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GASOHOL/ETHANOL: A REVIEW OF NATIONAL AND REGIONAL POLICY AND FEASIBILITY ISSUES

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Introduction

There has been considerable research into the feasibility of alternatives to petroleum fuels as a result of changes in supply availability, price increases, and concern about the strategic situation of the United States and its economy since the oil embargo of 1973. Ethanol mixed with gasoline was embraced by politicians and farm interests because it represented a known technology that could easily be implemented to extend fuel supplies and reduce the amount of petroleum imports. Ethanol quickly won the political support necessary to see policy implemented to make it feasible to bring it into use as a fuel extender in the form of gasohol. This of course seemed a logical objective as we approach the task of developing alternative fuels and seek to extend the number of different sources of portable fuels available. Accordingly, the notion of extending gasoline supplies by 10 percent through the use of gasohol was considered a worthy program for federal subsidies.

But the Reagan administration is implementing a new philosophy that emphasizes decontrol of oil prices and reliance on market forces to ration fuel supplies, stimulate production and substitution of alternative fuels. There is now a strong reluctance to proceed with a program which involves significant production subsidies by the federal government and consumption subsidies by state governments in the form of reduced or nonexistent fuel taxes.

As research results have accumulated it appears some of the concern about the national gasohol program is well placed. Some of the more simple arguments against ethanol that have been offered are that it demands almost as much hydrocarbon-based energy in its production as it ultimately produces as a fuel. Others indicate a serious concern that using a food (or feed) crop for fuel is not a feasible long-run solution to our energy needs. This group sees the food supply problem ultimately becoming as pressing, or more so, as our energy problems in the future. Others see the supply of corn relative to our fuel requirements as grossly inadequate for ethanol to seriously be considered as an alternative fuel in our total motor fuel requirements.

Approaches and Concerns with Ethanol

The policy approaches to date on ethanol fuel have raised many questions as to its feasibility. Policies supporting ethanol production were implemented

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with the Carter administration launching a considerable effort to increase ethanol production capacity. A recent *Wall Street Journal* article (May, 1981) reported the Department of Energy has extended loan guarantees of \$706 million to companies which is expected to triple current production capacity to 150 million gallons per year. Current petroleum market softness, coupled with the Reagan administration's emphasis on free market economics, has raised concern about the future viability of ethanol as a fuel. Accordingly, some companies that planned large ethanol facilities have cancelled investment plans. The higher price for gasohol versus unleaded gasoline is also meeting resistance and the market share of gasohol is currently declining. The uncertainties of the future that enter into business decisions about undertaking large investments are evidenced in the private sector's view of the current situation.

Similarly, state governments that moved to facilitate the economic feasibility and acceptability of gasohol at the consumer level by removing or reducing the road use tax are having second thoughts. Faced with overall reduced unit sales of fuels, as well as the loss of tax revenues from gasohol, some state governments have been forced to raise fuel taxes to keep their road use tax revenues at acceptable levels. One of the items on the list of a special session of the Iowa legislature in 1981 was an increase in fuel taxes, with the gasohol tax being increased 1 cent per gallon (the gasoline tax was increased by 3 cents per gallon and diesel fuel increased by 4 cents per gallon).

The policy approach and size of the ethanol fuels program has caused a good deal of concern and raised many questions. It is a program of significant size with cumulative costs just to the U.S. Treasury from exemption from the federal gasoline tax alone, as estimated by Sanderson [9], that will grow from \$400 million in 1982 to \$27 billion by 1992 plus another \$4 to \$6 billion in state subsidies if current tax exemptions remain at present levels. The list of incentives to produce sufficient ethanol to equal 10 percent of U.S. gasoline consumption by 1990, included in the U.S. Energy Security Act of 1980, included the following [9]:

- Exemption from the 4-cents-per-gallon federal excise tax on gasoline for gasohol containing at least 10 percent alcohol, through 1992 (Crude Oil Windfall Profit Tax Act on 1980).
- A special 100 percent investment tax credit (through 1985).
- An entitlement (of about 5 cents per gallon) for fuel alcohol produced from biomass (program terminated in January, 1981).
- Grants, loans, and loan guarantees totaling \$1.05 billion (Energy Security Act of 1980 and Supplemental Appropriations Act of 1980). Loan guarantees allowed to be leveraged on a 3:1 basis (P.L. 96-514). The Reagan administration has proposed to rescind this financing authority.
- Mandated use of gasohol in federal motor vehicles when available at "reasonable prices" (Energy Security Act).

