to go anhydrous through cooperative arrangements or corporations or community-based plants, and that I am unwilling to come under a mandate in an agreement with DOE that reduces this below about a $15 million plant size.

We have authority under other lending authority to go to whatever level we need, but under the windfall profits tax—and that's the only part DOE is involved in—they are insisting that we cut off at about a $2 million plant size.

After meeting on this subject, since last October, I have met my last time with DOE, and I have informed OMB that, under the circumstances, there is but one way to resolve the difficulties, and that is for the DOE, the USDA, OMB, the domestic policy staff, and anybody else interested in town, to put a memorandum in to the President that does two things: Do you want DOE in the lending business onfarm scale, and agricultural product; and second, if you do, what level of loan should the USDA be permitted to make under that policy?

I met as late as last Saturday afternoon at 4 p.m. and made that message directly to Mr. McIntyre. So, in essence, Senator, I am sorry that we have been unable to work out differences, but frankly, the Congress and the President are going to have either to put DOE in the lending business or put them out of it. They are not presently in it. In the meanwhile, the USDA is going to administer its lending authority that it presently has and take whatever dollars the Congress gives us and move steadily ahead into alcohol fuels.

Senator STEWART. With all due respect, this has been one of the most difficult problems I have ever had to track in my legislative career, and I served 8 years at the State level and dealt with folks who had been down there for 25 or 30 years and had their departmental concerns expressed to me and to others from time to time.

We have got—my concern is this—we have got enough problems in this area without having a conflict present in the administration. I say that understanding, Mr. Williams, that you have done everything that you can. You are sincere. You are fair, You have worked hard to try to resolve these differences, but where we are right now is we are working hard on an alcohol fuels program in the overall energy package. We have got some differences of opinion between the House and the Senate and between some of the committees that exist within the Senate and the House that have different jurisdictional concerns. We are trying to resolve those.

If we don't have a fix on the position that the administration is taking, I am afraid it is going to create some real problems for us. Those loans that Senator McGovern is concerned about, and Congressman Long and Senator Stewart and others, are going to be fairly well tied up in a conflict that exists between two departments whose job and responsibility it is to make sure that the energy policy works. And that is what I am concerned about.

I have expressed that concern to the folks at DOE, and I don't know quite how to handle it Senator, but I think we are going to have to handle it. I would hope that this administration that indicated a strong sense of urgency about alcohol fuels—and I address this in my prepared statement—that indicated a strong sense of concern about farmers and their fuel supply and their needs in that area, would have the capacity to sit down with the people at DOE and the people at USDA and get them together so that you could come to Congress and to this conference committee, that's going to begin to meet on alcohol fuels in the not-too-distant future, with a unified position, because I would hate for us to be tied up, Senator McGovern and Congressman Long, arguing about whether DOE or Agriculture should handle the problem.

I think you have got the research mechanism and the delivery mechanism in the field to deal with the agricultural interests. On your first two points, I have no problem about that. How you arrive at whatever you do, in the latter point, I frankly don't know the answer to that. That apparently is the sticking point that you have got. You don't want, as I understand it, a level of lending attached to any moneys that are provided to the USDA.

Mr. WILLIAMS. We don't even mind discussing it at the $15 million level. What we can't do is to in any way guarantee to a farmer with a small-scale onfarm proposition that he has access to a community-based cooperative or corporation in which he can market and get the 4-cent anhydrous credit. That is the guts of the argument.

It is embarrassing to come here, but, Senator, I have had 11 years of Government experience, and this has been one of the few times that I have absolutely failed in being able to hammer out a compromise.

Senator STEWART. Well, we're not going to fail. I just don't want to fail in this thing. We've put too much time and too much effort into it. And I will work with your staff and Senator McGovern's staff and Congressman Long's and others', and we are going to present a memorandum to the White House and ask that somebody from the Domestic Policy Council, if that is the proper approach to take, sit down with the folks at USDA and the folks at Energy and get this particular problem resolved.

The reason I want you all interested in this—and I have got this in my prepared statement—is, we had some hearings just the other day on solar energy. And we found that the DOE was somewhat biased—frankly, shockingly biased—toward the large-size concern. As a matter of fact, some of the very people who were opponents of solar energy technology being a part of our energy solution in this country were receiving the largest portion of the grants. As a matter of fact, we found out they were receiving about 95 percent of the money.

If we are really serious about giving people an opportunity to participate in solving the energy problem and doing it in a decentralized way, where we take advantage of the small-scale technology and the farmer's capability, I think the USDA has got to be involved in it, and I just feel very strongly about that.

Mr. WILLIAMS. Senator, the other point I would make is that there is no question about USDA's being involved, but the windfall profits tax doesn't make any effort to take USDA out of the lending business. It simply is being contemplated as a way to put DOE into the lending business. I have no problem with that if the Congress and the President want DOE in the lending business, fine.

Senator STEWART. Well, the way they lend in certain areas, I don't know that the small-scale production would receive much attention from them. That's the thing I am concerned about, to be very plain about it. I am just concerned about whether or not—you know, I have traveled throughout the State of Alabama; I have talked to farmers. About 250 of them with the Farm Bureau are up here this morning. Some of them are interested in alcohol fuel plants and facilities. I have told them that USDA is going to be ready, willing, and available, once the windfall profits tax passes and the energy package passes, to assist them and to help them. What it looks like now is, we are going to be involved in a conflict at the national level and they're going to be left waiting at the gate unless we get active and involved.

Mr. WILLIAMS. We are ready to go with $110 million now.

Senator STEWART. We want to give you more than $110 million. I don't want to be greedy, but I want you to have more capability than that, because if you don't have any more capability than that, I am afraid that portion of the alcohol fuels program I am concerned about won't receive the attention.

You think maybe Mr. Eizenstat and they would welcome some help and assistance in this area? We're going to try and give them some.

Mr. WILLIAMS. Well, I don't know. I have talked to everybody, including the President, on this one.

Senator STEWART. Well, so have I.

Mr. WILLIAMS. I think that there is no way short of a decision memorandum being executed by him that is going to resolve the issue, and that is not an unusual thing. On every major issue that comes along, he has to take a position, and we have been ready for months for the President to take a position. I think that we have failed to negotiate between the two departments. Both should be ashamed of ourselves, but I am ready to prepare a memorandum to go in to the President.

Senator STEWART. Well, we will work with your folks on that and attempt to assist you in getting that decision made. I hope that we can get it made rather quickly. Thank you, Mr. Williams.

Representative LONG [presiding]. Thank you very much, Mr. Williams, Mr. Hertzmark, and Mr. Carlson. We are very appreciative for your coming.

We are pleased to have five additional witnesses. Lance Crombie is a home-farm alcohol producer and a member of the Alcohol Fuels Advisory Panel, Farmers Home Administration from Webster, Minn. Sam Eakin is a member of the Alcohol Fuels Advisory Panel of the Farmers Home Administration, from Baton Rouge, La. Also, Al Mavis, whom Senator Percy has already introduced; Mr. Mavis, we are pleased to have you. Paul Middaugh is a professor of the microbiology department of South Dakota State University in Brookings, S. Dak.; and Mr. Don Patterson is the Virginia State coordinator for the American Agriculture Movement, from The Plains, Va.

Senator, if I may say a word, one of these gentlemen is from my congressional district and comes from an outstanding family that has made a major contribution to our State. I am sure he is continuing in that same regard.

Mr. Eakin, we are particularly pleased to have you with us today.

Mr. EAKIN. Thank you, sir.

Senator MCGOVERN [presiding]. Thank you, Congressman Long. I want to welcome our second group of witnesses this morning; especially Paul Middaugh, who is a professor of microbiology at South Dakota State University, and in our State he is known as the leader and the best known and most respected spokesman in this whole area of alcohol fuels.

We are very happy to have you here, Mr. Middaugh, as well as all of the members that comprise this distinguished group.

What I would suggest is that each one of you open with a brief statement and just highlight the points you most want to make, and then that will give us a little more time for a give-and-take.

We will begin with Mr. Eakin.

STATEMENT OF SAMUEL F. EAKIN, MEMBER, NATIONAL ALCOHOL RESEARCH INSTITUTE, UNIVERSITY OF SOUTHWESTERN LOUISIANA, LAFAYETTE, LA., AND MEMBER, ALCOHOL FUELS ADVISORY PANEL, FARMERS HOME ADMINISTRATION, BATON ROUGE, LA.

Mr. EAKIN. I would like to say, first of all, I appreciate the opportunity to be here to express my opinions on financing. I am a consultant to E. F. Hutton on alcohol financing and, as a result, am very eminently involved in the day-to-day financing of problems in the private sector.

I am at this point sympathetic to some extent with Mr. Williams concerning the stabilization of Government policy, because this is a problem; and at this point in time, every time that there is a fluctuation in the existing policy or there is some concern over changes, the attitude of Wall Street is: We're just going to hold back until we find out what the end of the line is.

It is significant to say that tax considerations play an extremely important part, and until those are stabilized and verified, the flow of capital out of the capital-intensive areas will be slow, at best.

I would also like to say that we, I think, as an industry suffer from a large dose of future shock, and that we are pushing technology as fast as we can because we didn't do that in the early 1970's. The result is now that the producers aren't sure of the collateral. At present, without the Government programs and without a Government policy, there would be no collateral at all, and, as a result, we are banking not assets, but future cash flows that are because of Government programs.

Along this line, I would like to identify the biggest problem I see as one of capital intensity that we are trying to move in the Government sector. We're trying to place a capital-intensive industry in the rural sector, and we all agree that we need more capital in the rural sector; we all agree that we need this industry. But our approach is the same as if we were financing a beauty parlor or any other type of standard farmers hall. We have got to recognize that there are extremely significant differences between alternate energy financing and standard Government program financing, as it exists today.

At this point in time, to put up a small alcohol plant of $3 million in a period of time when we have record crime rates and a contracting money supply, we are asking the banks to do two simple things that are totally exclusive of each other. We cannot ask a small rural bank to take on a $300,000 risk when its loan capacity is $100,000. Similarly, we are asking that same board of directors to take on a risk that is uncertain. As such, the financial community at the local level is really uninformed as to how to go about these things.

Senator MCGOVERN. Doesn't that underscore the need for USDA and DOE to be providing more technical and management advice and assistance to people that are getting into this field?

Mr. EAKIN. Absolutely, sir. I would also like to say, on that point, that even now there is a lot of talk about doing that, but the approach right now is not systematic in any form or fashion. There are plenty of good universities around who have really committed to ethanol and there are a lot of universities who are trying to jump on the bandwagon. No matter which one you decide to use, let's decide to use someone and get the ball rolling. We cannot do what is politically acceptable and throw money around to universities just to keep everybody happy.

I would like to suggest that right now—we find no problems in the development of equity capital in the market; the problem is, of course, long-term debt financing. Because of this, however, it should be recognized that 10 percent equity position in a plant of $2.5 million is a quarter of a million dollars and, in the rural sector, that represents normally a number of interests and gets into security transactions and investment tax credit and tax shelter aspects that are fairly sophisticated, and the Farmers Home Administration or the Small Business Administration isn't prepared to deal with these types of things at this point in time.

My answer to these things are really twofold. No. 1 is that we need to create—get across the syndrome that we are going to make alcohol financing to fit our programs and to start designing programs that fit the industry.

That is going to require some changes. I would suggest, first of all, that we take a look at the title XI merit financing, which serves the inland tooling industry and is a tax-exempt bond financing, which is 87½ percent, and similar equipment in nature to steel and depreciation value as ethanol plants. Also, the Housing and Urban Development mortgage amounts, when you get into tax-exempt financing, with the heavy availability of spreading the risk among capital-intensive sources and moving capital from insurance companies and Chase Manhattan into the rural sector.

Additionally, we should look at guaranteeing a large combine of notes, of funds, so that it can be carried through the correspondent banking system in such a manner as to get the Government out of the loan-processing business. Right now we have a number of Farmers Home Administration loan officers who are totally ill prepared and uneducated. It's not their fault; it is simply that we have constructed ill-financed loans that are sizably different from anything they've done before. Handling on a larger scale, by guaranteeing a set of 500 $100 million loans, we can quarantee one $500 million loan which can go through the federally regulated banking system. Then we have people in the private sector working for us who know the businessman who comes in, who knows that he can make a buck at it and knows how it's going to work out.

If there are problems in terms of the technological aspects and the availability of engineering, I assure you the private sector will make sure that it is bonded and that is it taken care of and that the risk is removed from the investor in all of the engineering companies.

Based on that, I think that there is a big future in the leasing industry. Farmers Home right now can guarantee tax-exempt bonds. Its policy is not to do so. It is common knowledge that the Treasury Department has put a lot of pressure on the Department of Agriculture not to enter into the guaranteed tax-exempt bond market. If you calculate the amount of revenues lost to the Government from the tax-exempt financing versus the amount of revenues generated by a new alcohol fuels business, even excluding the amount of payments that you save in terms of importing oil, it is a ratio of about 4 to 1, and it is a very shallow argument to suggest that we shouldn't allow the industry at this point in time use guaranteed tax-exempt financing.

Even though Farmers Home can guarantee tax-exempt bonds, they have, on one past occasion that I know of, guaranteed bonds for a rural sector, and that also was a hotel financing.

In terms of leasing, under Farmers Home—and to my knowledge, we have not found any precedent releasing within the industry—there is nothing to prohibit Farmers Home from guaranteeing loans to leasing companies and then allowing the leasing company to make loans out. Doing this, if you leverage Government money through tax shelters, adding approximately 30 percent of the total capital necessary, this would bring an additional 30 percent capital available to the market which would otherwise just not be there.

In doing so, also, we would find that leasing companies would standardize the industry to the extent that the Government cannot really do because this would represent a conflict of interest in choosing certain designs and engineering patterns.

Hence, my suggestion at this point, gentlemen, is that we pursue tax-exempt bond financing and leverage lease financing on a large scale and let the private sector do its work and get the Government out of the loan business, as such, until we have educated these people. Then if Farmers Home wants to make smaller loans to farmers, certainly they are prepared and capable to do that.

The only other statement I would like to make is a direct concern of mine concerning price guarantees. I know there are price guarantees coming down from the Department of Energy. I assume there will be similar price guarantees through the Department of Agriculture. The day that we start guaranteeing prices and profits to ethanol plants is the day that we insure that alcohol production will always exceed the price of gasoline.

If we are going to insure a profit, that profit has to be based upon expenses, and logically any investor is going to maximize his expenses to maximize his profits. Even if we define this in narrow terms, and limit salaries and so on, the investor will make sure that he expends more capital on debt financing so that he can pull profits out of the debt at a tax-free rate, and then have the Government pay for the debt.

As a result, we are inviting disaster with price guarantees. I, for one, see absolutely no way around that, and no reason that this should be pursued.

Thank you for your time.

Representative LONG. Mr. Eakin, I think your point with respect to the feasibility studies and the grants that are made is extremely interesting. We have gotten into the habit of thinking that we can throw money into these things. Elucidate on that point for a moment, if you will. I think the point you made in your statement is a very, very interesting point.

Mr. EAKIN. Well, my point there is that we have two ways to approach feasibility studies: one is to throw money at everything that walks, so that we can get private opinions on things, in such a manner that we have spot checks around the market. Now, if we were to approach this on a systematic basis and provide a study of the entire United States, county by county, in a way that we could provide the Department of Agriculture's field people with references so that they would know whether the data they were getting were reasonable or not, then that's one thing; but to put out $4 million on a coal gasification plant study—it makes sense to me that anybody who could realistically think about a coal gasification plant should certainly have the internal capacity to generate that study themselves.

I also find that the study, the cost feasibility studies, are grossly exaggerated and my firm does studies—and studying the market most of the time people are buying an engineering study as opposed to what is really—what needs to be an economic feasibility study.

Senator McGovern. Thank you, Mr. Eakin.

[The prepared statement of Mr. Eakin follows:]

Prepared Statement of Samuel F. Eakin

Thank you, Senator McGovern, for the opportunity to provide input on Federal policy for financing of alcohol plants. Because my area of expertise lies in the financing of small scale alcohol plants—10 million gallons or less annual production—I will restrict my statements to these types of operations.

All detailed illustrations represent the end product of countless hours of research into the economics and financing of alcohol plants.

PROBLEM AREAS

Changes in policy

(1) *Government policy.*—Because the industry at this point is a government creation with no history or track record per se, it is supersensitive to changes and fluctuations in government policy. Hence, with every change in subsidy, every new program, every new policy which affects alcohol fuels, comes a delay in the investment of alcohol fuels by the capital markets which are waiting for policy to stabilize before putting any money at risk.

Technological obsolescence

In this sense, the industry suffers from a bad case of future shock. As the government is now spurring technological innovation indiscriminately and as more policy decisions are made concerning alcohol fuels, the financial world is forced to place a zero value on alcohol production collateral due to the possibility of technological obsolescence and government dependency. This means that the industry as a whole may never be able to exist without government subsidies and programs until a more rational, stable policy is adopted.

Government guarantees

(2) Capital intensity.—By far the most serious problem existing today is the pervading government attitude that a guarantee will finance anything and that enough money will cure any problem. This relates directly with the capital formation problems currently being felt in the industry.

