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THE ECONOMICS OF ETHANOL PRODUCTION AND ITS IMPACT ON THE MINNESOTA FARM ECONOMY

by

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Executive Summary

- Ethanol production for motor fuel is not economic at present or past gasoline price levels unless highly subsidized.

- Ethanol production from grain has a negative energy balance (i.e. more BTUs of energy are required to produce the feedstock, process it, and distill to motor fuel quality than are in the ethanol). If solid fuels such as coal are the primary distillation fuels, than the "liquid" energy balance may be positive.

- Consequently, although there may have been some justification for an experimental ethanol/gasohol program as an alternative motor fuel a few years ago when there was near panic about the price and availability of liquid fuels, the situation has clearly changed. Long range research programs to develop economical alternative energy sources are required, not the subsidization of uneconomic technology.

- The ethanol/gasohol program has been justified as an aid to farmers and/or a possible solution to the farm problem. However, at current ethanol production levels (200 million bushels of corn per year), and if carryover grain stocks were roughly in balance, the increase in corn prices due to ethanol would be 7 cents a bushel. However, grain stocks are not in balance. Because of today's huge surpluses, corn prices at the farm are determined by the loan level. Corn used for ethanol production this year will reduce the Federal government's costs of holding surplus grain but have little influence on farm prices.

- It is not cost effective to forego $2.50 in gasoline tax revenue to take a bushel of $2.40 corn off the market.(Each bushel of corn yields about 2.5 gallons of ethanol. There is a $.60 federal and $.40 Minnesota gasoline tax reduction per gallon or $2.50 per bushel) In fact, the reduction in the feed grain supply is only 2/3 of a bushel because 1/3 of a bushel of feed by-product is produced. So we actually are spending $2.50 in fuel tax revenues to get rid of a $1.60 worth of corn.

- Ethanol production is not economic and requires major subsidies at the present low grain prices, which are below the cost of production for many farmers. Therefore it can not be a cost-effective way to assist agriculture in the long-run when crop prices have recoverd to higher levels.

- Fuel alcohol and corn are each standardized, interchangeable commodities that are identical wherever they are produced. It would make very little difference on state price levels where the ethanol is produced or consumed if we did not have large grain surpluses. I.e., Minnesota farmers and Iowa farmers will both get about the same benefit per bushel whether a plant is located in Iowa or Minnesota. There will be a limited area near any plant that will receive slightly higher prices because bid prices will be just high enough to draw grain to the plant.

- For each bushel of corn used to purchase ethanol about one-third bushel (16.8 lbs) of feed byproduct (DDGS) is produced. This feed has a higher protein and fiber content and a much lower pH than corn. When DDGS is fed in limited quantities to ruminents with a high by-pass protein requirement, it has a feed value approximately equal to soybean meal. However, this market is limited and for most uses DDGS competes as an energy source with feed grains. Consequently, when large quantities of DDGS are available it sells at a premium to corn but at a large discount from soybean meal.

- Large ethanol production plants (30-50 million gallons and larger per year) are more efficient than smaller plants. Small commercial plants (1 to 10 million gallons per year) will probably not be competitive even at guaranteed levels of subsidy where the large plants can prosper.

- Ethanol plants that rely on dry milling have lower costs than those that use a wet milling process.

- Minnesota has limited resources for roads, research and aid to farmers. Ethanol production is economically inefficient and is relatively ineffective in aiding farmers. The state should withdraw from subsidizing ethanol production and deploy its resources where they can be used more effectively. If fuel tax funds are to be used with the intent of developing alternative energy sources and/or aiding farmers they would be better spent on such things as energy conservation and research programs, direct aid to distressed farmers and agricultural research programs.

THE ECONOMICS OF ETHANOL PRODUCTION AND ITS IMPACT ON THE MINNESOTA FARM ECONOMY

INTRODUCTION

Ethanol use as an additive to gasoline has been increasing for two reasons. The first is a response to the Environmental Protection Agency's (EPA) mandated reduction in lead as a fuel additive. Ethanol has octane enhancing characteristics and can to some extent substitute for lead. The second is because of a number of state and federal subsidies. These include reductions in the motor fuel tax for "gasohol".