- Authority for the secretary of agriculture to grant alcohol producers preferential access to government-held stocks of corn, at the reserve release price (125 percent of support), instead of 105 percent of the call price (152 percent of support) applicable to other users (Agricultural Act of 1980).
- Authority for the secretary of agriculture to establish a gasohol feedstock reserve, using agricultural commodities acquired by the government as a result of export controls; these stocks may be released to alcohol producers at a price lower than 105 percent of the call price (Agricultural Act of 1980).
- Incentive payments to farmers devoting set-aside acreage to the production of crops for fuel (Amendment to Food and Agriculture Act of 1977).
- Priority allocation of natural gas (in the event of a shortage) for fuel alcohol (Energy Security Act of 1980).

Sanderson summarizes ethanol production cost estimates assuming \$2.50/bu. corn for a 50 to 100 million gallon per year ethanol production facility at \$1.30 per gallon with a net cost after subsidy of \$.82 (in 1979 dollars).

The value of gasohol relative to nonleaded gasoline should be adjusted for the difference in energy. Ethanol contains less energy per gallon than gasoline. Tests by Kaufman, Klosterman and Water [6] indicate that in comparing gasohol to nonleaded gasoline, there is a reduction in miles per gallon of about 3.3 percent. Sanderson points out that while ethanol raises the octane rating of gasoline, on balance gasohol is probably worth neither more nor less than nonleaded gasoline.

The goal of producing enough ethanol to meet 10 percent of national gasoline requirements by the year 1990 has very significant impacts and costs to the national economy. Antagonists of ethanol contend that the net production of energy from grains (mainly corn) is very small. However, Sanderson provides estimates of the net saving of what he terms premium fuel (liquid fuels and natural gas) in the gasohol program. The net saving of premium fuel under the program is positive, i.e., each gallon of ethanol produced nets the equivalent of 0.65 gallon of regular gasoline.

The question of impact on soil resources should also be considered. Timmons [11] has examined soil erosion losses connected with increased agricultural production from growth in exports of grain during the 1970s and with continued growth through the 1980s for the 12 corn belt states. His estimates under two scenarios, the first assuming production growth under historical trends, results in a 39 percent increase in soil erosion losses associated with a 17 percent increase in planted acreage. These losses vary across states from an increase of 68 percent for Iowa to 8 percent in Kansas. The second scenario, assuming greater expansion of exports, results in a 72 percent increase in soil erosion associated with a 29 percent increase in planted crop acres in the 12 corn belt states. The soil loss increase for the cornbelt states range from an increase of 106 percent in Iowa to 40 percent in Illinois. Timmons' estimates of the increase in soil loss under increased

production scenarios amounts to a major cost factor not considered in the gasohol program. To control soil loss would require a major increase in investment in soil conservation structures and change in practices in order to maintain the land resource base and long-term productivity of the soil.

The impact of the gasohol program on national and world commodity markets would be substantial. The increased demand for corn for ethanol would increase corn prices. The increase in distillers' grains, a protein feed that would compete with soybean meal, would reduce soybean demand. The interrelationships of agricultural markets would impact on other agricultural crops. Estimates of the extent of the impact on crop acreage, prices, and markets vary to some degree among those preparing estimates. Schnittker Associates [10] indicate the increase in corn prices as a result of the ethanol program would be about 5-10 percent in the 2 billion gallon case and 10-30 percent in the 4 billion gallon case. These figures are in line with Sanderson's conclusions of a 10 percent increase in corn prices and decrease in soybean prices of 2 percent. There, of course, would be some impact upon other crops as corn acreage is expanded to meet the demand created by ethanol production.

The impact of the ethanol program would also spread through the feed/livestock economy and ultimately to the consumer. Schnittker Associates estimates that if the real price of corn, other grains, and oilseeds increased by 19 percent in 1985-86 and 39 percent by 1990-91 this would work through the feed/livestock economy and increase food prices as measured by the Consumer Price Index by about 6 percent in 1985-86 and 12 percent by 1990-91 over their base line assumptions. With food making up 18 percent of consumer expenditures, the 6 and 12 percent higher food prices would increase the overall Consumer Price Index by about 1.1 percent in 1985-86 and by 2.2 percent in 1990-91.