Capital intensity and the rural sector

In a period of record prime rate and contracting money supply, where the federal government is restricting lending to control inflation, it is at the same time trying to place a capital intensive industry in the rural sector which lacks the necessary capital. As an example, consider the current effect of asking a small, rural bank with a $100,000 loan limitation to finance 10 percent of the risk for a $3 million alcohol plant, at a time when the bank cannot provide for its normal customer operating loans, much less make a $300,000 loan. Consider also the effects of asking the board of directors of that bank to take on a relatively large loan with indefinable risks—such as the collateral value of an alcohol plant.

Existing programs

In its effort to speed up production, the government has tried to make use of existing programs to make loans to the alcohol industry. Unfortunately, this has been done without recognizing the differences between financing businesses with known histories and collateral values and financing alternate energy plants.

The result is that there are currently a large number of field agents in these agencies who are as much in the dark about alcohol financing as the borrowers who come to them for guidance.

Equity capital

It has been my experience that equity capital for alcohol production facilities is readily available. However, due to the size and nature of the industry, there are many tax considerations and security laws which come into play and which have substantial effect on the investment as a whole. Because of this, investment and financing as a whole is a complicated, sophisticated transaction which, in most cases, does not lend itself to the existing types of government financing and application forms.

Long-term debt

Even given the availability of substantial equity capital, long term financing is not available without some form of government guarantee, due to the present tight money situation. Research indicates that the difference between seven- and ten-year terms are critical to the industry, even with rising gasoline prices far in excess of rising ethanol production costs.

Management education

(3) *Education.*—As I have indicated, the industry is currently faced with loan officers and field agents who are unfamiliar with gasohol production and finance. These people must be educated, made knowledgeable in order to help borrowers finance plants and at the same time minimize government losses. Additionally, the industry must have a legitimate vocation and educational resource for management. America has been experiencing a management shortage for several years. This shortage is expected to worsen in the 1980's. With the projected expansion of the alcohol industry in this decade, the industry will feel the management crunch far more than most other industries. The end result will be a higher loss rate on federal loans. At any rate, capital alone does not produce alcohol. Only proper management has that capability.

SUGGESTIONS

Alcohol financing problems

(1) First, the bureacracy must recognize that the alcohol industry has generic problems which are substantially different from most industries and which will require new ideas and new concepts now foreign to government financing.

Changes in existing programs

The agencies which are involved must stop trying to make the financing fit the programs, and adjust their programs to administrate the types of financing required for this industry. Consequently, it is absolutely imperative to the success of the industry that the financing used allow for the risk to be spread away from the rural sector.

Reallocation of capital resources

In effect, financing programs must be designed to move capital from the capital intensive sectors (i.e., insurance companies, major banks, etc.) to the rural sector for alcohol production. This can be accomplished through several types of financing instruments:

Tax-exempt bond financing

(a) *Tax-exempt financing.*—Tax-exempt financing through industrial bond districts will allow borrowers to receive a tax-exempt rate substantially below normal banking rates, thereby reducing the risk of the project. Most importantly, if the bonds can be guaranteed by government agencies they can be sold to large institutional investors around the United States, thereby spreading the risk while bringing in capital to the rural sector.

FmHA policy on bond financing

The Farmer's Home Administration has the legislative ability to guarantee IDR bonds but chooses not to, as a matter of policy. It has, however, guaranteed such bonds on at least one occasion in the past. This is not entirely the decision the Department of Agriculture, as it is common knowledge that the Department of Treasury is vehemently against the government guarantee of industrial revenue bonds.

Effects on taxes

It is not the suggestion of this report that all businesses be eligible for government guaranteed tax-exempt financing, only those businesses falling under the category of alternate energy production facilities, as this is consistent with the emphasis that alternate energy has received and may be one of the few ways to truly stimulate production and overcome some of the capital formation problems which have already been discussed. It is interesting to note that the Treasury Department argument against government guaranteed tax-exempt bonds is shallow, since calculations reveal that the total taxes generated far exceed the taxes lost from tax-exempt financing.

Industrial revenue bonds offer other advantages, such as encouraging industry in towns and cities which have industrial parks and welcome such industry, creating a better business atmosphere and involvement on a local level.

UDAG grants

Further, other grant money is available to such districts through the Urban Development Action Grant (UDAG) of HUD, which can substantially benefit both the business and the city.

Precedents for tax-exempt bond financing guarantees

There are a number of precedents for tax-exempt financing of certain industries in the United States. The last three years have seen billions of dollars in government guaranteed tax-exempt funds used for financing home mortgages during periods of high interest rates, essentially subsidizing the housing industry during a slow period. Title XI MARAD bond financing virtually saved the inland towing industry in the early 1970's, and has since successfully financed billions of dollars of marine vessels at tax-exempt rates. There are additional advantages to the administration of these funds versus the use of a network of loan officers/field agents which will be discussed later in this report.

Lease financing

(b) *Leasing.*—By using third party financing, or leasing, the government can expand its available supply of money for alternate energy, reduce its risk in operations and increase production at a much faster rate. This would be accomplished through leverage leasing, where the equity position of the plant is sold as a tax shelter, the remaining portion of the debt being guaranteed either through banks or tax-exempt bonds.

Use of tax shelter funds for lease

Under this type of financing, equity capital of approximately 30 percent could be generated, reducing the government's guaranteed portion to 70 percent, versus 90 to 100 percent in other forms of financing. This would mean that practically any operator with working capital could lease a plant with an option to buy at a later date. Since most of the working capital requirements are for grain, this would allow virtually every small grain elevator or on-farm storage unit in the country to enter into immediate production on a low-risk basis.

Expansion of available capital

This greatly expands the available capital market for alcohol production, since the potential investors in alcohol production normally do not need the tax credits, allowing such benefits to be passed on to third-party investors.

Lease advantages

Research into the comparative advantages and disadvantages of leasing reveals that five investors placing $250,000 in equity capital for ownership of a single 2-million-gallon unit would be able to produce five million gallons through leasing their plant, leading to more efficient use of capital. Currently FmHA is restricted from guaranteeing leases, but is not restricted from guaranteeing loans to leasing companies.

Loan administration

In the cases of both leasing and tax-exempt financing, it is the opinion of this report that, with the exception of very small-scale farm producing units which represent assembly line types of production and financing, the government should make use of the private sector's systems and expertise in financing commercial plants up to the $10 million limit. By using private-sector leasing companies and the correspondent banking system to make funds available to lendors, the time between application and funding could be cut by two-thirds, with less administrative costs and fewer bad loans than would be possible through the existing agencies.

Use of the banking system

This is the conceptual difference between making funds available for loan by professional, government-regulated lending institutions and making the loans direct. In the former case a single, guaranteed pool of funds of $500 million could be administered through the correspondent banking system, allowing banks wishing to participate to draw on the funds as loans come in. The availability of such funds could be restricted by state, by economic bracket, or other criteria determined by the government, as in the case of HUD mortgage bonds which are dispensed through local savings and loans.

Local authority

Ideally, such pools could be guaranteed on a state-by-state basis so that the local authority could issue tax exempts, which would then be serviced by the primary lendor (bank).

Standardization of parts

In the case of leasing companies, similar arrangments could be made, allowing leasing companies to syndicate the equity capital among high-bracket investors. Such a standardized leasing program would lead to standardization of plants parts and plant sizes in the industry. This would then provide for a more efficient used-equipment market and lower costs in the long run.

It is doubtful that such a degree of standardization could ever be obtained in the government sector since, for example, loans could not be restricted to one type of design, etc., by law.

Reinsurance for alcohol industry

In all cases of federal financing, a reinsurance pool, contributed to by all plants receiving federal financing, should be created to cover bad loans which accrue to the industry as a whole. Based on a 20 percent loss factor and current recognized annualized capital costs, this would equate to 5 to 7 cents per gallon of production.

Regional training and education centers

(2) *Education.*—The solution to the education problem in the industry is pragmatic and simple but politically difficult. While there are many universities ready to jump on the alternate energy bandwagon, there are not that many higher learning institutions which are truly committed and actively pursuing the industry. The leaders in these areas should be encouraged to develop a whole and unified curriculum for alcohol management, to give the industry a real vocation and standard of excellence. Certainly local universities should be used to help train the farming community. But the primary focus of training and information collection should be placed in regional centers, working together in a united and concerted effort, rather than the existing shotgun approach to education which is a result of poor planning between the departments of Energy and Agriculture.

As far as the education of field agents and loan personnel, this should also be approached on a regional, systematic basis so that such personnel have continuous reference points to keep abreast of a new and changing industry in which they can only be partly involved. The short term solution to developing knowledgeable loan officers and field agents to handle applications is to utilize the private sector as discussed above, until the bureacracy can reach a level of understanding on alcohol fuels financing and administration.

Private sector production

(3) *Government policy.*—In the short run, the best boost the government can give the alcohol fuels industry is to allow the private sector to produce, given the existing tax incentives and policy decisions. It is the opinion of this report that the private sector will produce significant results in the next three years, as the price of gasoline exceeds the price of producing alcohol. This, however, is contingent upon a stable, rational governmental policy concerning alcohol production, a policy which allows the private sector to produce without undue regulation and restriction and without fear in the capital markets of technological obsolescence.

Stable policy

In addition to those areas mentioned, where government policy can have a positive influence on the alcohol industry, there are two specific areas which, in the opinion of this report, represent a waste of public dollars and danger to the future of the industry.

Feasibility studies

Grants for feasibility studies, as they are currently provided by the government, are a waste of taxpayer money. Most of such grants will go to high-priced engineering and consulting firms, which incur such high overhead they must demand high fees. Since the cost of a feasibility study for small-scale production units accounts for less than 1 percent of total financing cost, investors without the capital for a study will have a low degree of success, at best. On the other side of the coin, investors who apply for feasibility grants for high technology plants (i.e., coal gasification) should have the internal capacity to generate studies for their own use. The net result is, the American public subsidizes the education of major chemical and petroleum companies, as well as engineering companies.

National study

For approximately $4 million, a state-by-state, county-by-county study, which would provide accurate production and feasibility data for anyone in America, could be compiled and computerized. Additionally, program upkeep would allow government to note plants as they were financed, making sure that alcohol production would not be oversaturating a given area, placing undue pressure on certain regional crops, etc. This would also allow for reduced start-up time for all alcohol plants in the country, providing FmHA, SBA and DOE with comparative data valuable in assessing information provided by applicants. As the situation currently stands, field agents and loan officers are forced to accept any feasibility study presented, due to lack of additional information.

Price guarantees

By far the most potentially destructive government policy being pursued at this point is that of price guarantees. The guarantee of profit by the government to the private sector will result in higher-cost alcohol to the public, since individuals will increase expenses to increase their actual dollar profit. Even if expenses could be narrowly defined (by restricting dividends, salaries, etc.), the capital cost of equipment will rise, as investors seek to extract tax-free debt by maximizing capital cost during the construction phase of operation. Aside from the obvious excess profits and costs which the government will encourage on the production end, price guarantees will force government into the warehousing and storage of alcohol fuels, disrupting market factors and encouraging the government to enter into the distribution and sale of fuel supplies. If one considers the track record of the Department of Energy in this area, the thought of government interference in these markets is indeed scary. And impractical.

I am pleased to say that I have felt encouraged and even optimistic about the work being done in the Office of Biomass in the Department of Energy. Specialization of agencies appears to be beneficial to all agencies; only where specialization does not result in duplication of effort, however. There is no question that the Department of Agriculture, through the Farmers Home Administration, has a large part to play in the development of the rural energy markets.

I would hope that the Department of Agriculture would display the type of flexibility necessary to make alcohol financing through its resources a major and successful effort in the near future.

Senator McGOVERN. Our next witness is Paul Middaugh. Welcome, Professor Middaugh.

STATEMENT OF PAUL R. MIDDAUGH, PROFESSOR AND HEAD, ALCOHOL FUELS PROJECT, MICROBIOLOGY DEPARTMENT, SOUTH DAKOTA STATE UNIVERSITY, BROOKINGS, S. DAK.

Mr. MIDDAUGH. Thank you, Senator McGovern and members of the subcommittee, for providing me the opportunity to testify today.

I believe that I can appear as a technical fuel alcohol specialist. I am the person who demonstrated a small skid-mounted fuel alcohol plant on the Washington Mall in April 1979 and converted corn to 95 percent ethanol, and then ran electric generators provided by Mr. Richard Blaser. Since then, this plant has been widely copied throughout the United States in a number of locations, and many of them successfully.

I am operating a small demonstration plant at South Dakota State University, which is being flooded by visitors from the farm and small community based scale. We typically have over 300 people each Thursday afternoon when we have an open house. I get an average of 53 phone calls a day. I have dozens and dozens of letters arriving, all asking for information and help on the matter of small-scale feasibility and their capability. They all seem to be either asking for blueprints or asking how to find out how to do this.

Senator McGOVERN. This is one of the things that I am going to ask the Department of Agriculture to do, if they haven't already done it. They got away before I thought about the questions, but that is to come out with a simple pamphlet, a Government publication to tell people what is involved in the small-scale productions, where you go for help, what some of the technical problems are.

It seems to me we need a document of that kind. I am like you, Mr. Middaugh. Every time I go home, I have scores of people ask me how you qualify, what do you do, how do you get started, what are the problems. I don't have to tell you about the interest in our State, or the questions, but it is the answers that are in short supply, and I think that is where we have had a breakdown on this end of the line.

Mr. MIDDAUGH. Senator McGovern, my plant has been financed by individual donations from farmers. However, recently we have a very small DOE grant to study the energy balance and the cost per gallon of making small-scale fuel alcohol. I might comment at this time that we also have a positive energy balance in our preliminary studies of the small-scale unit and this, I hope, will eventually set to rest the concerns of some people.

I would like to address very briefly three areas of citizen concerns. I have met with, in the past month, visitors to our demonstration plant, and have raised this question, and I think I have an essentially unanimous request which they asked me to transmit to the Congress, of three areas of concern.

First, they are having extreme difficulty in obtaining information on where to go, whom to see, who has jurisdiction over what size plant. I believe it is called fixing a turf. In the DOE-USDA area, and other agencies—there are some seven or eight agencies that are needed to be contacted and many of our people have been disillusioned by trips to Washington where they have been unable to contact the correct office or find the right bureau to get the forms, to find out what to do.

So they are asking for something of a central U.S. location in the grain and fuel potentially producing areas, of something of a national clearinghouse which they hope would be staffed with a representative of each of the many U.S. Government agencies, the Departments of Transportation, Commerce, Agriculture, Energy, and others; that these offices have the proper forms for financial, legal, regulatory, management, and educational programs which they can then afford.

I would suggest something on the order of a city such as Denver or Kansas City or some central U.S. location for this type of a clearinghouse, simply because these agencies already have major offices in this area. The concern is this—and I can draw a brief analogy with the Washington airport.

When I came in, the car rental agencies were gathered in one central location, next to the convenient point where everyone goes to pick up their baggage. It is convenient to the public and they had the forms ready and they have an efficient staff and you can easily get, in minutes, a car rental. There are satellite substations at the Washington airport so that even those in remote areas can get some of this information and help.

This is in contrast to the Washington, D.C., situation, where one can spend days and weeks traveling around trying to get similar help and education on the matter of alcohol fuels programs.

I have been asked to be a consultant to the Farmers Home Administration, Department of Agriculture, on setting standards for minimum quality, for guaranteed loans, for small and intermediate size alcohol plants, and I am very well aware that the standards are being set for the $100 million in loan guarantees and $10 million in grants. At this stage, there is no information at the State level.

When I came back from the hearings and reported to the farmers in the South Dakota area and the Minnesota area, they went to their agencies and found there was no information.

So we have a very real concern about the availability of the information.

Finally, there is a major concern about training, because this is not a simple process; it is not beyond the means and ability of the farmers, and so on, to operate this type of equipment, but they do need to be shown how to do it. You don't take a farmer and turn him loose on a $40,000 new type of tractor without some type of training and orientation.

I am the cofounder of the nonprofit National Alcohol Fuels Producer Association, which was designed to train farmers and citizens in small-scale fuel production. In a 2-month period, we trained over 800 farmers and others who paid their own expenses to come to a training school in Kansas. This model has since been adopted by the Department of Energy, through the appropriate technology program; however, their funding has been very inadequate. They have only been able to provide $10,000 in startup help for community college, which intends to get into the training program to help relieve the complete lack of information on alcohol fuels management decisions.

I emphasize that what they need to be doing is training whether or not to get into this, because many of the people should not, and those that do should have excellent, thorough training and help in order to qualify to make expert judgments.

What is needed is a grant for several centers of excellence in the United States where small-scale demonstration plants could be set up, or the people that want to do the training could attend and get hands-on actual training, so that they could then go back and set up a community college vocational technical school or other type of training program. I estimate that $250,000 would be adequate to set up a small training center and actual operating farm scale plant.

In terms of the research and development, I would like to comment on several of Mr. Williams' comments. First of all, the animal feed can be fed wet, in this form, which is something I produced yesterday on our small plant. This runs 30 percent fibrous solids. It is easily screened and removed from the animal stillage coming off the columns. It contains better than 28 percent protein and is a high quality protein supplement if used on a small scale.