Minnesota's and the national agriculural economy is severely depressed with the real prices of commodities as low as they were in the Great Depression. An increase in production and comsumption of ethanol will provide an alternative market for grains and increase grain prices. Policy makers need to consider and balance the impact of ethanol subsidies on the state's revenues with the impacts of increased ethanol production on agricultural prices and incomes and the impacts on rural communities.

The objectives of this study are to assess the potential impacts of increased ethanol motor fuel use in Minnesota on Minnesota's argiculture. The study procedure began with a literature search of previous Land Grant University and United States Department of Agriculture (USDA) studies on the economics of ethanol production from farm commodities commonly produced in Minnesota and the impact of various levels of ethanol production on agricultural commodity and livestock prices. The literature seach was conducted by accessing the computer data base Agricola (Agricultural On Line Access) which is the cataloging and indexing database of the National Agricultural Library. This database represent the actual holdings of the National Agricultural Library. A complete listing of the literature reviewed can be obtained from the authors. The search was limited to the time frame of 1979 through 1985 to include only the most pertinent data during this period of major ethanol production. Ethanol production was less than 10 million gallons in 1978 but had increased to over 550 million gallons in 1985. Prodution and capacity of the U.S. ethanol industry are illustated in Figures 1 and 2.

Although ethanol is not generally cost competitive with gasoline as a fuel on a cost of production basis, it becomes economically feasible when substantial subsidies for gasohol are available. However, a reduction in the gasoline tax collection means reduced revenes in the highway trust fund for road constuction and maintenance. Such a reduction in revenues may lead to a deterioration of Minnesota's transportation infrasructure with a resulting increase in motor carrier operating cost in Minnesota.

The Components of Gasohol

A mixture of nine parts gasoline with one part ethanol has been commonly called gasohol. To better understand the characteristic of this ethanol enhanced fuel consider the two major components. Gasoline is one of the many products that can be produced from crude oil. The products available from crude oil range from propane gas to asphalt. Gasoline is a mix of various (over 200)