The increase in the Consumer Price Index resulting from higher food prices would spread through the labor cost structure of the national economy by way of the cost-of-living adjustment mechanism. This process could ultimately result in an estimated total effect from the gasohol program on food prices of 25 percent and an overall effect on the cost-of-living of about 5 percent. [Sanderson, 1981]

There are two other major problems that should be considered in the ethanol program. Exports of U.S. grains have expanded rapidly over the decade of the 1970s. The ethanol program would cut into exports, a market where the United States has proved to have a competitive advantage. Sanderson points out that importing countries may view the American gasohol program as an OPEC-like program to raise grain prices and this may cause them to pursue policies of self-sufficiency even at very high costs and promote foreign protectionism.

A final point that is of concern in the gasohol program has to do with the variability in supply when the demand for a commodity is inelastic. Schnittker Associates applies the historical price movements experienced during the 1970s to the projected prices for corn under the gasohol program to examine

the possible level that prices might climb if similar world supply-demand circumstances were to develop in the future. If the same magnitude of price fluctuations were to be encountered and were to act on the projected prices of the ethanol program, the price of corn could become higher than its marginal value product in ethanol production. The point is clear that adding another major use to the corn market could result in very high prices and major disruptions in the food sector if there were to be a serious corn production shortage for one or two years.

Is There a Feasible Approach to Ethanol?

The basic problem of the gasohol program is related to scale of program and scale of ethanol plants. The problems to scale of program have been reviewed in the previous section. The problems related to plant scale involve the costs of assembling corn for ethanol production and transportation costs connected with marketing both the ethanol fuel and distillers grain feed products under a program of large scale ethanol plants. Ethanol has also been investigated for small scale on-farm production, but small scale operations may be expected to have very high production costs and possible quality control problems.

The very nature of the ethanol production process, wherein the raw material has to be gathered over space and transported to a location to be processed, and then the joint products of ethanol and distillers grain feed products must be transported again to be marketed, suggests that scale is an important element in any equation of feasibility. Costs per unit of production will decline with larger scale facilities, and transport costs for assembling the corn for

Figure 1. Relationship Between Volume Collected and Distributed and Total Collection Cost and Distribution Cost for an Expanding Plant Service Area.

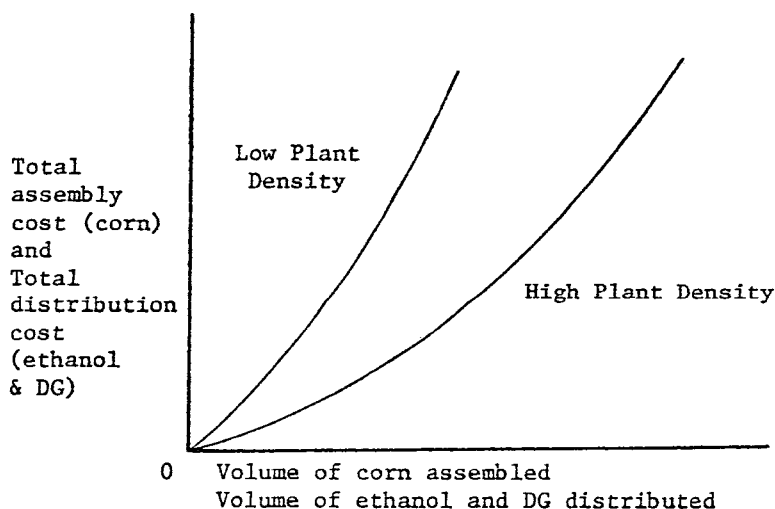
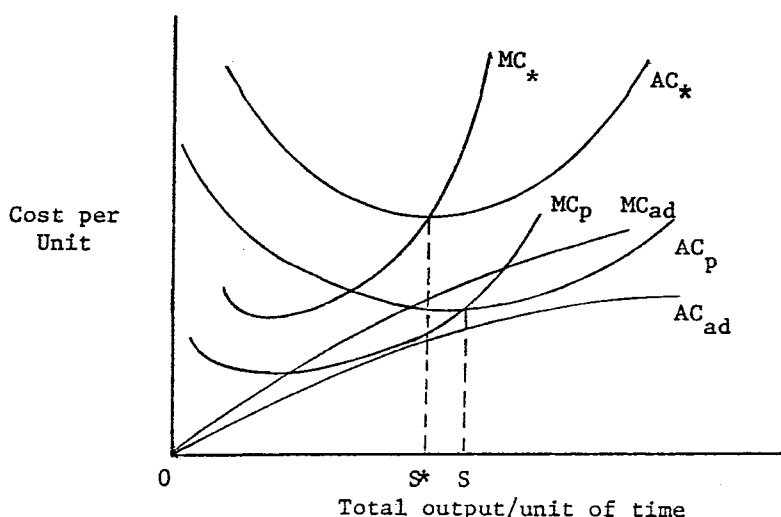