There's a very real economy in small-scale and farm operation, because we have a great deal of biomass which can be used as a replaceable fuel. It does not require petroleum or other products of this type. It can use up to 30 percent of the biomass which is not sent to market for various reasons of quality. Yet all of this can be fermented into fuel alcohol.

There is cheap transportation and utilization of the materials directly on location, and finally, this 65 percent human food protein is available.

The final conclusion is this, that we can make anhydrous alcohol on a farm scale. These molecular sieves can be used on a continuous basis to make alcohol and also through the use of solvent extraction and other techniques; so there is a potential for farm-scale production of anhydrous alcohol.

Thank you very much.

Senator McGOVERN. Thank you very much, Mr. Middaugh, not only for your testimony, but for the leadership you have been providing for so long in this area.

[The prepared statement of Mr. Middaugh follows:]

PREPARED STATEMENT OF PAUL R. MIDDAUGH

Senator McGovern and other members of the subcommittee: Thank you for the opportunity to testify on needs and concerns of a very large "ground-swell" of citizens who wish to make informed decisions on whether or not they could produce fuel alcohol in small and medium sized plants.

Three areas of citizen concern include:

1. The very real need for a central U.S. location of a National Clearing House staffed with representatives of each of the many U.S. Government agencies and offices with financial, legal, regulatory and management and educational programs for liquid fuel alcohols.
2. The need for rapid establishment of guaranteed loan programs to be made in 1980 in time to use surplus or damaged sugar or starch producing crops for farm and community use of fuel alcohols. This includes the need to rapidly evaluate and certify both manufactured small scale alcohol plants and pre-engineered plants of 1 to 5 million gallons per year for 10 year guaranteed loans to eliminate poorly designed and overpriced commercial plants.
3. The need for adequately staffed, trained and funded training schools to provide balanced education in management, financing and technology of fuel alcohol production and recovery of the high protein co-product.

I am Paul R. Middaugh, Professor and Head of citizen sponsored alcohol fuels research and development project at South Dakota State University. In 1978, a group of South Dakota citizens as members of the East River Electric Power Cooperative, Madison, S. Dak. voted to fund an alcohol fuel project with 50 cents per member to initiate the study of means to produce fuel alcohols using cellulosic crop residues for conversion in farm and small community scale plants. Our research is supported technically by the U.S. Army Natick Research and Development Laboratories who provided the enzyme producing mold cultures and basic technology. The National Rural Electric Cooperative Association, Washington, D.C. provided an additional $10,000 for equipment. In 1979 the project was expanded to include studies on the conversion of damaged or unmarketable crop materials such as moldy corn, chemically treated seed grains, culls and undergrade crops which I have learned can total 30 percent of the crop in areas from Dothan, Alabama to Klamath Falls, Oregon during some 40 alcohol fuel plant presentations which I have made in the past year.

At the invitation of the Director, Mr. William Holmberg, Citizen Participation Division, Office of Consumer Affairs, U.S. D.O.R., two students and I had built and transported a skid mounted two-column small scale distillation unit on a pickup drawn trailer, within three weeks, to the Washington, D.C. mall where we converted corn into fuel alcohol of 95 percent purity at the rate of 22 to 24 gallons per hour for the Alternate Community Technology Fair 1979 from April 26–30, 1979. A subsequent demonstration in Kansas drew an estimated 5,000 visitors.

National interest has increased dramatically in producing fuel alcohol following President Carter's announcement on January 11, 1980. I am receiving an average of 53 telephone calls each day from almost every state of the U.S. and have an average of over 60 letter per day. Visitors to our fuel alcohol production demonstrations in our small scale of 25-gallon-per-hour plant average over 300 visitors at each demonstration.

1. The major area of citizen concern by these hundreds of visitors is the extreme confusion about where and how to obtain information of the announced acceleration for fuel alcohol production.

Hearing agenda item 4.C. Improved Federal Assistance is a very real concern and bottle-neck between Washington and regional and state offices of the U.S. Governmental Agencies for information and forms and procedures for the numerous agencies from Department of Transportation, Department of Commerce, Environmental Protection Agency, Bureau of Alcohol, Tobacco and Firearms of the U.S. Treasury Department and the numerous offices within the Department of Agriculture and the Department of Energy.

I have heard many complaints that they have traveled at extreme cost in time and money to Washington and have traveled from agency to agency seeking the correct office to obtain application forms and information, often without success. Jurisdictional arguments between agencies on the "turf" belonging to each leave the citizens "in the crack" and without help.

Over 500 citizens in the past two weeks have unanimously agreed that the Washington, D.C. location is remote from the central grain producing areas where fuel alcohol will be produced.

Recommendations: A National Clearing House should be established in a Central U.S. city easily reached by air and highway. The Center should have senior staff representing every U.S. Governmental agency or office that controls some phase of the fuel alcohol program. The representatives should be a sort of supermarket or shopping mall for alcohol fuels information, forms and advice in all phases to include management decision help, A.T.F., E.P.A., OSHA etc. regulatory forms and information, technical and nontechnical information sheets, bulletins and perhaps even some training functions so that at one location an interested person can locate the correct Governmental agency and obtain effective information and help to make informed decisions on whether to build or buy a fuel alcohol plant to apply for and have reviewed the proper forms to expedite the applications.

A single office should be responsible for coordinating the Central Clearing House, possibly the U.S. National Alcohol Fuels Commission to report to the Congress and the President in the event that legislation or other action is required to clear roadblocks.

2. I was invited on January 30, 1980 to provide input on the technical specifications for U.S. Department of Agriculture, Farm Home Administration guaranteed loans with respect to minimum performance and construction standards to provide $110 million dollars in fiscal year 1980 funds for the construction of small, medium and large scale fuel alcohol plants. My trip is rumored to be wasted, if the recent Jack Anderson column is correct, that no fuel alcohol plant loans will be made by FmHA in 1980.

The central location for the Service Center of National Clearing House could well be in Denver, or Kansas City, where the agencies already have regional offices. The term "Service center" would be new in government to serve the tax paying citizens by providing central, convenient, efficient service rather than prohibit all but a few determined citizens from an expensive, time consuming trip to Washington, D.C. for door to door searches for assistance in building fuel alcohol plants.

The practical technology of fuel alcohol plants is well established. A commercial supplier of fuel alcohol is producing 150,000 gallons per day of anhydrous fuel alcohol plus many tons of high protein animal feed. Our small scale plant has produced fuel alcohol routinely in a simple two column design which has been copied in several hundred home built plants. In one county in Campo, Colorado Dr. Gene Schroder has a very successful plant of similar design which has an energy balance that is positive by a ration of 2.9 times more fuel alcohol energy produced than is required in renewable fuel. S.D.S.U. plant has similar positive data.

3. Improved Federal Assistance to help provide citizen training on decision making and actual construction of fuel alcohol plants and their management and operation.

In June, 1979 I was the co-founder with Reverend Lincoln Justice of a not for profit, national traing school, the National Alcohol Fuel Producers Association, which started in July, 1979 to train interested adults to make informed decisions whether or not to build or buy a fuel alcohol plant, and the technical steps to produce alcohol fuel from any sugar or starch containing crop, and methods of concentrating the co-product fuel alcohol and high protein animal feed. By mid-September over 800 adults had attended the school.

More recently, the Director, Citizens Participation Division, Office of Consumer Affairs, U.S. Department of Energy has announced a nationwide training program to start 40 training centers in community colleges, Vocational-technical schools and similar locations. The effort is hampered by very low funding that is available. Initial grants to set up such a school total $5,000 for teaching materials and $5,000 for teaching equipment. No budget is available for full time instructional staff training or for realistic "hands on" alcohol process equipment. The result can only be a textbook rather than a hands on training. Because of prohibition on, common knowledge is available on practical fuel alcohol fermentation and distillation or recovery of the animal feed product.

Funding should be provided for a few regional, on farm fuel alcohol demonstration and training centers which would serve to train the teachers for the remaining training centers. An additional benefit would be the development of practical, model small scale alcohol plants to permit them to serve as models for excellent working plants. If flow meters were provided a large amount of data on energy balances and costs of alcohol production per gallon would become available to resolve the unceasing and unsupported arguments pro and con on fuel alcohol production.

Our S.D.S.U. fuel alcohol plant is determining the energy balance of alcohol energy output versus energy input. The cooking step in Btu/gallon is for steam, 12,500 Btu, for enzyme production 940 Btu and electrical motors, 270 Btu for a total of 13,710 Btu. Fermentation evolves heat and need stirring at 40 Btu/gallon; Distillation in 12 inch two column still requires steam 19,400 Btu and electrical, 480 Btu for a distillation total of 19,880 Btu. The overall total is 33,630 Btu per gallon input. If 95 percent fuel alcohol has 80,180 Btu/gal then the ratio of energy output per gallon of alcohol is 80,180/33,630 input or the ratio is positive at plus 2.38. With insulation of the distilling columns, addition of a heat exchanger and reuse of most of the hot stillage water will increase the already positive energy ratio.

Small scale, less than 500,000 gallons of fuel per year, fuel alcohol plants have and economy of small scale. Transportation is minimal, damaged or other unmarketable crops can be used, renewable biomass energy can be obtained, labor costs are reduced and the co-product alcohol can be used on the farm and the 35 percent moist animal feed cake can be fed to animals on the farm.

A typical small scale fuel alcohol plant with capability of producing 750,000 gallons per year, in 330 days of operation at 24 hours per day, with an anhydrous alcohol production of 25 gallons per hour would cost about $250,000 with automation by a microprocessor and animal feed recovery centrifuge.

Senator McGOVERN. Our next witness is Lance Crombie, an on-farm alcohol producer and member of the Alcohol Fuels Advisory Panel at FmHA, Webster, Minn.

STATEMENT OF LANCE CROMBIE, ON-FARM ALCOHOL PRODUCER, AND MEMBER OF ALCOHOL FUELS ADVISORY PANEL, FARMERS HOME ADMINISTRATION, WEBSTER, MINN.

Mr. CROMBIE. Thank you, Senator.

"The organic origin of ethyl alcohol, with its contemplated use in displacing mineral fuels, offers a truly corrective measure to our unbalanced order." That statement was made by Alex Hale in his book, "Prosperity Beckons," in 1936. It is very appropriate today.

I will make a brief statement, because we are running short of time. The alcohol fuel program is moving in several directions. The greatest interest is in the grassroots area. Many plants, small and medium, are being built or are about to start up or are operating. Alcohol fuels are here to stay. They will expand and grow at a rapid rate. We have to remember the primary objective of the whole program should not be to debate or study the technology or the concept, but to fill the fuel tanks.

Any help or assistance given to the program should always be evaluated as to how many gallons were produced or how the tanks were filled. The simple reporting system of the Department of Treasury Bureau of Alcohol, Tobacco and Firearms will tell if, in fact, we are filling the fuel tanks.

I firmly believe that we should accept the facts that are based on scientific principles and economic reality.

No. 1: That alcohol fuels are good, high quality, nonpolluting fuels.

No. 2: That the raw materials, namely the carbohydrates, are available in vast excessive amounts and are renewed each year.

And No. 3: The production technology, the fermentation, distillation, and the like, is well known and being improved upon daily.

No. 4: The processing of grains to alcohol produces more food from alcohol production that without alcohol production.

No. 5: The modern alcohol production plant is economically viable and profitable, with a payback of 5 years or less.

No. 6: The energy produced in a modern ethanol plant is truly energy positive, environmentally beneficial, and agriculturally sound.

What is needed? We feel the solution to the national economic crisis, which has its basis in the national energy crisis, is to build a large number of small fuel plants. This requires capital, a capital expense that government and private industry will have to invest in.

We are starting a new industry, and our goal should be to fill the tanks. This is truly an emergency situation and I feel very strongly that three things should be done immediately.

No. 1, we should have an education and information dissemination system. Many people have mentioned today that we simply can't get the information out to the people that want it. I look to the extension agents, the colleges, universities, the Department of Energy, the USDA, and anyone else that could print and disseminate infromation or put on seminars, training schools, or development and it should be formed immediately.

The second step is to look at research and development. We do need research and development and it should be on a practical application of the basic research that we already know that will be directed to fill the tanks. Colleges and universities, backyard inventors should be funded to expand the horizons and deliver practical answers to new agricultural practices, production techniques, and use technology.

No. 3, the facilities construction. Here we need financial assistance, due to the high intial capital cost of plant construction. We will require loans, loan guarantees and grants, again, to be directed to fill the fuel tanks. The production equipment must be built.

The third step will require the largest amount of capital investment and produce the greatest results in the shortest time. I feel strongly that the small to intermediate size, 5 million gallons or less, plant should be built, which will spread the risk of the capital investment and will come on line and produce alcohol to fill the tanks.

I see the national plan as, very simply put, initially to create a funding pool administered by the USDA, the Farmers Home Administration—not the Department of Energy, because they have failed to give us energy independence—that will provide direct loans and loan guarantees at 5 percent for plant construction and operation.

Further, I would suggest that we collect a half a cent per gallon of tax on the alcohol produced to reduce and repay the debt to allow funding. The funding pool will grow and provide future loan guarantees. The money used for set-aside acres should and would be diverted to alcohol plant construction. Current and future economics of alcohol production from biomass is a good national investment. We need merely to ask for agriculture's help to solve our fuel problems and economic crisis. The public and private financial stimulus will be repaid at least a thousandfold.

Thank you very much.

Senator McGOVERN. Thank you for your testimony, Mr. Crombie.

[The prepared statement of Mr. Crombie follows:]

PREPARED STATEMENT OF LANCE CROMBIE

> The organic origin of ethyl alcohol, with its contemplated use in displacing mineral fuels, offers a truly corrective measure to our unbalanced order. Alex Hale, 1936.

This statement is true today in that we have the technology and resources to move at least to 100 percent Gasohol fuel in a very short time.

The alcohol fuel program is moving in several directions. The greatest amount of interest is in the grass roots area with many small and medium plants being operated or about to start up. Alcohol fuels are here and will expand and grow at a rapid rate. The primary objective of the program should not be to debate or study the technology or concept, but to "fill the fuel tanks." Any help or assistance given to the program should always be evaluated as to how many gallons were produced or how the tanks were filled. The simple reporting system of The Dept. of Treasury, Bureau of Alcohol Tobacco Firearms (ATF) will tell us if we are or are not filling the fuel tanks.

This author submits the accepted facts as based on scientific principle and economic reality.

(1) Alcohol fuels (blends or straight fuel) are very high quality fuels, clean and non-polluting.

(2) The raw materials (carbohydrate) are available in excessive amounts and are renewed each year.

(3) The production technology (fermentation-distillation) is well known and being improved upon daily.

(4) The processing of grains produces more food than without processing to fuel alcohol.

(5) The modern production plant is economically viable and is profitable with a pay back of five years or less.

(6) The energy produced in a modern ethanol plant is truly energy positive, environmentally beneficial and agriculturally sound.

WHAT IS NEEDED

The solution to the national economic crisis, which has its basis in the national energy crisis is to build a large number of small fuel alcohol plants. This requires a capital expense that government and private industry will have to invest in to start the new industry on the road to fill the fuel tanks. This is truly an emergency situation. Three things must be done immediately.

(1) Education and information dissemination should be in the form of a library development and mailing system to distribute the information known. The Extension Agents, Colleges, Universities, DOE, USDA, etc., could be the information centers. Funding required would be minimal. Seminars, training schools and development groups will be formed.

(2) Research and development will include practical development of results from basic research in that it will be directed only to "fill the tanks." Colleges, universities and back yard inventors will be funded to expand the horizons and deliver practical answers on agricultural crops for energy, production techniques and use technology.

(3) Facilities construction. Financial assistance is needed due to the high initial capital costs of plant construction. This will require loans, grants or loan guarantees and the lack of the same is the largest single reason this new fuel industry cannot move forward to "fill the tanks." The production equipment must be built. This third step will require the largest amount of capital investment and will produce the greatest result in the shortest time. Small to intermediate size (5 million gallon/year or less) plants will be built to spread the risk and can come on line very fast. There is no single best plant design, all are good if they "fill the tanks."

THE NATIONAL PLAN

Initially a funding pool, administered by the USDA (Farm Home Ad.) would provide direct loans and loan guarantees at 5 percent interest for plant construction and operation. Further, the collection of 0.5 cents/gallon tax on alcohol production would retire the debt and allow the funding pool to grow and provide future loan guarantees. The monies used for set aside acres would be diverted to plant construction. Current and future economics of alcohol production from biomass is a good national investment. We need merely to ask for agriculture's help in solving our fuel and economic crisis. The public and private financial stimulus will be repaid a thousand fold.

Senator McGovern. Our next witness is Al Mavis. Mr. Mavis please proceed.

STATEMENT OF ALVIN M. MAVIS, EXECUTIVE DIRECTOR, AGRI STILLS OF AMERICA, SPRINGFIELD, ILL.

Mr. Mavis. Senator, it is a pleasure for me to be here, but I find myself in a different position than most of the witnesses. We are producers, and I left you a sample of the product. I am very much against loan guarantees because of the high interest rates we find in agriculture. It doesn't make any difference how many loan guarantees you've got, the little guys cannot pick up the tab.