Figure 1

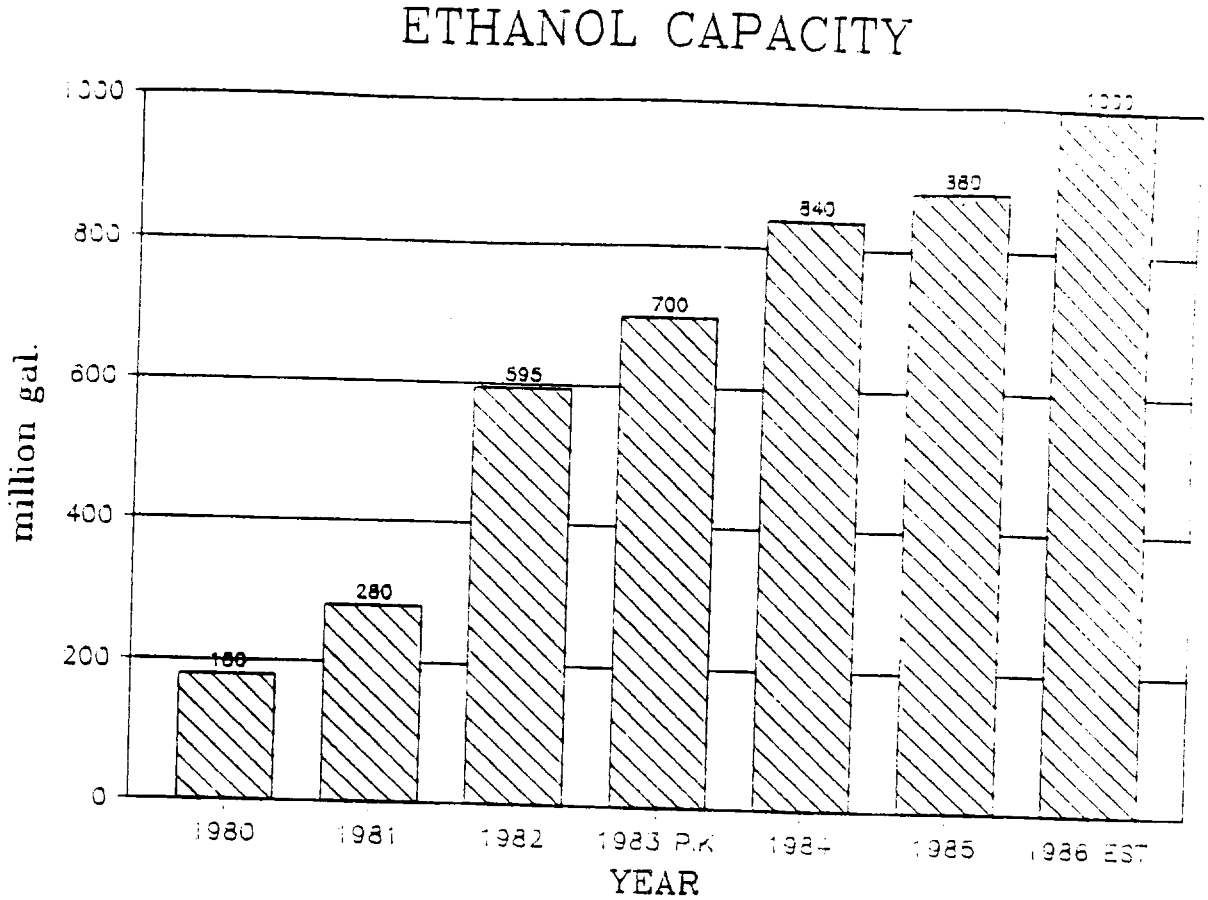


Table 1

YEAR	ETHANOL PRODUCTION million gal.	PLANT CAPACITY million gal.	PLANT UTILIZATION
1980	40	180	22.22%
1981	80	280	28.57%
1982	210	595	35.29%
1983 PIK	375	700	53.57%
1984	430	840	51.19%
1985	550	880	62.50%
1986 EST	?	1000	?

Source: Information Resources Inc. Washington, D.C.