Figure 2. Average and Marginal Costs Associated with Assembly, Distribution, and Plant Operation Per Unit of Output.



processing would increase as the supply area is expanded, as well as transport costs for distributing the joint products of ethanol and distillers grain. Optimum organization then involves a balancing of the decreasing average unit production cost against the increasing assembly costs for grain and distribution costs for the final products. The point is illustrated with the diagrams of Figures 1 and 2. Production systems organized on a small scale high density plant basis and large scale low density plant basis are represented in Figure 1. Total production system assembly costs and total distribution costs would increase at an increasing rate as larger assembly and market areas are considered due to transport costs associated with greater distances.

Figure 2 combines economies of scale in production with assembly and distribution costs. Transport costs of assembly and distribution rise with increasing output. The average and marginal costs per unit connected only with production of ethanol and distillers' grains are represented by AC_p and MC_p and the minimum average cost is at output S . Combining both assembly and distribution costs with production costs yields the combined cost curves AC^* and MC^* . The minimum cost scale plant would be smaller when transport costs are considered (plant size S^* as opposed to S).

Under the concept of regional ethanol/feed plants, the corn production area would be served by a set of plants with circular assembly and market areas. The circular market areas would give way to hexagonal market areas in the idealized theoretical spatial solution (Losch, [7]; Bressler & King, [2]). Actual highway systems, physical geography, and distribution of farms, livestock density, etc., would cause the pattern to deviate from the theoretical solution. It should be mentioned that this approach would yield a set of plants with

exclusive market areas. The most efficient organization for collection of inputs and distribution of outputs, and organization of market areas and plant locations is for the system to be organized as spatial monopolies with exclusive service areas.

David, et al. [3] have estimated scale and transport cost functions. These costs are summarized for three plant sizes representing small, medium and large in Table 1. According to these estimates of scale and transport costs, the scale factor declines faster than transport costs increase over the range examined. Thus, transport costs would not impinge on scale over this range of plant sizes for the given technology. Since grain transport has the greatest cost per gallon of ethanol, the plant site location criterion would be access to local grain supplies.

Another important element in scale and feasibility analysis is the distillers grain products. Feasibility studies have credited the distillers grain product from ethanol production in the cost analysis. Its impact on the animal protein feed market and soybean production has also been taken into account. Distillers dried grains have generally been viewed and treated as a by-product and have been valued at only about 60-85 percent of soybean meal in the feed

Table 1. Summary of Scale and Transport Costs for Ethanol Plants of Varying Size

	Ethanol Plant Size (mil. gal./yr.)		
	10	60	120
	(\$/gal.)		
Total Conversion Costs	.901	.602	.544
Transport Costs: ^a			
Low	.120	.221	.283
Medium	.065	.101	.131
High	.050	.060	.068
Total Conversion and Transport Cost			
Low	1.021	.823	.827
Medium	.966	.703	.675
High	.951	.662	.612

^a The low, medium, and high transport costs represent purchase/sales density in cwt./square mile for grain and distillers grain. The purchase density for grain and distillers grain corresponding to the range are:

	Low	Medium	High
Grain	50	500	5,000
Distillers Grain	2	20	200

Source: Summary data from: David, Milton L., et. al., *Gasohol Economic Feasibility Study*. Development Planning Associates, Manhattan, KS, 1978.

market. Recent animal nutrition research by Berger [1] indicates the value of distillers grains has not been fully appreciated in the past. Berger indicates that the wet distillers grain fed to beef cattle (also dairy cattle, hogs and poultry with varying results) produces greater weight gains than soybean meal. He indicates that distillers feeds' protein may be utilized more efficiently than soybean protein because it reaches the small intestine where it is absorbed and used for growth. His figures indicate 18.5 lbs. of distillers dried grains plus solubles (DDGS) are recovered from each bushel of corn. (David, et al. estimated only 16.8 lbs/bu. and a price of \$110/ton which would indicate a value of only \$.92/bu. of corn.) Berger prices the DDGS on the basis of nutrient value relative to soybean meal and indicates that if DDGS are worth \$.09/lb. (\$181/2000 lbs.) then the value of DDGS produced per bushel of corn is \$1.66 (based on prices 10/27/80). The credit of \$1.66/bu. is 48 percent of the original cost of \$3.48/bu. for the corn at that point in time (See Table 2). Berger's research on the use of DDGS adds a very positive element to the cost equation in that not only can the wet feed be utilized, saving the energy required to dry it, but the fact that feeding results indicate the value of the feed has been underestimated.