So we are looking at the thing in an entirely different situation. I would like to kind of go through my presentation and skip through it so you get some things that I think are important.

We need to get this thing off dead center some way, and when I look at the press in last night's paper, where the "Worldwatch" was talking about what's going to really happen to the food situation, it is a real concern to me because, you see, everybody has overlooked what Mr. Middaugh just pointed out: You cannot make alcohol out of the good grains of this country without coming up with food. There is no other way.

The export, the embargo grain that the President had the guts to embargo, and I was proud of, is the fact that it had 1.7 billion alcohol in it, which was fuel, but more than that, it had 1 billion dollars' worth of protein that we would give away, because the alcohol is worth about $1 billion more than we had the whole crop sold for.

So we have to take a close look at what we are doing with our products. We can feed this world if we refine it first. We cannot do it by shipping it overseas.

I look at the token sums you mentioned, and it's so true. We're so busy talking about $100 million; that's less than one Archer-Daniels-Midland plant. The $100 million would, however, build 300 plants the size I am talking about, that makes 500 gallons a day, and will consume 80,000 bushels of corn and will produce a couple of hundred thousand gallons of fuel.

Senator McGOVERN. Your plant is located in Springfield?

Mr. MAVIS. In Springfield, Ill.

Senator McGOVERN. And roughly, what is your production size?

Mr. MAVIS. We exceed 500 gallons a day. The interesting thing is, this kind of thing is all modular. When you learn how to run that, if you want to raise it to 1,000 you can put two plants in the same building, or if you want 2,000 gallons, you put in four plants. Everything is in modules and it can be expanded.

What is missing is the finances that rural agriculture needs to buy it. I am concerned about what I read in the Wall Street Journal, just Friday, that we gave $800 million to Israel for two air bases, that we'll never get back any of the money—and we can't come out with $800 million to produce fuel for this country that may preclude the next war.

We're about to go to war in the Middle East over liquid fuel, and we have the potential here in America to produce it, if we can just get going, if we take some of that money and put it over here in fuel alcohol. The USDA and Jim Williams have missed a lot of things. Why don't they get the research people involved in this diesel study that we're talking about? Every contact I have had with their people has been to show that something wouldn't work, not that something would work. For instance, the national laboratory in Peoria, Ill., Agri Stills offered them their field service program to test what they have, and the same old gobbledy gook—nothing. What they've been doing in the laboratory for 40 years—whatever it is—they don't have the guts to bring to the country.

More of the same old kind of thing; and we're going to get caught in this thing if we keep pouring our money into those old programs. We have to get away from the old laboratories. We have to get the money out in the country where there is an innovative farmer, an innovative young college student, who will make the thing work.

As we look at the economy and the situation, we must make sure that we have long-term low interest loans. If we had a problem with electricity a few years ago, we really have one with liquid fuel now. There isn't a tractor that I have in my area or any other area that will run on anything but liquid fuel. We can have all the fuel and gas from geothermal, but if we don't have liquid fuel, agriculture won't go to the field.

The gentleman here earlier today, from the University of St. Louis, was talking about conservation tillage. Every good farmer has been doing that for a long time. What has him in trouble is, economics are so poor that the farmer is pushing down another set of trees and plowing up another hillside to get a few more acres to pay the note off at the bank. These are the kinds of things that have put us in serious trouble.

I don't know what the answer is going to be, but you'll note that I do predict that we can do more than the President's goal, with the little plants that we're talking about. They're easy to proliferate. If you had a building ready 2 weeks from the time you put the first tank in the ground, you would be up in full production.

We still have enough cheese whey to make 48 million gallons of alcohol. The potato industry tells me they are dumping 100 billion pounds of waste which would make 1 billion gallons of ethanol. We

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simply haven't taken a close look. I don't believe we should have a feasibility study to cite what we have. If the local extension people and the USDA people don't really know what's in their county, they should; and they should have the answer for some of these programs that they have got going.

To give you an idea of why we cannot continue to export our grain overseas—and I'm very against Illinois being the largest exporter of grain—$2 billion of corn only buys about $5 billion of foreign gasoline. If we keep it here, it's got 9 billion dollars' worth of ethanol in it, $4 billion worth of protein and oil, and we replace 5 million gallons of farm gas. It now has a value of about $16 billion and we're bragging about how we sold it for $5 or $6 billion. We didn't create any new jobs, we didn't develop a new industry, and we don't have a cleaner environment.

With national security at stake and agriculture in a real dilemma, I would like to remind you of a couple of things. I'm going to talk about the benefits of 1 gallon of ethanol. I was here when Amoco got permission to sell gasohol. In their statement, they talked that 1 gallon of agricultural renewable ethanol added to 9 gallons of cheap gasoline made it a premium fuel, and it added about three points of octane for each gallon, or 60 cents for the octane boost. Then they said that every time they refine the gasoline and make the cheaper leaded rather than premium unleaded, they save 7 percent petroleum, and that's 57 cents when you multiply it times the 9 gallons involved. On today's price of $1.84 for fuel alcohol, we have alcohol selling for 67 cents in place of 90-cent gasoline.

It's long overdue for agriculture to recognize, and the Government to recognize, that we can do our part in conservation by simple substitution.

The other thing Mr. Williams talked about is an exciting thing: one gallon of ag ethanol, 87,000 Btu of renewable energy replacing, and 350,000 Btu's of nonrenewable diesel. That is conservation in its best form. I hope you people will watch and help us to develop ethanol. We can take one unit of ethanol and mix it with two units of coal in a laboratory and burn it, environmentally acceptable, and we hope we're able to burn this fuel in the ethanol plant I'm talking about here today before midsummer. The product is called ETHaCOAL—100 gallons of daily ethanol production and two-thirds of a ton of coal will produce enough energy to fuel our plant for a complete day's run.

I'm going to close and tell you what we see. We think you ought to have a real forward program on long-term low-interest loans. I don't think we should have loan guarantees. I don't believe in grants. I think the Government is entitled to get its money back. We've got too many people running around with their hands out, and I hope I'm not one of them.

Our plant is an economical, feasible situation. A little plant like that requires five people. It is employment, it is fuel, and it is national security.

A recent farm paper, "Prairie Farmer," quotes the feed council talking about we ought to be spending a lot of money.

The current thing that we ought to do, that this is the kind of support we need to come up with a strong feed grain market development program. If we're able to send long-term low-interest loans and loan programs to our foreign countries, we certainly should make them available to agriculture. That's the kind of liberal credit the Government should make to fuel ethanol if it's going to make agriculture succeed. I will guarantee you, if you will give us that liberal credit in agriculture, we will produce you a lot of fuel, produce a lot of food and fiber, and we will produce new wealth for America.

I close by reminding you that our choices are very thin: either we go to war in the Middle East over liquid fuel, or we produce it out of agricultural products.

Thank you.

Senator McGOVERN. Thank you, Mr. Mavis. I was impressed when you were talking about the need to get some of this research and development out in the field. The staff is telling me about two high school boys out here in Leonardtown, Md., that have developed six prototype stills in the past year with the help of the St. Mary's County Board of Supervisors. They've got one of those that produces about 25 gallons a day, which isn't bad for two high school boys operating largely on their own.

[The prepared statement of Mr. Mavis follows:]

PREPARED STATEMENT OF ALVIN M. MAVIS

Small Scale AG Ethanol Production

It is indeed an honor for me to appear before this subcommittee to help develop programs and initiatives that will assure America has immediate implementation of a successful national program for renewable AG ethanol and other fuels.

Senator McGovern, as chairman of this hearing, I want you to know that myself and most of rural America are in full concurrence with you, "that present program initiatives constitute an abysmally under-funded and largely fragmented and unfocused effort that totally fails to answer the small scale production needs of the farm and forestry sectors. In effect, the Federal Government finds itself in the position of doing little more than throwing token sums of money at the problem with little prospect of fully realizing the tremendous energy resource potential of on-the-farm and rural community production".

For the past several months I and most of rural America have been led to believe there was great movement on the part of all Government agencies to fully fund and develop AG ethanol for fuel. This is not true.

Starting with President Carter's appearance in Iowa to announce his rural development initiative of $11 million for 100 small-scale plants, rumors of Farmers Home money, small business loans, community service money all are paper and press. When you get through the hogwash you discover that you might get a loan guarantee at absurb interest rates. You present your program to a staff who doesn't understand, doesn't care, and who has no guidelines.

America is overrun by seminars on renewable fuel, production, use, and financing. Here you get the same old story about what is planned, what is coming.

Successful, operating, renewable alcohol plants are few and far between. Those that are in operation cannot be proliferated because of high interest rates, shortage of money and the lack of leadership and funding by the U.S. Government.

These plants are not in need of grants, loan guarantees, etc. What is needed is long-term, low-interest loans, similar to the old REA program. America faces a much more critical situation in liquid fuel than it faced in getting electricity to rural America. A shortage of liquid fuels will create a much more serious change in our way of life than did rural America face by not having electricity.

Without a new reliable source of liquid fuels America will face a major national security problem, an American transportation system in a shambles, and the American farmer without enough fuel to plow, plant, and harvest. Without fuel there will be no food.

True, agriculture uses only 3 percent of America's liquid fuel, but without this 3 percent we will not have the food, feed, and fiber for 220 million fat and sassy Americans, 32 billion exports needed to partially pay for high priced and scarce foreign oil, and surpluses that depress farm prices below cost of production.

Distinguished members of this subcommittee, in addition to being thankful to you for recognizing the difference between what you want with respect to a renewable AG fuel program and what really is happening, I would like to take this opportunity to thank the Arabs for sticking it to us in 1973. Even this didn't get America moving, but when they stuck it to us in 1977, 1978, and 1979 a few of you took notice. Without this economic jolt, without the embarrassment of hostages, and now the possibility that America could go to war over liquid fuel, you probably wouldn't be meeting here today.

While I'm in the thanking mood, I must also thank the President for his firm stand on embargoing the grain shipment to Russia. He had two good reasons for doing this. One, we shouldn't be selling grain to our potential enemy, or any other product or technology. Second, and just as important, the President must have recognized it as an economically bad sale.

The 17 million metric tons had a reported sale value of $2.25 billion. This embargoed shipment contained 1.7 billion gallons of fuel ethanol worth more than $3.2 billion. The liquid fuel value is $1 billion more than the reported sale value. In addition this grain contains a billion dollars' worth of protein and oil that could be used to feed the hungry of the world, or the livestock industry of America.

Just as important is the value of foreign gasoline replaced by this AG ethanol. It is worth an additional $1.7 billion.

It is easy for me to see why the President would embargo this sale. At the same time he stated we would process this grain for fuel. I have just shown you it would be worth about $6 billion and yet 3 months later the farmer waits for a market and America waits for fuel.

I am particularly glad you presented specific questions. This requires specific answers which you need. I will answer these on the assumption there is to be a full-fledged U.S. commitment by Congress and the White House to renewable alternate fuels.

1. PRODUCTION POTENTIAL AND ECONOMICS

A. Potential oil displacement capacity of renewable energy resource fuels:

1. 500 million gallons in 1980;
2. 1 billion gallons in 1981;
3. 2 billion gallons in 1982; and
4. 5 billion gallons in 1985.

B. Potential capacity of small scale, on-farm and rural community renewable energy resource production:

1. 10 million gallons 1980;
2. 250 million gallons 1981;
3. 1 billion gallons 1982; and
4. 2 billion gallons 1985.

There is a direct correlation between the size of a plant and the length of time to construct.

C. Current and foreseeable net energy balance:

1. The net energy balance for fuel ethanol production has always been a net gainer in spite of what you have read or heard.
2. As each day goes by, fuel ethanol plants are getting more efficient and smaller in plant size.
3. What good is energy balance if our farm tractors do not have liquid fuel? Not a tractor I know of can operate on coal, nuclear, Geo-thermal.
4. What is the net energy balance of having military units who can train only 2 days a week because of lack of liquid fuel?
5. What is the energy balance of going to war in the Middle East for liquid fuel when the American farmer faces financial disaster because of no market for his production.
6. American agricultures production is full of starch waiting to be converted to the liquid fuel America and the world needs.

D. Alternatives to improve present crop cultivation patterns to increase renewable energy resource fuels without significant interruption of food and fiber supplies:

1. Alternatives are quite simple; a profitable agriculture that can afford to rotate.
2. Refine our exported corn before it can leave America. This will help alleviate the transportation bottleneck, furnish the world the protein and oil it needs and America new jobs, new industry, cleaner environment and 5 billion gallons of liquid fuel.

2. ECONOMICS

A. Cost of production, including grain by-product and livestock production:

1. Agri Stills of America has the only commercial community-size fuel ethanol production system I know of that is in daily operation. The high quality co-product is being fed to swine, dairy and beef cattle. When these by-products are credited to production costs fuel ethanol from agriculture can profitably be marketed at current prices.

2. One must be careful to remember that 1 gallon of fuel ethanol has many values that must be credited to it when mixed with gasoline, diesel or coal.

(a) 1 gallon of AG ethanol mixed with 9 gallons of regular unleaded increases the octane ratings and has an economic value of more than 60 cents.

(b) The gasoline needed for mixing with AG ethanol can be refined with 7 percent less petroleum than the premium no lead it replaces.

(c) When mixed with gas, diesel or coal it acts as a catalyst and burns carbons that won't burn by themselves. That is why gasohol gets as good or better mileage than the regular unleaded.

(d) 1 gallon of aquahol (50 percent AG ethanol and 50 percent water) can be fed through turbocharged diesels and replace 2½ gallons of nonrenewable diesel and maintain the horsepower.

(e) 1 part of AG ethanol can be mixed with 2 parts of coal and form a new, exciting fuel called Ethacoal.

B. Possible effect of renewable energy resource fuel production on food and fiber commodity prices:

1. I would be terribly concerned if it didn't lead to farm price increases so that rural production sells for more than cost of production.

2. If this didn't happen and all that was accomplished was to get fuel for our cars America would still have an economic collapse. I will leave with your staff four papers written on how AG ethanol will eliminate the peaks and valleys of livestock production so we have more livestock and meat production at more uniform prices.

C. Economic development-job creation potential of renewable energy resource fuel production:

1. A 200,000-gallon-per-year community-sized fuel ethanol plant like Agri Stills of America will require five employees in addition to all others involved in trucking grain, alcohol, protein; new jobs in welding, new opportunities in education, full time employment for filling station operators, continued car sales and on and on.

3. TECHNICAL ASPECTS OF SMALL SCALE PRODUCTION AND USE

A. Production potential with present off-the-shelf technology:

1. Fuel ethanol plants such as Agri Still are modular and expandable and basically built with off-the-shelf technology.

(a) 1980—10 million gallons;
(b) 1981—250 million gallons;
(c) 1982—1 billion gallons; and
(d) 1985—2 billion gallons.

B. Technology and cost of engine modifications required for pure fuel use:

1. Simple modification—$25;
2. Complete, high compression, new pistons easy start—$600; and
3. Aquahol for turbocharged diesels—$1,000.

C. Gaseous and electric power generation potential of renewable resources:

1. Co-generation of AG ethanol at power stations with the AG ethanol being used to produce Ethacoal and Ethacreme can fuel unlimited industries and utilities.

4. COST AND IMPROVED FEDERAL ASSISTANCE

A. Investment requirement range for individual on-farm fuel production facilities:

1. 30 gallons per day—$20,000; and
2. 100 gallons per day—$100,000.

B. Investment requirement range for individual rural community production facilities:

1. 200,000 gallons per year—$375,000;
2. 500,000 gallons per year—$750,000; and
3. 1,000,000 gallons per year—$1,300,000.

C. Steps required to consolidate and coordinate delivery of management, technical and financial and marketing system assistance for on-farm and rural community production and use:

1. The rural and community areas of America have all the elements necessary to assure successful implementation of agriculture as the producer of clean-burning renewable fuel, if it had immediate long-term, low-interest money.

2. The U.S. Feed Council has just published a story in a farm paper that the situation in the Middle East "* * * has moved the United States to broaden its ties with the People's Republic of China. The result is what appears to be an increased U.S. interest in providing the P.R.C. with economic and defense support, most-favored-nation status, and more liberal credit offering. This is precisely the kind of support we need to come to us with a strong feed grain market development program".

Here is America out of liquid fuel, we have the technology and desire to convert America's feed grain into food, feed, and fuel but we find the support and liberal credit offering going to foreigners.

3. A viable business like liquid fuel doesn't need time-wasting feasibility studies, more research, or loan guarantees—it needs money at a price it can afford to use so as to get into production now.

4. The other important need and second only to money would be the complete removal of BATF regulations and bonding for fuel ethanol production plants. Setting up an honor and reporting system similar to our current income tax system.

Some of you may be caught up in the "cut the budget" program, and this is needed. Yet, you wouldn't hesitate to give your full blessing to the monies needed to send an Army, Navy, and Air Force to the Middle East to protect what you feel is our right to the Middle East's oil. Why then wouldn't you, and the others in Congress, in the agencies, and in the White House give immediate and full funding to America's only hope, renewable AG ethanol.

Current Government programs of gas rationing, small cars, weekend closings are all programs of denial. Renewable AG fuel offers everyone the chance to conserve by substitution.