Figure 2

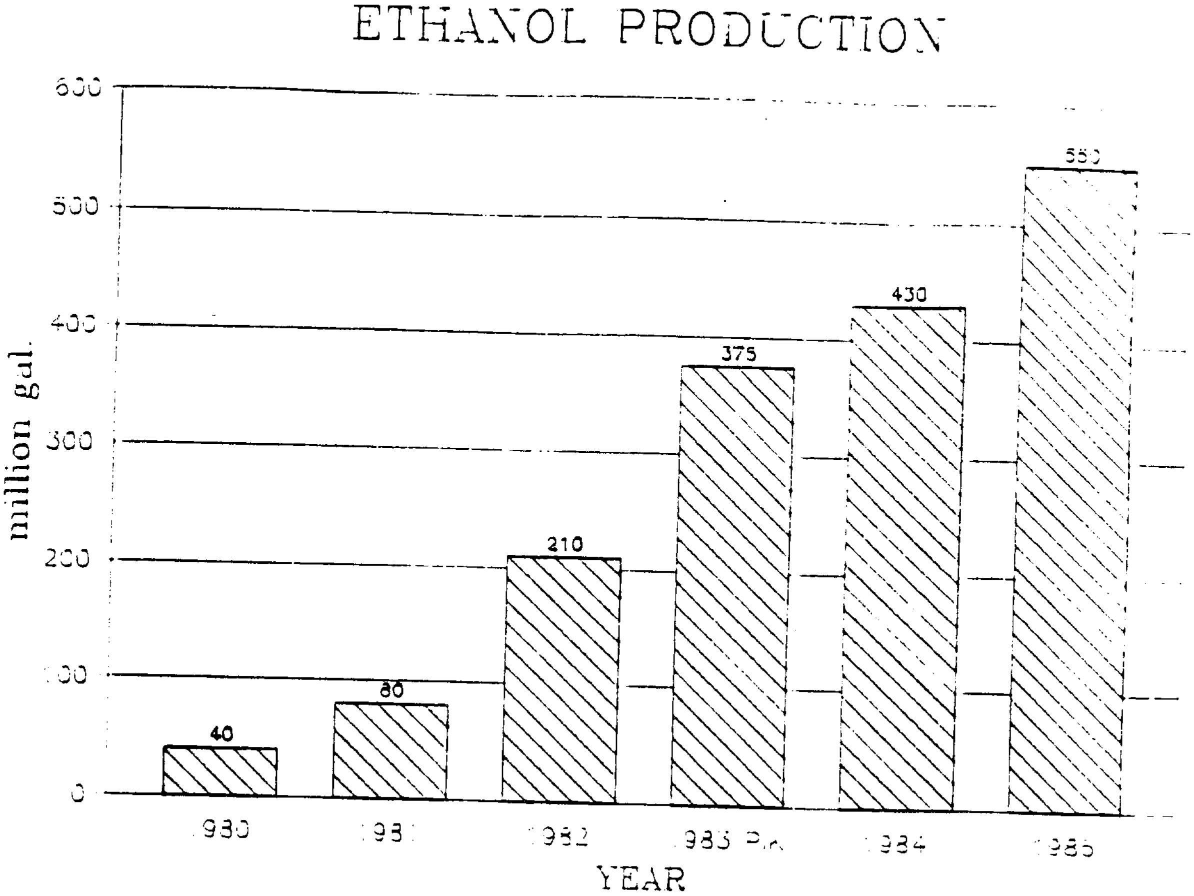


Table 2

YEAR	ETHANOL PRODUCTION million gal.	CORN USED mil. bu.	CORN USED % OF SUPPLY
1980	40	16	.19%
1981	80	32	.35%
1982	210	84	.81%
1983 PIK	375	150	2.06%
1984	430	172	2.05%
1985	550	220	2.18%
1986 EST	?	?	?

Source: Information Resources Inc. Washington, D.C.

hydrocarbons (chemical compounds formed from hydrogen and carbon) distilled from crude oil along with other additives. Gasoline commonly contains about 125,000 British Thermal Units (BTU's) of energy per gallon. The four major groups of hydrocarbons used in gasoline are olefins, naphthenes, parifins, and aromatics. Each of these products have different molecular shapes and sizes which effect the fuel characteristics. The amount of these various hydrocarbons that are obtained from a given quantity of a certain grade of crude oil can be changed with different techniques. "Cracking" in various way allows petroleum engineers to change the "size" of the hydrocarbons along with their "shape" and "structure". These change the properties of the fuels that effect an engines performance. Octane numbers measure the resistance of gasoline to engine knock. The higher the number the better the anti-knock quality. Octane ratings depend on the fuels molecular structure.

The other component of gasohol is made up of ethyl alcohol. Ethyl alcohol (ethanol) is an organic compound which is produced as a result of fermentation of sugars or starches. Feedstocks for fermentation fall under the general catagories of :

1) Sugars (molasses, sugar beets, sugar cane)
2) Starches (grain, cassava, potatoes)
3) Cellulose Crops and Residiues

In fermentation, microorganisms convert simple sugars to ethanol and carbon dioxide. Feedstocks with starch or cellulose are converted to sugars by cooking or enzymatic processess. This fermentation yields a beer which must then be distilled and processed to obtain 200-proof anhydrous fuel grade ethanol. Ethanol contains about 84,400 BTU's per gallon. The blended fuel, gasohol typically has an octane rating 1+ points more than the gasoline feedstock and about 121,000 BTU's per gallon.

It is clear that because gasoline makes up 90% of gasohol, the price of gasoline and changes in the price relationships between gasoline and ethanol has major impacts on ethanol use. The average wholesale price for regular gasoline was $.85/gal in Minnesota in December, 1985 and dropped to $.76/gal during the first week of January, 1986. The current (2/17/86) price is $.594/gal with the spot market price down to $.455/gal (excluding transport, markup and state and federal taxes).

The retail cost of gasoline can be seen in Table 3 and Figure 3 from 1967 to 1985. To see how the "real" price has changed over this time period three different deflators were used for comparisons, The Comsumer Price Index (CPI) with 1967=100 (Table 4 and Figure 4), the Gross National Product (GNP) Implicit Price Deflator 1972=100 (Table 5 and Figure 5) and the Personal Consumption Expenditures (PCE) 1972=100 (Table 6 and Figure 6). Using these to adjust for inflation during the period, the "real" price of gasoline is very near to what it was in 1967 . The highest real price of gasoline occured during 1980/1981, but has since declined rapidly. The nominal price of $1.11 in 1985 was approximatly equal in real terms to those in the late 1960's and the early pre-embargo years of the 1970's - when real gasoline prices were at 30 year lows. Even prior to the recent rapid drop in oil prices, gasoline had declined in real terms to pre-OPEC levels.