Table 2. Value of Slowly Degraded Protein

	SBM	DDG	DDGS	CGM
% Crude protein	45	28	28	62
Protein efficiency, %	100	173	137	100
Lbs. needed to equal ton SBM				
Protein source	2,000	1,853	2,346	537
Urea		135	87	160
Corn		12		1,303
Value/ton SBM equivalent ^a	\$258	\$181	\$220	\$172

^a Based on 10/27/80 Foodstuffs prices: SBM \$258, CGM \$280, DDG \$180, DDGS \$180, Corn \$124, Urea \$200.

Source: Berger, Larry L., *Nutritional Value of Distillers Feeds for Livestock*. Department of Animal Science, University of Illinois, Urbana, IL, 1981.

Regional Ethanol/Feed Facilities

We identified two important factors in the previous section in the feasibility of ethanol fuel — scale and value of the DDGS. We have also identified two sources of energy saving — the feeding of the wet distillers grains saving the energy that would be used to dry the product, and the transport savings of corn, ethanol and DDGS if scale is kept at the lower end of the range.

Suppose we examine the feasibility of ethanol fuel based on a regional scale, starting with some of the positive factors and constraints connected with ethanol production. First, it has the possibility of adding an increment to our

national fuel supply without reducing food supplies if the program is considered on a scale consistent with the livestock-feed economy. As a first approximation suppose that the livestock-feed parameters are the basic constraints to the feasibility of the system. Can plants be built to fit the local livestock industry? Under this approach DDGS can be substituted for soybean meal. There may be slightly more corn grown and fewer acres of soybeans, but the change in acreage under this scheme would be so small that there would be little impact on the local or national grain, livestock, or crop markets.

If the ethanol fuel and DDGS were to be used on a local basis by farmers, this would reduce assembly costs of the corn and distribution costs of the ethanol and DDGS. The exact corn relationships of a regional ethanol/feed facility and output levels might be investigated as to their feasibility along the following lines. For example, consider a market area about the size of four Iowa counties. About 6 percent of the corn produced in this area would provide the 3,846,000 bushels of corn required to produce 10,000,000 gallons of ethanol per year. The plant would also produce enough DDGS to feed 81,350 steers weighing 800 lbs. [1]. The average four county area of Iowa had about 54,000 cattle on feed in 1980 so the 10,000,000 gal./yr. facility would match reasonably well with the feed requirements of the cattle on feed and cow herds on farms in the area. The average four county area has about 1,000,000 acres of cropland. Iowa farmers used about 6.3 gallons of diesel and 10.7 gallons of gasoline per cropland acre in 1977. If farmers substituted ethanol at the rate of 10 gallons/acre in field operations and related farm transportation, this would use the 10,000,000 gallons of ethanol produced by the regional plant.

Policy Approaches

The gasohol program is an example of what happens when ambition precedes sound information and there is a move to implement a program through the granting of generous subsidies without ample background research. When the implementation of a program takes major and continuous subsidies to make it feasible, it should by this very fact be a signal that perhaps a different approach should be followed. It does not mean that the basic concept has no merit, but that the program should be carried out only at the research and demonstration stage until more information is gathered.

The ethanol research program should emphasize the testing of a variety of technologies and be of a reasonable size so as to properly evaluate the technology. This approach would stress the accumulation of adequate information before launching into a large investment program. While the technology of ethanol production is well known, an ethanol fuel program that is farm oriented needs to be conceived in a new light. Accordingly, research and development should be undertaken to investigate each stage of the production process of ethanol fuel/livestock feed *with emphasis on reducing the costs of smaller scale plants, and developing the delivery systems for the DDGS feed product.*

In line with policy recommendations from the Ford Foundation-Resources for the Future study group, chaired by Landsberg [4], temporary subsidies for solar applications that will conserve premium fuels may be sound policy. An excellent example of this approach would be subsidies to produce ethanol with a solar assisted distillation unit. The research of Holden & Smith [5] at The University of Iowa in solar assisted ethanol distillation indicates that the annual costs of a 3 million gal./yr. solar assisted unit would be 17 percent greater than a natural gas fired unit (\$282,300 vs. \$329,500). Use of solar would reduce natural gas requirements for distillation by one-half. The subsidy necessary to build the solar assisted unit would be \$.16 per gallon of ethanol assuming a 20 year plant life. Compare this to the more \$.50/gallon subsidy in federal gasoline tax credits and other federal incentives and state gasoline taxes foregone.