I would be stupid if I didn't think you will hear the shouts of those who do not want America to have an alternate way of life and an alternate fuel. You and your colleagues will hear those who tell you it may be too costly. When this happens, I ask that you ask yourself how cheap a successful renewable fuel program will be if it prevents a war and your son or daughter, brother or sister from being killed in trying to hold a Middle East oil field.

Again, I thank this committee for their foresight and leadership, and I close by reiterating that an immediate implementation of a long-term, low-interest program will get immediate positive response, and my goals as stated herein could be quite low.

Senator McGovern. Our final witness is Don Patterson, who is the Virginia State Coordinator of the American Agriculture Movement from The Plains, Va. Welcome, Mr. Patterson.

STATEMENT OF DONALD PATTERSON, VIRGINIA STATE COORDINATOR, AMERICAN AGRICULTURE MOVEMENT, THE PLAINS, VA.

Mr. Patterson. Thank you, Senator, and thank you for your leadership in bringing this issue forward today.

In regard to those backyard stills, we do have to be careful in promoting plants that are too small to pay their labor costs. As we proceed, we need more work to determine just exactly what the economical scale is.

We also need work in the area of automated control in order that plants of an economical scale can be made smaller than presently is the case because of the need to cover the labor cost involved. There are a number of areas where we can still be critical of the activities of the Federal Government, but I think that when we look back over the last year, we have to recognize that we have come a long way. In spite of the fact that the DOE and the USDA have not been able to get themselves together, both agencies are further down the road on this than they were when we were working on it a year ago, and much further than we were 2 years ago.

I would like to really praise Mr. Williams because since he has come on board at the USDA, we have moved ahead on alcohol fuel, as we were not moving at all before his leadership was injected into it. Similarly, I would like to recognize Steve Potts, Bill Holmberg, and others at the Department of Energy who have carried the Department of Energy commitment forward this year. Last year at this time we would come before committees, and you wouldn't think that the Department of Energy and the USDA were participating in the same administration. So at least there is some progress.

Our problem is that there is an enormous amount still to be done. In my judgment, we have not looked at the alcohol fuel issue in a broad enough overall perspective. In particular, it should certainly be within the mandate of this subcommittee to look at our energy situation in an overall economic policy perspective. Only through the application of overall economic correctives will we be able to move ahead powerfully enough to overcome the limitations of an approach which so far has limited itself to the simple appropriation of Federal loans and loan guarantees.

The ability to form capital comes from profit, and systematically over a 25-year period, Federal agricultural policy has been managed in such a way as to withdraw profitability from agriculture. We are now up to $160 billion of net farm indebtedness. It takes about $14 billion just to service that debt as compared to $30 billion in so-called net farm income, which is really not net farm income as any other business would calculate it. What the USDA calls net farm income is really return to management, labor, and capital; in any other business these entries would be considered costs.

We would like to request that this subcommittee look more fully at the full perspective so that we can return profitability to agriculture. As has been heard over and over again, we can solve our energy problem on American farms and meet our food needs, too. Yet, we look at the administration commitment, $3 million of loan funds for alcohol, out of which $300,000, 10 percent, is allocated for small farm production. Particularly in light of what has been said here today, that is pathetic testimony to the way our political system works. The only way we can possibly meet the President's alcohol production targets is by building lots of small plants; large plants cannot be built fast enough. It should be turned precisely around. We are putting 90 percent of the funds into the hands of people who not only will produce alcohol less efficiently, but who already have the leverage in the capital markets to borrow what funds they need. The 90-percent portion should go instead to the farmers of America who have the best capability to get the job done, but who have been so systematically squeezed over recent years that they do not have any ability left to form capital. The Federal Reserve System has painted itself into a corner where all it can do to try to control inflation is to vainly continue to raise interest rates. This policy transparently promotes the continued concentration of wealth at the disastrous expense of the vast majority of Americans.

Last summer the Federal Reserve Bank expressed glee that finally now they had their hands on a means of controlling inflation in our economy. In the process, they were going to choke the economic capability of rural America. The rural sector does not have the market leverage to pass on its higher interest costs.

Now here we are again turning over effective responsibility, in spite of the rhetoric, to those sectors that have already amassed more market leverage than, in a healthy competitive system, they should have. Over and over again in pursuing energy choices, this is what has happened. Federal dollars have gone to further lubricate those technologies where substantial private commitment is already observed. Instead of putting productive capacity and the capability to earn income back in the hands of the people at the bottom so that we can rebuild our economic system, we have funded the entrenchment of a form of economic collectivism that benefits corporate America only. In fact, we are in the process of reincarnating feudalism in modern America.

Until be begin to rebuild earned income in our system from the bottom, we will not be able to correct either the economic or the energy problems that face this Nation. To accomplish this goal, we must reverse the pattern of establishment thinking that governs Federal agricultural policy. The Worldwatch Alcohol Fuel Study follows the pattern. The Washington Post editorials of recent months—and last winter, too—follow the pattern, as do various other published reports. These examples are simply the current manifestations that arise from a mentality that can be traced all the way back to the last century.

Back in the 1960's, the Committee for Economic Development argued that it was necessary to reduce "overemployment" in the rural area by squeezing the agricultural economy. The goal has been to squeeze cheap labor, cheap fiber resources, and cheap food into the industrial sector and into the urban areas of this country to keep the engine of industry turning.

Back in the 1920's, similarly, as we went into the crash of 1929, we see that the managers of our economy, Andrew Mellon, the then Secretary of the Treasury, for example, arguing the same basic line. To keep business and industry healthy in this country, they believe they had to squeeze surplus labor and cheap fiber and food resources out into the urban and industrial sectors. This faulty logic was pursued until it brought the country to its knees.

Fundamentally, the crash of 1929 followed inevitably the collapse of the rural economy. Other factors also contributed to the Great Depression, but among all the causes, the role of agricultural policy is too often conveniently overlooked.

We face a very similar situation right now again today, and the only solution is to restore profitability to the agricultural sector. By improving the management of agricultural policy in the context of overall national economic policy and by providing effective oversight, this subcommittee can give us some of the leadership required to get the needed job done.

You have direct personal experience, Senator, with the patterns of entrenched establishment thinking that gets us into these kinds of problems. Your leadership, starting way back in the 1960's, was seminal in getting our national thinking straight on the question of the Vietnam war. At that time, we were up against a very similar pattern of entrenched establisment thought which was leading us deeper and deeper into trouble. You had the vision to recognize the truth and speak out before any other Member of the Congress was willing to break the political habit of getting along by going along.

The management of our farm policy is a similar issue. We need to have that same kind of visionary leadership now. It is in the interest of the consumers of this country and the Nation as a whole that we have it. So far, the battle has been fought by farm people because farm people understand it, but we are only 3 percent of the people in this country, and we cannot by ourselves meet the Nation's food and fiber needs, solve the enormous energy problem, and fight the political battles over national economic management as well. We need help. Until the consumers of this country recognize the importance of sound policy management that can put the rural sector of the economy back on its feet, we will not succeed.

Alcohol fuel technology is uniquely suited to small farm scale plants, and yet the tendency toward concentrated large scale plants continues. Habitually and diabolically, almost, we incline the aid program toward large scale production.

I understand that a GAO report, which has not yet been released, reveals the facts to support the case I am making: that agricultural health is fundamental to the health of our national economy. We need the assistance of this subcommittee to get that report released so that information from such an important source can be circulated.

Now, to address some of these specific questions that have been raised. Here this morning, it has been suggested that we go to a leasing approach rather than to an acceptance of the Federal loan responsibility and Federal leadership in developing an alcohol industry. That, I would suggest to you, is a copout on the Federal responsibility. When the nuclear industry was getting started back in the 1950's, did anyone come before the Congress at that time to argue for a leasing approach, suggesting that nuclear development should be a private responsibility? No; that did not happen. We had a massive Federal commitment at the rate of one-half billion dollars annually for nuclear reactor research alone, lubricating the private money that was also being invested.

But when it comes to a sector that doesn't have the economic power to form capital, we hear voices saying, oh, this should be handled privately. Never mind that the farm sector can do the job better than any other. When will we hear the end to this kind of Federal buck-passing? When will we have an end to the feeding of money into the areas that already have financial strength and the denying of resources to those who can truly get the job done in a hurry?

We hear, also, that alcohol will not work in diesel tractors. We hear this given as a seeming excuse for foot dragging by the USDA. Indeed, how long does it take for the USDA to send people to Brazil to see with their own eyes trucks made in Detroit that have been operating for hundreds of thousands of miles on a mixture of alcohol and castor oil?

I think that USDA performance has improved, but there is a great deal that they obviously have not done to get us moving. We can make anhydrous alcohol on the farm. We have demonstrated that capability already. We do not need to wait for large scale plants to handle that part of the job.

Further, we have shown better net energy balances than any of their large scale plants can demonstrate.

Two weeks ago, I testified before a subcommittee of the Science and Technology Committee in which they brought forward witnesses from the Midwest Solvents Co., saying that they had originally produced alcohol for 171,000 Btu's per gallon. Now, as the result of great effort, they have learned how to produce it for 105,000 Btu's per gallon—there are 87,000 Btu's in a gallon of alcohol.

We have farm scale plants that are producing alcohol for less than 20,000 Btu's per gallon of alcohol by using very meticulous and thorough recycling of the heat within the process, using well-established heat exchanger technology. Further, we could improve the figures even more with solar process heat if the high front-end costs were not so difficult to manage.

The anhydrous aspect is very, very simple. Clay bed drying of the alcohol has already shown promising results in farm scale plants. These systems are here. All we have to do now is get the word out to the people across this country and provide the funds to get the job done. The ingenuity exists. Let's not fumble on it again, and let's not let ourselves run up a blind alley again as we have on nuclear energy.

Senator McGovern. Thank you very much, Mr. Patterson, for your testimony.

[The prepared statement of Mr. Patterson follows:]

PREPARED STATEMENT OF DONALD PATTERSON

Much has happened to advance the cause of alcohol fuel and biomass energy generally since those of us active in the American Agriculture Movement first began to work on this issue in Washington during the early winter months of 1978. Much of the misinformation and anti-alcohol propaganda has been dispelled, and we can be grateful for the clear-headed analysis and well-focused discussion of the real issues that have begun to take place in Washington and elsewhere across the country.

On some days, we are tempted to believe that we have even accumulated some laurels to rest on. However, for us to start coasting now would be a disservice to our country. It would manifest a misunderstanding of how the political process works. A great deal of work still has to be done to make sure that we can successfully follow through on the declarations of political commitment which have been made by Democrats and Republicans, Congressional leaders, and most importantly the administration.

It is too easy in the world of politics for leaders to make sweeping statements on popular issues and then fail to follow up in ways that are necessary to achieve positive action and success. Too often, political talk, real leadership, and solid achievement on a clear time table are separate and distinct, not to be confused with one another.

We can make a success of the alcohol fuel program, other biomass energy technologies, and other alternative energy technologies, but unfortunately to achieve this success on a time table that this country needs requires a solid and immediate commitment of resources and manpower. Lip service is not enough.

It would be very easy to give strong lip service in this political year without providing the backup resources. Then a year or two from now, leaders could point to the fact that the whole idea had not worked, thus freeing the faddish inclinations of the federal establishment to lurch off in some new direction.

We have pursued wrong energy ideas too many times. As a nation, we are guilty of sins of both omission and commission. Too often federal energy priorities have been set because private political influence was already providing the political leverage to see that federal dollars lubricated the private commitment.

Too often the federal treasury has been looted for energy projects more out of expediency than wisdom. The time has come when we can no longer afford to make unwise policy commitments. Our backs are against the wall.

Last summer, one Congressman justified his vote on a bad synfuels policy, noting, "It was the mood of the American people that we 'do something,' even if that something is wrong." We cannot afford any longer that kind of politics. It is time to do something right.

We need vision about the course that can rebuild the health and strength of our American system. Energy choices are the key to our future. Bad energy policy has been undermining the fabric of our economic system for too long.

No technology is perfect, and no one technology alone can solve all of our problems, but alcohol fuel technology is the only technology immediately available to help us reduce our dependency on foreign oil and meet our needs for domestic liquid fuel in the near term.

Alcohol technology has been handed to us, perhaps, as a final reprieve, after a multitude of errors. Perhaps we can count it as a gift from the merciful Heavens, handed to us at the brink.

The policy that will provide us the liquid fuel production capacity we need in the shortest time is the policy that facilitates the construction of a large number of relatively small scale plants. Not only are the larger scale plants less efficient in the production of alcohol—partly because of transportation costs associated with the long distance handling of feedstock resources, as well as the cost of drying by-product distillery mash and returning it to the farm for feeding—but large plants take much longer to build. In contrast, smaller farm and community scale plants are capable of helping us almost immediately meet our liquid fuel needs.

Last year, in 3 weeks' time, a 20-gallon-per-hour alcohol fuel plant was constructed and operated on the mall demonstrating the production capability that can be put into the hands of American farmers quickly.

Energy companies have long been hostile toward the creation of a farm alcohol industry because they know that the economies of scale in alcohol production are highly unfavorable to concentrated control. Unlike petroleum, alcohol production lends itself to relatively small scale plants that can be operated at least as efficiently and generally more efficiently than larger scale functions.

Because alcohol plants can be most productively operated on the farm or by a group of farmers working cooperatively, it is very important to understand the context of the agricultural industry within which this new energy undertaking can be most fruitfully launched. Unfortunately, agriculture is not in the strongest economic position to launch alcohol production when, as a result of many years of low commodity loan rates, farmers have been denied a fair return on their investment, labor, and management.

Alcohol fuel can enable us to rebuild the health of the farm economy from the bottom and generate economic strength throughout the entire economy, but to build the plants to produce alcohol requires capital, and capital is formed from profit. Profits, however, have been effectively denied agricultural producers over recent years as a result of both federal policy management and a cost-price squeeze that is threatening to result in the same kind of concentrated control over agriculture which already is observed in too many sectors of our national economy.

It is essential for our future economic health that we maintain production at that scale which is most efficient in production, not at the scale which offers efficiency only in market domination.

In the absence of profit out of which to form capital, farmers have had to rely on credit. As a result of continuous annual borrowing, American farm indebtedness has risen now to 160 billion dollars. Out of only $30 billion of what the USDA calls "net farm income," $14 billion is required just to pay the interest on that debt. In this environment, and with interest rates now at record all-time highs, more and more bankers inform us that money is simply not available at any price for an purpose. Even if money is available, how, when farmers enjoy no leverage over commodity prices, can they suddenly find the economic strength even with alcohol production to pay interest charges off the top?

America's most efficient farm producers are under pressure directly because of federal agricultural policy and federal monetary policy which couldn't have been better designed to continue concentrating the ownership and control over farmland in the hands of those who have cash flow from other income sources to lever their expansion into agriculture. Add further, tax and investment credit laws which give corporations, wealthy individuals, and foreign investors a better after-tax bottom line than a working family farmer can take advantage of, and we have the skeleton of a policy which effectively insures the inability of family farmers to meet the energy challenge that otherwise they would be best suited to take on.

This is the economic scenario as the curtain opens today. The question: is the Congress able or willing to do anything about this situation? Where with the Administration sandbagging can the leadership be found? How can urban and suburban Congressmen that make up the vast majority of the House of Representatives be persuaded to understand their own best interests? Can we explain to urban and suburban voters why it's in their best interest to provide a new lease on life for American farm producers so that they can have an opportunity to develop a fuel industry for the benefit of us all?

Who will bell the lionine policy-makers over at the Federal Reserve who purport to fight inflation with ever higher interest rates which actually do more to generate inflation than they can ever do to stop it? Who is responsible to provide the overview, the oversight, and the vision—who is responsible to blow the whistle and point the way? Can we not hope this committee will rise to the job?

As we have attempted to face this issue squarely, we have heard too much about the potential conflict between food and fuel, when, in fact, alcohol is the by-product of a process of improving the nutritional feedability and digestibility of feed grain for livestock. We can actually make agriculture more efficient in the process of producing alcohol fuel.

To start with, 93% of the nation's corn is used for livestock feed. Alcohol could be produced from this corn without jeopardizing the nutrient value of the corn. Alcohol production utilizes only the 20% carbohydrate content of the corn, leaving the protein and other nutrient value even more fully available than they are in kernel grain.

At present, when grain is fed to livestock, much of its nutritional value passes through the animal and out in the manure undigested. The problem has been of such magnitude that animal nutritionists have developed means of reclaiming this waste for re-feeding. Enzymatic treatment in the process of alcohol production is a better system for dealing with this problem. Experiments have already shown its superiority. Animals grow fatter more quickly when fed grain by-products of the alcohol production process, although they cannot be maintained on this diet alone.

Instead of causing a reduction in world food supply and contributing to increased world-wide hunger, the production of farm fuel can actually improve our ability to meet the hunger challenge. While hunger is mostly a purchasing power problem, it very much relates to the development of international productive capacity and the need to increase nutritive protein levels in available food supplies. In general, the world's hungry do not lack sources of carbohydrate; they lack protein. The by-product of grain alcohol distillation can be effectively used in human nutrition.