Figure 3

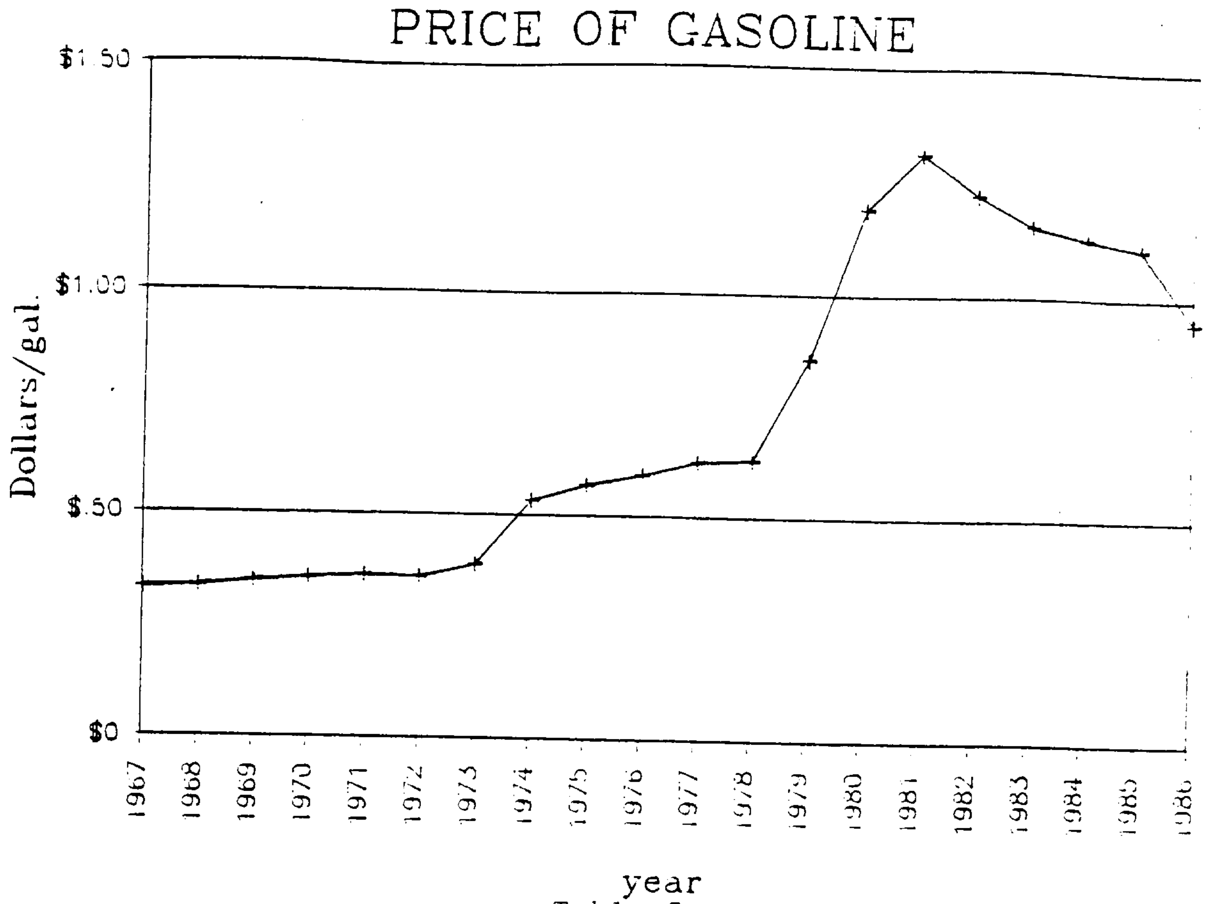


Table 3

YEAR	AVE RETAIL GASOLINE PRICE
1967	$.332
1968	$.337
1969	$.348
1970	$.357
1971	$.364
1972	$.361
1973	$.388
1974	$.532
1975	$.567
1976	$.590
1977	$.622
1978	$.626
1979	$.857
1980	$1.191
1981	$1.311
1982	$1.222
1983	$1.157
1984	$1.129
1985	$1.110
1986	?