The implementation of a regional ethanol/feed facility would involve a complete new system of production, market system and conversions of vehicle and tractor engines or the purchase of new ethanol fueled vehicles and tractors. Even at comparable prices for ethanol to petroleum fuels there would be reluctance perhaps to adopt the ethanol/feed facility system because it would entail major capital outlays for engine conversion, new tractors, trucks, and new feed delivery and storage systems. Accordingly, government loans, loan guarantees, and special purpose loans and terms may be needed to see such a program implemented.

Finally, the question of the organization of the fuel/feed plans must be considered in light of the fact that the most efficient spatial organization of the plants would be the spatial monopoly scheme with each plant having an exclusive service area. Farmers would likely be reluctant to make the capital investment to switch to the new fuel/feed system unless costs were favorable and if they had assurance they had control over costs, either through organization as a cooperative facility or through long-term contractual arrangements that might tie the price of ethanol to the price of other fuels.

Conclusions

The gasohol program does not appear to be an economically viable program basically because of its national scale approach. As it stands, the gasohol program has the potential, if carried forward over the next decade, to be very disruptive to the national and world food sectors. Moreover, it is apparent from comprehensive analysis that the costs of the program are greater than the benefits.

There may still be a role for ethanol fuel if it is conceived within a regional agricultural framework. The approach outlined in this paper of a regional ethanol/feed plant scaled to the fuel and livestock feed requirements of a multi-county region holds some promise as a possible feasible program. The main technical problems of the regional program that are research-related are focused on reducing costs, especially costs related to the scale of ethanol production. Also, there is need for information on the kinds of incentives it may take to induce farmers to switch to such a fuel/feed system. And if subsidies

are to be used to promote the development of alternative fuels, it would appear that perhaps capital subsidies for solar assisted ethanol plants and to help farmers convert to ethanol fuel/feed production system may yield greater benefits per dollar of cost than the national gasohol program.

REFERENCES

1. Berger, Larry L., *Nutritional Value Of Distillers Feeds For Livestock*. Department of Animal Science, University of Illinois, Urbana, IL, 1981.
2. Bressler, Raymond G., and Richard A. King, *Markets, Prices, and Interregional Trade*. John Wiley and Sons, Inc., New York, NY, (1970) 426 pp.
3. David, Milton L., *et.al.*, *Gasohol Economic Feasibility Study*. Development Planning Associates, Manhattan, KS, 1978.
4. Landsberg, Hans (Study Chairman), *The Next Twenty Years*. A report sponsored by the Ford Foundation and administered by Resources for the Future, Ballinger, Cambridge, MA, 1979.
5. Holden, Matthew L., and Theodore F. Smith, *Assessing Solar Assisted Ethanol Production in the State of Iowa*. College of Engineering, The University of Iowa, Iowa City, IA, 1981.
6. Kaufman, Kenton R., Harold J. Klosterman, John R. Water, "Highway Fuel Economy of Gasohol and Unleaded Gasoline." *Agricultural Energy*: Vol. 2, BioMass Energy Corp Production. American Society of Agricultural Engineers, St. Joseph, MO, 1981.
7. Losch, August, *The Economics of Location*. Yale University Press, New Haven, CT, 1954.
8. Nag, Amal, "Gasohol Demand Ebbs Due to Ample Gasoline." *Wall Street Journal*, 61, No. 220, August 25, 1981.
9. Sanderson, Fred H., "Benefits and Costs of the U.S. Gasohol Program." *Resources*, No. 67, *Resources for the Future*, July, 1981.
10. *Schnittker Associates, Ethanol: Farm and Fuel Issues*. Washington, D.C, 1980.
11. Timmons, John F., *Land Resources, Soil Erosion, and Non-point Source Pollution: An Overview*. Testimony before Joint Hearings of Agriculture Committee, U.S. House of Representatives. Department of Economics, Iowa State University, Ames, IA, July, 1979.