At present, we are attempting to export increasing quantities of American farm commodities to offset our current balance of trade deficit, a deficit which has resulted from greatly increased imports of foreign oil. In an effort to keep up with the unfavorable oil-related balance of trade, federal policy has been managed to maintain artificially low commodity prices and high export volumes, in spite of USDA computer analyses showing that higher commodity prices would return more against our balance of payments deficit, even while we sold somewhat less of our commodities.

Even apart from these facts, we are simply crazy to believe that we must be prepared as a nation to produce food for the entire world at prices that are less than the cost of production for our own farmers. We must look at food policy and energy policy in an integrated way, recognizing that current international grain trading policies are really benefiting only one group: the international grain traders. They are not even benefiting many of the countries which receive our grain. Artificially cheap grain from the United States is, in fact, serving to undermine the agricultural economics of these countries.

While exporting our homegrown energy potential at cheap prices, we are turning around and paying six or seven times as much for imported oil supplies.

Since the AAM delegate body passed its resolution supporting the development of the alcohol fuel industry in the United States, interest in a wide variety of alcohol production technologies has grown among farmers involved in the Movement. We have looked at both large scale and small scale techniques for alcohol production, and while a great deal still needs to be done to refine and demonstrate the ideas we have been exploring, we believe that we have seen enough already to know that efficient production of alcohol fuels in small and moderate-sized farm and community plants is definitely possible. We believe that the national and international benefits resulting from the development of this industry can be substantial.

As you are no doubt aware, the prime concern of the AAM is to achieve a fair price for agricultural commodities and a fair return of farm investment, labor, and management. Because our prime motive is to preserve American family farms and a sound agricultural economy, we are not interested in programs which simply utilize agricultural commodities without providing farmers with a fair return on their efforts. The program has to make economic sense at grain prices which yield a fair farm income.

We want to help solve the energy problem, and we believe that we can do that while utilizing commodities at fair prices, manufacturing valuable by-products, helping to improve food products available to combat world hunger, and at the same time improve depressed income conditions on America's family farms. While believing that useful studies of the economics of scale and net energy efficiency of alcohol production can still be undertaken, we believe that we have learned enough already to know that small and moderately-sized community scale plants can be more efficient than large scale plants. By feeding the by-product mash wet on the farm, the expense and energy necessary to dry and transport this by-product can be saved. Just as cows are milked on the farm, alcohol production should be concentrated on the farm and in farm communities close to both the feedstocks and livestock to which the by-product mash will be fed.

Too much of the current discussion of legislative incentives and regulatory patterns concentrates on providing opportunities for alcohol plant development to those who already enjoy better than average ability to form capital and control resources. The American Agriculture Movement is not interested in supporting the development of a new industry for the benefit of those who already have family farmers over a barrel by virtue of their superior market leverage and oligopolistic organization. We are interested in policies which are the most wise for the long-run health of our national economy, and we do not believe that further concentration of the ownership of yet one more technology is healthy for the nation. The wisest course, given the economies which have been so far demonstrated, is to use the opportunity for the establishment of this new industry to re-establish important balance in our economy. If we can rebuild a proper urban-rural balance in our pattern of economic development over the next few years, we will do a great deal to preserve the economic and political system handed down to us by our forefathers.

We are at a crossroads right now: we can make the system work again or we can contribute to the further development of the lopsided imbalances that have gotten us into our present economic difficulties. The decentralization of our economic system for the revitalization of our rural economy is essential to the restoration of broad national economic health. We want to restore earned income to America's farms as a corrective to present policies which are increasing farm debt and effectively transferring fair farm income into the hands of bankers, energy, fertilizer, and other farm input suppliers, as well as others on whose mercy agriculture too much depends.

For the sake of our national economic future, it is time for this country to pursue decentralized energy technologies and to study carefully the social and economic economies of scale as well as the economic externalities which go into making our energy development choices. For too long, we have accepted biased numbers from firms in the energy industry purporting to defend certain economies of scale without reference to enormous social and environmental costs which have gone uncalculated.

Too often, accepted figures have failed to take into consideration important direct costs, not to mention indirect and external costs. We have accepted, for example, such enormously costly resource allocations as that which has brought us the Alaskan pipeline, only to learn now that Californians must wait in lines at the gas pumps while Alaskan crude oil flows through refineries in Japan.

Agriculture has suffered continuously as a result of its inability to stay organized, to fight off the power held over it by other economic sectors. If ever there were a sector of our economy which deserved to be indexed to preserve its health and to restore balance within our total national economy, that sector is agriculture—the major economic sector made up of many competitive units, all of which are incapable of the market control and therefore the assured profitability which seems so directly and so frequently to translate into political power within our system.

The American family farmer is truly the goose that lays the golden egg, but even the golden goose has its limits. It can be choked only for so long before the golden eggs are laid no more. The farm can be the source of greater benefits than we have yet realized, but to achieve those benefits a better understanding of the relationship between farm economics and the larger issues of national economic management must be reached by more members of the Congress and more Americans so that more effective agriculture policy can be written.

In conclusion, during the years when the policies which began the American farm income squeeze were begun, we also embarked on a program to develop the nuclear industry. Through the Atomic Energy Commission, the U.S. Government injected in excess of one-half billion dollars annually for more than a decade into civilian reactor development alone, not to speak of other government support for the nuclear industry. One-half billion dollars annually—and that was when the dollar was worth more than it is today. Just think what we could do to develop the biomass fuels industry today if that amount of money were made available. Brazil, with an economy smaller than ours, has made such a commitment of resources.

The Congress holds the power to enhance or destroy this new industry. The oil industry has had its oil depletion allowance; other energy industries have had similar breaks. And yet, there are those who argue that the biomass fuels industry should get along with less than peanuts in the DOE budget and mostly only loan guarantees from the USDA. Without wanting to look a gift horse in the mouth, we still don't know how to make use of a loan guarantee when we can't get a loan and can't pay the interest on it if we could.

This nation is pursuing economic policies to make the rich richer and the poor poorer while destroying the middle class and the family farmer. Where are our leaders to blow the whistle? Where will we be as a nation when current policies have done their work?

The foregoing general analysis is offered as fundamental to our capability of addressing our national energy needs as well as to the necessity of reestablishing national economic strength. In addition, several questions should be addressed more specifically and directly.

I. PRODUCTION POTENTIAL

A. Potential oil displacement capacity of alcohol fuel within the immediate short-term and relatively near future: Enough agricultural commodities can be easily made available to alcohol production to meet the Administration's targets of 500 million gallons of alcohol by 1981 if the capability to form the capital to build the necessary plants quickly enough is provided. The existing facilities for providing capital ought to be sufficient if the funds are put in the pipeline. Presumably the Farmer's Home Administration has the capacity to process the loans and get funds into the hands of producers quickly. At present, long lags have been experienced in receiving authorized funds through FMHA programs and in addition difficulties have been experienced because of a shortage of qualified personnel capable of handling anything more complex than the simple home and business loan applications. Frequently, biases against farm applicants in favor of home owner and business applicants have been experienced in FMHA offices.

Over the longer term, the use of cellulosic wastes particularly forest residues provide perhaps the most promising source of alcohol fuel, even more promising than sweet sorghum and other crops grown especially for alcohol purposes.

B. Current and foreseeable net energy balances: Already in farm scale plants as a result of the application of heat exchange technology, very favorable net energy balances in alcohol production have been realized. BTU input of less than 20,000 per gallon of alcohol has been monitored. This number can be further improved upon as heat exchange techniques are refined and solar pre-heating technologies are introduced as well.

C. Alternatives to improve present crop cultivation patterns to increase renewable energy resource fuels without significant interruption of food and fiber supplies: The closing of another ecological loop involving the production of methane from animal wastes enables the production of highly nitrogenous fertilizer at the same time as the farm can become a net exporter of electric energy instead of at present a net importer. The introduction of methane by-product fertilizer will help improve cultivation patterns and enable farm economies that will in turn enable better conservation practices. Farmers will always take better care of land they own than they take care of land which is leased. Very few farmers feel that they can afford to take appropriate conservation measures on leased land because of the long-term nature of the investment in relation to a short-term lease. If profit can once be returned to farming, the financial pressures to cut corners on conservation will be reduced.

II. ECONOMICS

A. Cost of production, including grain by-products and live-stock production: As a result of the heat recycling within the alcohol production system, costs of production have been reduced substantially with plant construction costs now being the major cost factor. The second largest cost is labor until such time as increased automation of plant controls becomes possible.

B. Possible effect of renewable energy resource fuel production on food and fiber commodity prices: For some time to come, there is no reason that commodity prices in the United States should rise as a result of alcohol fuel production. It will take a number of years to build sufficient plant capacity to outdistance available biomass. Particularly in the short run, the increased efficiency that will result from improved feeds will have the effect of actually extending supplies rather than reducing them. It is a question of getting multiple benefits from a product that is now offering only a single benefit. The alcohol fuel technology has qualities similar to the perpetual motion machine in some respects. However, over the longer term, management policy decisions will have to be evolved to balance food, fuel, and fiber needs and to try to maintain production which is optimally harmonious and avoids head-on competition among the three. Even the prospect of future competition for available amounts of land for cultivation should not defer or retard our launching alcohol fuel programs. When we review other energy alternatives, all have greater disadvantages, leaving biomass development a virtual necessity.

C. Economic-development/job-creation potential of renewable energy resource fuel production: Alcohol production is not labor intensive, but in generating renewed health in the rural economy throughout America the multiplier effect will help increase production in other economic sectors. Direct effects will be felt in plant fabricating, and there will be a variety of secondary service industries that will develop in support of alcohol fuel. Some of these will arise out of existing liquid fuel service industries. The main economic impact will result from keeping dollars at home instead of sending them abroad for the importation of foreign petroleum products. The multiplier effect of this income throughout our economy several years ahead could be significant.

III. TECHNICAL ASPECTS OF SMALL SCALE PRODUCTION AND USE

A. Production potential with off-the-shelf technology: While new technology is definitely in the works, we have a national problem now which current technology is capable of addressing. Distillation alcohol is economically feasible right now and every sign suggests that it will continue to remain economical even if more efficient technologies are developed in the years ahead. We cannot wait to solve a pressing national problem because another technology may come along to offer greater efficiency soon.

B. Technology and cost of engine modifications required for pure fuel use: Modifications are very minimal for pure fuel use. Although current production engines are not optimal for alcohol, they are adequate. The only modification to provide suitable running of engines on alcohol is a 40 percent increase in carburetor jet size and perhaps an injector to allow for starting the engine on gasoline or some other more volatile fuel in cold weather.

C. Gaseous and electric power generation potential for renewable resources: Clearly, there is a very large potential for methane generation, particularly in relation to feed lot and dairy operations. Electric power generation can make America's farms net energy exporters. One facility recently constructed at a dairy farm in Gettysburg, Pennsylvania suggest thats the capital costs of the facility can be paid off in from three to five years. The facility uses manure from approximately 700 head of dairy cows and produces enough electricity for costs the diary's electricity needs, offsetting approximately $20,000 of electric ⅔ of annually. The plant capacity will be increased in the future.

IV. COSTS AND IMPROVED FEDERAL ASSISTANCE

A. Investment requirement range for individual on-farm fuel production facilities: Turnkey cost for a 20 to 40 gallon per hour alcohol fuel facility is estimated to be in the range of $200,000, depending in part upon the size of the mash tanks and the extensiveness of solar process heat facilities and heat exchanger equipment. If the producer puts in the facility himself, substantial cost savings can be realized. Once control automation is possible, smaller facilities could become cost-effective. Caution should be exercised lest facilities be built which are too small to be capable of covering labor costs. Backyard systems can be too small to be economically feasible. There is still room for a great deal of work analyzing and experimenting with different technologies, plant sizes, and control systems. Figures developed now are based on very rough preliminary estimates.

B. Investment requirement range for individual rural community production facilities: These figures would vary depending upon the nature of the agricultural area and the available feedstock supplies as well as animal feed lot capacity in the neighborhood. The range could be no larger than the aforementioned farm scale plant sizes or considerably larger. As long as feedstock resources were available, an efficient operation and a means of disposing of byproduct mash are possible.

C. Steps required to consolidate and coordinate delivery of management, technical and financial and marketing systems assistance for on-farm and rural community production and use: Existing USDA capacity should be sufficient for this purpose, but the commitment must be made to develop the capacity in the field and this is where a great deal of work needs to be done. Presumably, the extension service is the proper arm for extending management, technical, and marketing assistance; however, a great deal needs to be done to develop the capacity to provide this assistance on a local basis. Financial assistance, presumably, can be delivered through the Farmer's Home Administration or through some other lending facility, i.e. land bank/production credit association, commercial banks, Small Business Administration, or whatever. Some technical capacity (as well as guidelines) would be needed by loan officers to make sure that the applicants were capable of fulfilling the promise of efficient plant construction and operation. An important part of the overall delivery system should be management and construction training workshops. Already, the capacity to deliver workshops has been developed by the National Alcohol Fuel Producers Association, community colleges, and others. Some guidelines could be helpful to make sure that minimum standards are maintained, although nothing will replace caveat emptor as the marketplace will certainly abound with hucksters. Perhaps the Department of Energy is an appropriate agency to play a role in capacity building as they offer better technical capacity at present than exists in the Department of Agriculture.

Senator McGOVERN. Gentlemen, one of the points that I think you heard Mr. Williams make is that the whole process is being held up by the failure to nail down this tax incentive on gasohol and alcohol fuels. Do you gentlemen accept that verdict?

Mr. MAVIS. Senator, if that's so true, how come they've been so slow in getting out what they have? I mean, they're talking about what's coming out. Why don't they move what they have?

I talked to the State office just before we left. They tell me that if they were going to approve a loan for an alcohol plant in Illinois, the people would have to put up a 20-percent cash incentive—not land; cash incentive. I said, if a man subscribed his corn and committed corn; they said they'd have to take a look at it. Then all you're going to get is a loan guarantee.

Senator, you've been around agriculture long enough to know if you put up 20 percent cash, the local banker is going to take or not take you anyhow, and all you're going to get is a loan guarantee.

So I ask the USDA: Why don't they move what they have and show us some signs?

Senator McGOVERN. Mr. Middaugh.

Mr. MIDDAUGH. Could you restate your question, sir?

Senator McGOVERN. Secretary Williams, when I asked him why they hadn't made any of these loans, or any to speak of—I think they have made seven small loans, but they are sitting on $110 million, and that's not a lot of money; but as Mr. Mavis said, they ought to at least use what they have. Well, his answer was, we are waiting for Congress on the windfall profits tax to make sure that proviso is included which exempts alcohol from the excise tax, so that this becomes economically feasible to product it.

I think it is a 4-cent-a-gallon tax.

Mr. MIDDAUGH. Actually, in South Dakota I have been contacted by many groups, and all of them are planning to put a substantial amount of their own money into this operation. They simply need some small encouragement from the Government, particularly through the Department of Agriculture. The one thing they asked for was, could it be possible for the FMHA to come out with a reasonable rate of interest on small loans. Therefore, this $110 million could be available immediately.

Senator MCGOVERN. Mr. Eakin, did you want to be heard on that?

Mr. EAKIN. Yes, sir. We have syndicated so far about 3.5 to 4 million dollars' worth of equity for alcohol plants in the Southeast. Those are based on existing tax shelter aspects which are known and available.

What I do think can be a problem—and I find this true when talking to the major insurance companies concerning lending on alcohol—is that they are just waiting for the air to clear and see if there are any more goodies coming down the chute or what else is going to happen. I think there is a discrepancy that needs to be noted there.

Senator MCGOVERN. Just to see if we can get some general consensus here, do all five of you gentlemen agree—and I think you do, if I heard your testimony properly—that we need to improve the information and educational dissemination on these alcohol fuels programs? Is there anybody who does not regard that as an important part of the problem?

Mr. PATTERSON. Senator, I would say in relation to your previous question as well, that for the USDA to use the excuse of the congressional slowness on the tax incentives is perfectly ridiculous, in view of the tremendous amount of work that they have to do just to develop the technical capacity to get information out to people. It will take them months if they were to proceed full steam ahead. Large numbers of people are not waiting to see what the Congress does on that particular piece of legislation before they consider building plants. Those that are waiting are the larger scale operators and not the farmers who have the capability of operating the far more efficient plants that we should promote anyway.

Senator MCGOVERN. I have mentioned the need for a government document of some kind. There is one dated this month, March 1980, called Small-Scale Fuel Alcohol Production, that is literally just out this month. Still, it doesn't tell you where you go for help in terms of, say, if you wanted to find out what funding is available. You won't find it in that book.

You will find a lot of the technical problems outlined, and I commend the Department of Agriculture for at least coming out with something that attempts to pull together some of the technical information we have in this field. But it still doesn't provide practical, down to earth information on how a community, for example a small rural community, or a farmer or a group of farmers or a cooperative or what have you, how they go about organizing the capital, the possible loan assistance, guaranteed loans or whatever, what government services are available to them, what kind of technical assistance is available.

I haven't read this in detail, but I don't think that information is in here. It seems to me that all of you have made a point on the need for the Government, first of all, to get its act together so that there is general agreement on what we're going to do in small-scale alcohol production; and, second, get that information out to the public.

Mr. Eakin.