Source:U.S.DOE "Annual Energy Review"

Figure 4

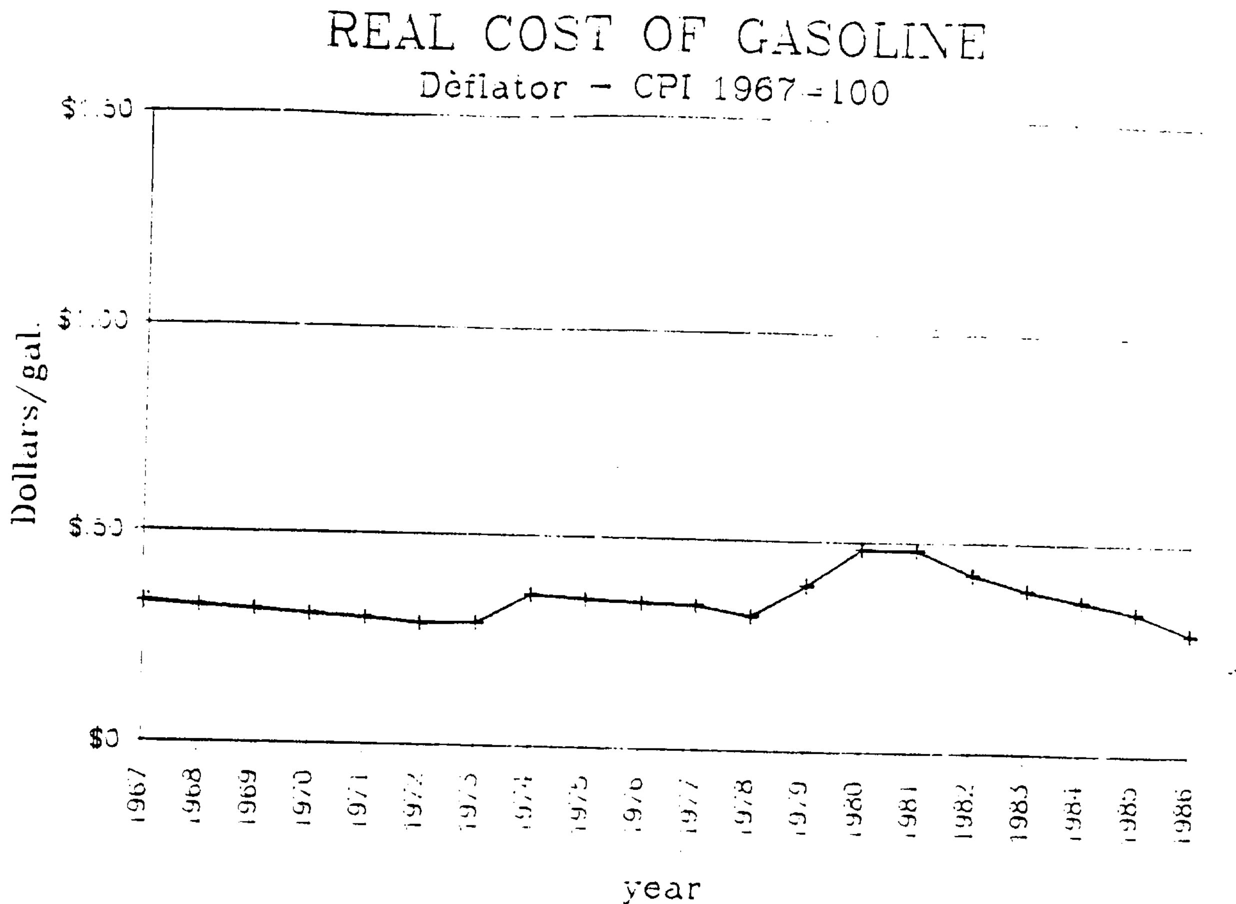


Table 4

YEAR	AVE RETAIL GASOLINE PRICE	CPI	CPI ADJUSTED PRICE
1967	$.332	100	$.332
1968	$.337	104.2	$.323
1969	$.348	109.8	$.317
1970	$.357	116.3	$.307
1971	$.364	121.3	$.300
1972	$.361	125.3	$.288
1973	$.388	133.1	$.292
1974	$.532	147.7	$.360
1975	$.567	161.2	$.352
1976	$.590	170.5	$.346
1977	$.622	181.5	$.343
1978	$.626	195.4	$.320
1979	$.857	217.4	$.394
1980	$1.191	246.8	$.483
1981	$1.311	272.4	$.481
1982	$1.222	289.1	$.423
1983	$1.157	298.4	$.388
1984	$1.129	311.1	$.363
1985	$1.110	329.2	$.337
1986	?	?	?