Mr. EAKIN. I would like to make two points on that, Senator. One is that Mr. Middaugh and Lance Crombie and I are on the Farmers Home Advisory Panel. We met maybe the end of January, and at that time this subject came up and I think we discussed it with them and suggested and outlined avenues for an approach. So I think they are aware that something needs to be done.

Who has taken the ball since that meeting, I don't know.

The other thing is the point that you just made yourself, and that is that capital formation is just not like financing a beauty parlor or a normal inventory of any small business. This is fairly sophisticated stuff. You get into tax shelters; you get into SBA, anti-pollution, bond financing; you get into a lot of different aspects of capital formation that the Government and most people in the Government themselves are just not sure of how it works.

Senator McGOVERN. I think that's right, Mr. Eakin. I can see the point you make, but I thought Mr. Patterson made an excellent point, too, that that did not stop us when we decided to go into the construction of nuclear plants, and to whatever extent a 2 to 5 million gallon gasohol plant represents a capital intensive investment, it is still pretty small potatoes compared to a nuclear plant.

Mr. EAKIN. It certainly is, but that is not really relevant. What is relevant is the capital of the investors in this sector versus the capital of the investors for nuclear. I couldn't agree with you more.

Senator McGOVERN. I can see the point. I just think, though, that we sometimes have to keep these matters in perspective. You are quite right that it does require some capital and we haven't yet outlined very clear procedures to interested people and how they get in line or how they qualify.

Mr. Crombie, you've been trying to get recognition here, I think.

Mr. CROMBIE. I would like to update you as to how the information system works now, and it usually goes something like this: They have a number of WATS line numbers from the Department of Energy and they will usually get some general answers or a general overview about alcohol fuels, where to go, whom to talk to, things like that. What they do is give my number out, and they call me, and then if I can't answer the question, I tell them to call Al Mavis. I assume Al Mavis tells them to call Paul Middaugh or some of the other people that are active. There are about 10 or 15 of us throughout the Nation that help. I get calls perpetually. I get some 50 letters a day. I stopped counting at 9,000 letters. I don't answer any of them because I have no budget, no office, no secretary. I can't get any financing and I am in the process of struggling to build my own little plant.

The way the system works as far as information is that they call me at midnight, 2 o'clock in the morning, and any other time of the day and night, and I am frankly, for the past 2 years, getting very tired of it.

I would like to ask Mr. Williams—and we did this about a year ago—where are the experts in the Department of Energy?

Senator McGovern. They're going to answer that. We're going to submit some questions in writing that have come out of the testimony of you gentlemen, and I'm going to ask the staff to summarize the principal questions and recommendations that have been made here and put that in the form of a written directive to the Department of Agriculture and, where necessary, to the Department of Energy, so that we can get some of those answers cleared up.

Mr. Williams has agreed to give us a monthly report on every loan they either make or they guarantee, the size, and where it's going. Beyond that, I intend to press them to see if we can't get clear information on what they are doing in terms of their educational and informational and technical assistance responsibilities, because that's just as important as providing the money, providing the loan guarantees.

Yes, Mr. Middaugh?

Mr. Middaugh. The three of us did recommend strongly to the Farmers Home Administration a month ago that they try to fund the Farmers Home Administration loans in the ratio of about 70 small plants under 500,000 gallons per year for each very large plant. I do not see any testimony today from the Secretary that indicates they have listened to this suggestion.

Senator McGovern. Well, thank you very much, gentlemen.

The hour of noon has come and passed, so we're going to have to bring this hearing to a conclusion. We are going to follow up on the points that have been made here and see if we can't accelerate the whole process of arriving at some kind of a coordinated policy in the Government. It is not only a matter of great interest to our people out in rural America. I can tell you it has gotten to the point where it has become a matter of personal survival for some of the Senators who are trying to go home these days.

We appreciate the help you have given us here this morning. Thank you. The subcommittee is adjourned.

[Whereupon, at 12:05 p.m., the subcommittee adjourned, subject to the call of the Chair.]

APPENDIX

STATEMENT OF M. JAMES PUFAHL, FARM ALCOHOL PRODUCER, MILBANK, S. DAK.

The only way the United States can become independent of OPEC imports is to push renewable energy hard and fast. With the Mideast ready to explode like a tinder box we must develop our own energy sources!

The need for financing is very evident when the only government agency that will finance on-farm alcohol plants is Farmers Home Administration. To qualify for a loan from this department, a farm operator has to mortgage his farm, his home, his wife and offspring for years to come; and the sorry thing about it is that it is usually a second or third mortgage because the government has used agriculture for a scape goat for the rest of the country's economic problems. Agriculture has been receiving 60 percent of what the rest of the economy has been receiving so most of its people are already deeply in debt.

While the rest of the business community can get loans on strictly the plant and equipment, farming can't. If FHA approves the loan, they don't have the money available, if an individual is fortunate, he can get a temporary loan at 18–22 percent to get into production. Loan guarantees are empty promises. Businesses accept money, not promises; you can't buy anything with promises. Agriculture cannot afford such expensive interest! The fastest method of getting plants into operation is to use the existing ASC grain handling type loan that's already being used for agriculture.

It is extremely inequitable of our government to force agricultural producers to mortgage their livelihood every year to "pick up the bill" for the cheap food policy this nation is employing. Every year more and more rural people are being driven off the land. Now there are those who expect us to provide food and fiber and to put fuel in their boats, planes, recreational vehicles, lawn mowers and pay usurious interest rates to do so. Farmers make 3 percent of their investment and less than that for wages.

At the present time we are producing alcohol for less than 90 cents per gallon. This figure is actually high because we're not using all the by-products. Corn is presently $2 per bushel here, yeast, enzymes, acid costs for conversion of a bushel are 75 cents, interest, taxes, depreciation, return on investment come to 89 cents which come to $3.64. Two and one-half gallons of alcohol (from one bushel) at $1.25 a gallon is $3.12; 20 gallons stillage equals $1.20 (the 20 gallons fed to a beef animal will put two pounds of gain on the animal); 18 pounds of spent grain at 10 cents a pound is $1.80 which comes to $6.12 or a net profit of $2.48. If the distillers grain is used on the farm it doesn't need drying. Research could be done to learn how to use all the by-products.

The energy companies seem to get as much government help as they want, experimental syn-fuel, coal gassification, et cetera. Have you ever considered helping the most efficient producers of renewable energy in the world to produce alcohol at the same efficient rate they produce grains and meat and milk and fiber? With a little financial help you would be very surprised at how fast agriculture can help to pull our United States out of the economic and fuel crunch it is experiencing! Give us the same treatment (financial help, low interest loans, grants, et cetera) that are given to other segments of the economy and it is possible for our nation to have a surplus of fuel in two years.

Our Congressmen take tours all over the world; please come out into the midst of our nation's life support system and take a learning look at what can be done right here at home! Spend a little of that money this nation's legislators so willingly and easily throw around the globe to build up what's been deteriorating here at home for 30 years because of some unrealistic economic theories. It is time for all of us to pull our heads out of the sand and start building again!

For the $100,000,000 the DOE just recently made available for 4 feasibility studies, there is a firm that could have manufactured 3,333 alcohol fuel plants which would have the ability to produce 633,270,000 gallons of 185 proof alcohol. With minor adjustment to internal ignition engine carburetors, this fuel would give clean excellent milleage without being mixed with gasoline. Please let us start growing again!

[From the A. T. Times, Butte, Mont., December 1979]

ALCOHOL: A QUESTION OF SCALE EMERGING

The long struggle to bring fuel-alcohol to the attention of the public and the nation's law makers is over. Once considered an "orphan technology," alcohol fuels (or "gasohol" when blended with gasoline) have now become "an issue on a par with motherhood and apple pie"—as a Kansas Congressman recently said.

To the aging proponents of the alcohol fuels movement of the 1930's, it must seem like a dream come true. Their movement, led by Henry Ford and William Hale, took root in the populist sentiment of the depression, only to wither under unfavorable economic circumstance and blistering oil industry attacks. Their experience is re-told in the first of a three-part series beginning on another page with this issue.

But with the elementary questions behind them, the new alcohol fuels movement faces even tougher choices, some of which revolve around the question of scale. Many farmers and even urban alcohol producers are faced with the choice of building their own "backyard" still—of 100,000 to two million gallons per year scale—or throwing their lot in with large scale cooperatives, with plans of building 20 to 50 million gallon per year distilleries. Of course, even the "large-scale" distilleries are small in comparison to mammoth oil refineries churning out millions of barrels daily, and will have far less environmental impact, gallon for gallon, than the oil system it is hoped they will replace.

There are questions, though, of survival. Will a proliferation of very small, on-farm stills be able to weather peaks and dips in the price of corn and other feedstocks? Will they begin a cut-throat competition with each other that larger-scale community cooperatives could avoid? And would a community still of 20 million gallons be able to maintain community control in an uncertain economic climate when its mortgage is in the hands of a New York bank?

We don't have the answers, but feel it vital to raise some of the questions. In doing so, we asked Hal Bernton, a veteran writer long familiar with alcohol fuels issues, to prepare this article. Hal took to the road for six weeks, interviewing corporate executives and on-farm stillbuilders, attending alcohol school in Colby, Kansas, and in general, appraising the health of an emerging soft-technology. His report follows:

Breaking the oil industry's hammer lock hold on liquid fuels has long been one of the toughest projects for the appropriate technology community to tackle. But as the decade of the seventies draws to a close, a new vision of a decentralized alcohol energy industry has appeared on the horizon. Ethyl alcohol—a clean burning fuel that can be produced in low cost stills from any organic material containing ample amounts of starch or sugar—has received the greatest amount of attention to date. But methyl alcohol with one less carbon in its molecular structure, can be destructively distilled from cellulosic materials (wood) in inexpensive pyrolysis units. These two alcohol fuels appear to offer both rural and urban dwellers tantalizing new possibilities.

But while some farmers fire up small 25 gallon an hour ethyl alcohol stills, multi-national engineering firms are carefully planning the construction of 20–50 million gallon a year distilleries which they hope will dominate the alcohol markets of the future.

Although most of these engineering firms are working primarily with midwest farm groups who hope to control the economic reins of the giant distilleries, funding for these projects will come primarily from traditional financial sources. The New York investment community is now eagerly searching out such farm based projects. For example, a financial arm of the nuclear power industry, the General Electric Industrial Investment Fund, is becoming active in financing large scale alcohol distilleries.

Just what shape will the alcohol fuels industry of the future take? Will there be a place for the farmers, small entrepreneurs, and cooperatives who are now struggling to break into the business? Or will the smaller ventures be shoved out of the market place by the larger distilleries who may take advantage of more sophisticated technology and high powered financial backing?

Final answers to such questions are not easy to come by. But the strong grass roots movement to keep part of the ethyl alcohol industry under local control has already been launched. At the forefront of the movement is Gene Schroder, a tobacco chewing farmer (with a veterinary degree from Colorado State University) who spearheaded the bitter wave of farm protests which swept across the nation the past two winters. Last February, after one final futile tractorcade to Washington, Schroder, his brother Bill, and father Derrel, decided that the time had come to shift their efforts from lobbying for farm parity to building a small, energy efficient still.

Schroder had little hope of making much money off his arid acres in southeastern Colorado. "I pretty well quit," he explained as I rode with him through his sparse fields of sorghum and millet. "We went out and farmed the land but it don't take much time to farm the land the way we do now. We just went out and planted the damn thing, ran a cultivator through it once, and will go ahead and harvest it. If we make 100 bushels an acre, well fine. We didn't spend much money on it so we won't get burned. I am not going to be a slave to this system anymore."

After taking a thorough look at a small alcohol still designed by Dr. Paul Middaugh of the University of South Dakota, the Schroders set out to work building their own in an old barn. The trio started simply, using a small pot still made out of a water heater to learn the basics of fermentation and distillation. But after a few weeks practice, they moved on to design and build the real thing. For three months they worked 12 hour days, seven days a week to put together their system. They would often dine on brown bag dinners, easing themselves back into tattered old sofa chairs beside the unfinished still. As they ate, they would slowly go over the day's work, searching for new modifications that might improve the final system's efficiency.

When the still was finally fired up, it proved capable of churning out 25 gallons of 190 proof ethyl alcohol an hour. This high proof moonshine can be used to power a modified internal combustion engine, although these vehicles will obtain from 10 to 25 percent less miles per gallon than their gasoline counterparts.

The basic components of the Schroder still (which contains about $50,000 worth of materials) are a steam generator, cooking tank, fermentation tank, and three 16-foot-tall distilling columns. Milo, corn, and wheat have all been processed through the system. It uses a series of heat exchangers and heavy insulation to cut down on the fuel used to ferment and distill the alcohol. Although Schroder has not yet gone into commercial production, he esitmates that he can produce his alcohol for about 90 cents a gallon. He gave his blueprints to the American Agriculture Movement's newsletter which reprinted them in an excellent practical, guide called "Makin' It on the Farm." But building and operating Schroder's still takes a high degree of technical competence. A sound background in welding, plumbing, electrical wiring, mechanics, and microbiology is essential to success.

Unfortunately, most farmers don't have Schroder's background. A handful of fast buck operators have rushed poorly designed and inadequately tested small stills on the market. To try and prevent farmers from getting burned by these companies, a school for moonshiners opened up at the Colby Community College in western Kansas this August. The week long seminars, taught by professors, engineers, and mechanics, have attracted hundreds of farmers, educators, and members of the AT community. An intensive 42 hours of classroom lectures and laboratory experiments are designed to give participants the basic knowledge they need to either build their own still or ask the proper questions when purchasing one from an engineering company.

So far, the seminars have received mixed reviews from participants. The early August classes attracted some top flight people. Ted McFadden, a retired administrator of the Treasury Department's Alcohol, Firearms, and Tobacco Division, offered a thorough review of the federal regulations governing ethyl alcohol production. Dr. Paul Middaugh explained the engineering concepts behind his pioneering small scale still.

But not all the Colby seminars have been able to offer teachers with the same degree of expertise as the early August sessions. The small still (owned by Alternative Energy Limited) which the class inspected as a teaching model often, failed to perform up to expectation. Middaugh has now disassociated himself from the Colby seminars and is starting up a new school in South Dakota which he vows will offer more hands-on training experience. The Department of Energy is making available small amounts of seed money to start up similar seminars at community colleges all over the country. If small scale alcohol production is ever to be widely practiced, there will be an enormous need for technically competent personnel.

Gene Schroder is already urging local mechanics to learn how to modify automobiles and pick up trucks so that they can run on his 190 proof alcohol. In addition to local farmers, Schroder may find another market of his fuel at a moderate sized 2 million gallon a year distillery being built in nearby Walsh, Colo. ACR Process Corporation, the engineering firm designing the Walsh distillery, is installing reprocessing units which can kick the Schroder's 190 proof brew up to the 199 proof anhydrous level. This anhydrous alcohol can be mixed with gasoline to service the rapidly growing "gasohol" market. Over 1,000 service stations across the country now offer a 10 percent alcohol blend. But to date, the alcohol for the blend has come primarily from two large midwestern distilleries.

Richard Chambers, a bearded physicist who serves as ACR's Vice President, is hoping to help bring about the construction of some 40,000 2–4 million gallon a year distilleries in the United States. "My personal goal is to get to 100 percent alcohol fuels in use by the year 2000," he optimistically declares. ACR has already contracted to design over a dozen such projects and Chambers predicts that the distilleries will be surrounded by hundreds of small "satellite" stills. The alcohol would be picked up from these farm based "satellite" stills by a delivery man who would carefully check out the average proof level. The higher the proof, the more money the farmer would receive for his product. This system is not much different from the way farmers now sell graded milk to dairies. Chambers is confident that his distilleries would be able to compete head on with much larger 20–50 million gallon distilleries.

The man with the technical expertise needed to bring about this satellite system is ACR's President John Chambers. A chemist, who once helped design a 1948 synthetic fuels plant, Chambers has spent the past 30 years designing traditional beverage alcohol distilleries for major liquor companies. These distilleries built during an era of cheap fossil fuels, were terribly energy inefficient. "I made very high quality alcohol and I got a very high yield but I didn't care at all about the energy balance," Chambers remarked in an interview in his Springfield, Ill. office. These distilleries used well over 100,000 British Thermal Units of energy to produce less than 90,000 Btu's of alcohol.

The oil industry carefully compiled these gloomy energy balance figures and tried to use them to defuse support for gasohol. Robert Lindquist, a chemist for Chevron Oil, went so far as to tell the New York Times that a shift towards alcohol fuels would actually end up increasing foreign imports of oil. It was an effective but misleading argument. For the science of distillation, although stagnated for decades under the conservative domination of the beverage alcohol industry, could be dramatically improved.

When the price of oil skyrocketed in the early seventies, Chambers decided to "change my normal process to make it more energy efficient." Like the Schroeders, he would make use of heat exchangers that recycle much of the low grade heat used in distillation. He also began to investigate new membranes (developed by Dr. Harry Gregor of Columbia University) which would separate out alcohol from fermented mash without the use of distilling columns. But the beverage alcohol industry was afraid the new innovations might alter the taste and quality of their brews. Once the 4 cent federal highway tax exemption for gasohol blends was passed in 1978, ACR began to receive a steady stream of phone calls from both beverage companies and farm groups hoping to produce fuel grade alcohol for the new gasohol market. Chambers would finally have a chance to try out his new technology.

The mushrooming interest in alcohol fuels hasn't been confined to the midwest or to Whites, either. One of the original farm-scale distilleries set up for excess and spoiled crops was the Southwest Alabama Farmer's Cooperative (SWAFCA) distillery in Selma, Alabama. For the past two years its director, Albert Turner, has been a leading figure in the alcohol fuels movement, advocating a "gasohol revolution" to increase black farmers' self-reliance.

The SWAFCA co-op was organized in 1966 when thousands of black tenant farmers were being kicked off plantation land for daring to participate in Martin Luthur King's voter registration drives. "A large portion of blacks had to leave and there was a big urban exodus," Turner remembers. "We felt we just had to do something for the people. We organized the co-op in direct opposition to the power structure to counteract what they were doing."

The co-op helped farmers find plots of land to settle on, provided reasonably priced fertilizer, credit to buy seeds and set up a system to market crops. But white resistance to the co-op's early efforts was so strong that Turner had to go to Canada to find a market for cucumbers. In the mid-seventies, mold damage severly affected several crops, and the idea of turning spoiled crops into alcohol for fuel was launched.

In the summer of 1977, the co-op applied for a grant from the Office of Minority Business Enterprise (OMBE) to get a small, experimental still built. By the spring of 1978, a crude system had taken shape on the concrete loading platform outside the co-op's vegetable packing house. A brick fireplace built around the garbage dumpster was converted into a giant cooking pot. A large gas storage tank was used to ferment the grain mash. Slabs of pine, piled up next to the still, served as an energy source while an old piece of pipe was converted into a column. With the aid of a former moonshiner named Albert Hubbard, Turner managed to coax 170 proof brew out of the still. Despite the alcohol's low proof, it worked well in the co-op's tractors and trucks, even when mixed with gasoline. Problems with such low proof blends, however, may crop up in colder climates.

To convince the people of Selma that the co-op's alcohol would really work as a fuel, Turner decided to give away free samples to anyone brave enough to try it out. His first customer showed up a few hours after a fresh batch of alcohol had been run through the column. His mouth broke out into a wide grin when he recognized the customer as a prominent local minister. A gallon jug full of alcohol was carefully poured into the minister's gas tank and then he drove away. Beaming with satisfaction, Turner remarked that "Once the preacher gets hooked on this stuff, the whole congregation will go for it."

The co-op's first still has now been decommissioned and a more sophisticated model is taking its place. With the aid of OMBE funding, Turner hopes to put up a 2 to 4-million gallon per year distillery which could handle all of the co-op's surplus crops. A feedlot is planned as an adjunct to the still, since cows and pigs grow fatter on the high-protein grains left over in the distilling process than they would on smaller amounts of grain. And the manure from the feedlot will be used to generate methane gas to fire the still.

Despite the difficulties in raising the multi-million dollar investment needed to construct a 20-50 million gallon a hear distillery, many farm groups are convinced that these giant plants are their best bet. "The worst thing that could possibly happen," Clayton Litchfield of the North Dakota firm, Grain Products International, said, "is to have 1500 stills an area and then have farmers start competing with each other on the price of alcohol and byproducts." Six farm co-ops are in the process of reasibility studies with GPI, and Litchfield maintains "the money is there, (and) the prospects are tremendous." Alcohol fuels, he says, "give us something we've been looking for 200 years—an alternate place to put our crops. For the first time, the farmer will be able to control the price of his product."

Litchfield maintains that huge investments from major financial firms will not lead to takeovers of community based stills, since a cooperative system for grain use by the distillery was economic advantages over a distillery controlled by a bank, which would have to buy the grain outright. Most of all, a backyard still "doesn't put bread and butter on the table," Litchfield says. The economies of scale are not attractive. "Twenty million gallons per year is the minimum. When you get down to one million per year the cost rises drastically, between $1.50 and $2.00 per gallon."

The belief that large-scale plants are more economically viable is bolstered by the dramatic success story of Archer Daniels Midland (ADM) Corp., a large midwestern soybean and corn processor which currently dominates the new gasohol industry. This summer I visited ADM's plant on the outskirts of Decatur, Ill., where I was ushered into the front office to meet with its public relations specialist, Richard Burkett. Behind his desk were samplings of some ADM products; a box of "Make a Better Burger" containing textured soy protein and a "12 Day Diet kit" containing fructose sugar. It is this fructose sugar (a byproduct of wet milling process that first extracts oil protein, and starch from each bushel of corn processed, which has proved to be the key to ADM's plunge into gasohol. ADM ships some of this corn-derived fructose to soft drink companies and then put the rest into fermenting vats to be distilled into alcohol.

Originally, ADM tried to peddle this alcohol to the liquor industry but found few buyers. The stuff just didn't taste quite right. So ADM decided to try and break into the gasohol market by installing anhydrous units that would kick the 190 proof beverage alcohol to 199 proof. ADM soon began racking up healthy profits; producing the alcohol for about 90 cents a gallon and eventually jacking the selling price up to over $1.50 a gallon.

A host of engineering firms have appeared on the scene offering to build integrated food processing plants similar to ADM's. But farm groups who do business with these firms must first come up with enough cash to finance an initial "feasibility study." This study hopefully provides the critical documentation needed to attract investment capital. Most of these engineering firms are reputable—but their services never come cheap. A feasibility study can cost anywhere from $30,000 to 300,000 dollars, depending on who you talk to.

Two years ago the St. Paul, Neb. (population 2000) Chamber of Commerce set out to land a large plant in their town. Located in the heart of prime, irrigated corn country, St. Paul has benefitted little from the riches that the land produces. In the past couple of decades the town has grown only slightly. "We got old farmers coming here to die instead of young people coming here to live," said one local resident. "Instead of exporting kids and corn, we'd like to try and find jobs for our children processing the corn right here in St. Paul."

The Chamber of Commerce figured the best way to accomplish this goal was to maintain firm community control over any plant that would be built. Some 200 local businessmen and farmers banded together to form the St. Paul Business Development Corporation which they hoped would someday own an alcohol plant.

Once the newspapers reported that St. Paul was in the market for a large plant, the Chamber of Commerce began receiving a host of calls from consulting firms peddling their assistance at exorbitant fees. One man from Texas offered $50 million worth of financial assistance which he claimed he could quickly rustle up. But when the caller's background was checked out, it turned out that he worked as a humble printer for a Texas newspaper.

The St. Paul Development Corporation spent months evaluating the sales pitches of different firms and finally settled on a Swiss corporation which offered an innovative, highly energy efficient process to extract human food, cattle feed, and alcohol from corn. A contract was signed to have the Swiss corporation perform a $35,000 feasibility study. The money to pay for the study was coughed up out of the pockets of local St. Paul residents, much of it in small $100 donations.

The Swiss corporation used poorly qualified contract help to perform key parts of the feasibility study and the final report proved to be of little use to the New York investment community. Embarrassed, representatives of the Swiss corporation offered to redo portions of the study. The St. Paul group, though disillusioned by their experiences with the Swiss corporation, still hopes to obtain financing for a large alcohol plant.

The fiercely independent Gene Schroder strongly believes that his small, self-financed still system makes much more sense for communities than the massive 30 to 50 million gallon distilleries the St. Paul group and many of his colleagues in the American Agriculture Movement have opted for. "There is no way that the farmers could ever finance a large plant so they are going to the big people," said a cynical Schroder. "They get their plant in operation and everything will be going great and then the price of corn soars to five dollars a bushel and they can't hack it. They won't be able to make their payments and then the bank will come in and acquire control of the distillery and replace the board of directors. The banks will wait until the price of corp drops back down and then make a killing."

For the highly politicized Schroder, alcohol is one more weapon to use in his battle to raise farm income. "We buy from an oligopoly and we are essentially a group of atomistic farmers," he said. "With alcohol you bypass the processors and send a product manufactured on the farm directly to the consumer."

Schroder also points out that small stills will have significantly lower transportation costs. When servicing a small area, only minimal expenditures will be needed for trucking grain to the still and shipping out alcohol to service station outlets. If the price of grain goes up, Schroeder (who won't have to worry about making many bank payments) can shift to cheaper feedstocks such as spoiled millet. ACR's Robert Chambers is also impressed by the transportation economies of small scale operations and confidently declares that "there is no way in the world those 20 million gallon a year plants can compete with the little plants we are putting up."

Predictably, those working for the large engineering firms, have come to quite different conclusions. Ed Kirshner, a top engineer for Davy-McKeen said in an interview in his downtown Chicago office that "We have been designing small units and found they don't have much going for them. We tried to develop a small $100,000 unit and came to the conclusion that a true factory type operation would not be economical on that scale."

Davy-McKeen's public relations man Calvin Todd explained that "We're used to building five to forty million dollar projects for your large food companies. These are the type projects we feel more comfortable with."

Clearly, it is difficult to predict just what the future holds in store for alcohol fuels. But the skyrocketing price of crude oil and its uncertain availability make it a poor bet to see us safely through the end of the century. Political tensions flaring in the Middle East could easily send the retail price of gasoline spiraling up past the current $1.50 a gallon price of Archer Daniel Midland's alcohol. If ADM and a few large distilleries are able to dominate the alcohol fuels market, they will probably try to keep their product priced just under that of gasoline. If such a closed market develops, the savings from new technologies now promising to dramatically reduce the cost of alcohol production may rarely be passed onto the consumer.

To prevent this from happening, the technical network of the appropriate technology community should be strengthened so that it can keep community groups and small entrepreneurs abreast of new developments. This will help insure that the alcohol fuels industry treads a different path to maturity than that of the oil industry.

[From the A. T. Times, Butte, Mont., December 1979]

ALCOHOL: DOLLAR LEVERAGE FOR FARMERS

(By Hal Bernton)

Two years ago, when gasohol first began to gain national prominence, most of the criticism against this upstart fuel came from the oil industry whose spokesmen insisted that it was technically inferior to gasoline and could not be efficiently produced. Now that gasohol sales are booming at over a thousand service stations, most oil companies have silenced their critics and are busy trying to figure out how to break into the business.

Today, a more thoughtful critique of the rapidly growing gasohol industry is being offered by concerned members of the farm community who worry about the long term impact of turning to agriculture to help solve the nation's energy needs. They point out that U.S. agriculture, heavily reliant on fossil fuels for its survival, is scarcely a renewable system. If you take away the petroleum needed to power farm equipment and produce pesticides and fertilizers, the system would abrubtly collapse.

Robert Rodale, publisher of Organic Gardening Magazine, lashes out at gasohol on an even more basic level. He points out that the U.S. agriculture system eats up soil as well as oil. The Department of Agriculture (USDA) reports that (on the average) top soil is eroding away at twice the rate it is being formed. Once a tract of land loses its topsoil, it is of little use in either food or energy production.

Congressional plans to take marginal farm lands out of pasture and put them into energy crop production could increase this already dangerous rate of soil erosion. This is because some of the marginal lands are hilly and particularly susceptible to the ravages of water erosion while other tracts of this land are located in dry areas vulnerable to wind erosion.

Another development in the push for gasohol that could effect the rate of soil erosion is the current push to develop new enzymes that convert cellulosic crop residues into alcohol. University, government, and private laboratories across the country are now engaged in feverish research to commercialize these new enzymes. Gulf Chemical has already successfully tested a small pilot plant which produced fuel grade alcohol from cellulose.

The danger posed by this new technology is that a massive, uncontrolled harvesting of crop residues could cause dramatic increases in erosion and a decline in soil fertility. The U.S. Department of Agriculture, found that "When returned to the soil, crop residues retain plant nutrients, and help maintain soil porosity and tilth for easy soil tillage and good growth. When removed from the soil, residues remove large amounts of nutrients that must be replaced by mineral fertilizers or other sources . . . proper use of crop residues can be the best means to control wind and water erosion and maintain . . . the quality of water running off agricultural land."

The USDA scientists found that in rich, corn belt farm lands, only 35 percent of the residues could be safely removed from the fields and in six southeastern states fully 90 percent of the residues should stay on the land for water erosion control. But once a lucrative energy market develops for these residues, corporate farmers or even hard-pressed family farmers might sacrifice long term soil fertility for more immediate profits.

One more trend which may be intensified by the growth of the gasohol industry is the growing involvement of large corporations, banks, and insurance companies in agriculture. Once the gasohol market is firmly established, agriculture will provide even more attractive speculative investment opportunities than it does right now. Land prices may be pushed up at a faster rate and young farmers will have an even harder time getting a start.

The growth of the gasohol industry offers both problems and promise. Like most new technologies (including solar) alcohol fuels can be used or abused. The challenge lies in trying to direct the growth of the gasohol movement in an environmentally-sound fashion geared to meeting the long term needs of people rather than the short term needs of corporations.

Large, corporate-controlled distilleries plugged into the current petrochemical intensive system of farming may well prove to be a loser. But, farm and community-based skills could be easily integrated into a more balanced system of food and energy production. One hundred bushels of corn taken from an acre of farm land can be converted to 250 gallons of ethanol and 1700 pounds of 27 percent protein mash. The alcohol can power farm vehicles while the mash can provide a key portion of a balanced diet for livestock. The livestock, in turn, provide the manure needed to fertilize fields or power a methane digestor system. An alternative way to go would be to simply bypass the livestock and feed the mash directly into a digestor or spread it back onto the fields to return its nutrients to the soil.

Carbon dioxide produced by the fermenting mash can be captured and pumped into a greenhouse (partially warmed by waste heat from the still) to promote plant growth. Roof-top solar collectors that would preheat water used in the fermentation process could be installed. In short, alcohol can be used as a valuable development tool by the appropriate technology community.

It is also too soon to automatically assume that the development of the gasohol industry will inevitably increase erosion rates. Perennial crops, such as Jerusalem artichokes, which need little cultivation, could replace wheat and corn on some marginal soils, thus reducing erosion rates. On other marginal lands, tree crops (such as the eucalyptus which grows in extremely arid areas) may replace irrigated row crops which now strain the soils fertility to the limits. Soybeans, a shallow rooted crop which causes a great deal of the erosion in the midwest, may becomes less important to the agricultural economy as new energy crops are developed.

Farmers earning substantial new income from making their own alcohol and selling it directly to motorists may start to find a way off the chemical treadmill. With the added leeway that the extra income brings, they could cut down on the intensive cropping of their land they now need to make the payments at the bank each year. Natural farming techniques, stressing balanced crop rotations with nitrogen fixing legumes, organic fertilizers, and natural pest management would have a better chance of being tried out on a wider scale once farmers gained some economic stability.

Guiding alcohol fuels down a soft path to development will not be easy, but if successful, could help create a truly renewable system of American agriculture.

[From the Jack Anderson column, the Washington Post, Mar. 7, 1980]

Gasohol Project Moves, But Slowly

President Jimmy Carter is belatedly posing as a pioneer spirit dedicated to the development of a gasohol industry that could help the United States weather the energy crisis. But unfortunately, he has consigned much of the program to bureaucrats who would rather dawdle than drive.

For three years, I have been urging the government to get behind a crash gasohol program that could reduce U.S. dependence on oil imports and ease the Arab-imposed fuel crunch. But the White House and the Energy Department, under former secretary James R. Schlesinger, ignored evidence that an alcohol-gasoline mixture could provide a domestically produced substitute for the high-octane gas used by American motorists.

During the past year, Carter finally became a convert. He named a new energy chief, Charles Duncan, who has reversed the antigasohol stand of his hidebound predecessor. Yet the dismal fact remains that some of Carter's energy stewarts are producing more hogwash than gasohol.

The bureaucratic block in the gasohol project can be traced to the Agriculture Department, where Secretary Bob Bergland is dragging his feet on programs designed to extract ethanol from grain. Farmers and motorists throughout the country favor gasohol development, but Bergland and his stand-pat Agriculture Department advisers are obstinately bulking at any innovation that might cut into grain exports or drive up the prices of farm products.

"It's always one step forward and two steps backward with the Agriculture Department" a congressional supporter of gasohol told my associate Peter Grant. "We got rid of Schlesinger and now the Energy Department is really moving. All we have to do now is get rid of Bergland."

Here is some of the sorry history of how Bergland and his subordinates have undercut the gasohol program:

In 1977, Congress authorized the Agriculture Department to guarantee $15 million in loans to set up four pilot plants that would extract fuels from farm products. The department backed only one loan to a gasohol test project run by an individual who had testified publicly against the concept. The borrower eventually backed out, and the department withdrew the loan guarantee.

The agriculture bureaucrats have provided scant assistance to farmers who wish to set up small alcohol stills. Agriculture Department studies on the potential of gasohol are at best unenthusiastic, at worst pessimistic. One 1977 report inaccurately stated that ethanol did not raise the octane level in gasoline.

Energy Department experts fought a backstage battle with their agriculture counterparts over gasohol production goals. The Energy Department experts eventually prevailed and persuaded the president to aim for a 1981 target of 500 million gallons. Bergland and his advisers wanted to produce less.

Bergland has postponed the distribution of $100 million in loans to finance small gasohol stills until they can be "tested and proven." The fact that gas stations in all 50 states are stocking tanks with gasohol and are reporting a high demand from satisfied customers apparently means little to the procrastinators at Agriculture.

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