Source: U.S. DOE "Annual Energy Review"

Figure 5

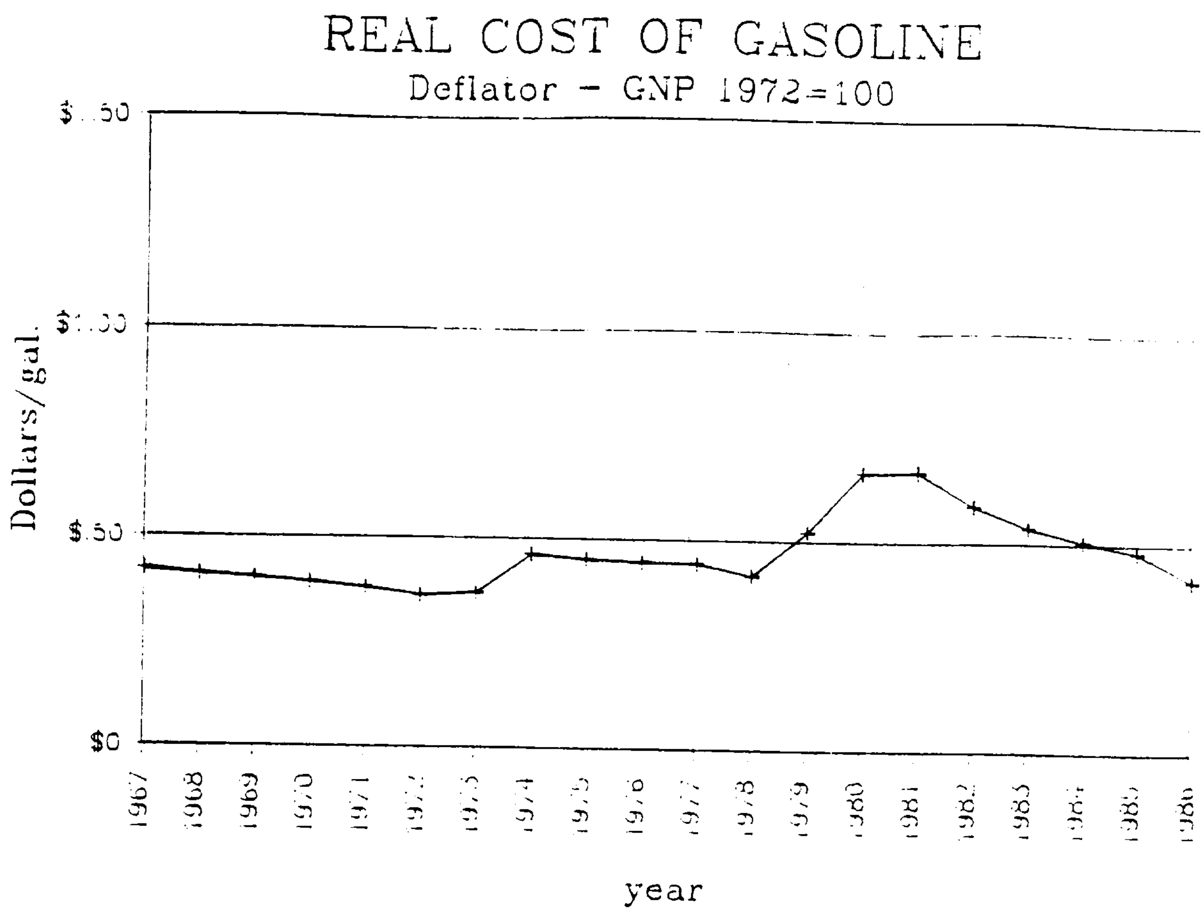


Table 5

YEAR	AVE RETAIL GASOLINE PRICE	GNP	GNP ADJUSTED PRICE
1967	$.332	79.06	$.420
1968	$.337	82.54	$.408
1969	$.348	86.79	$.401
1970	$.357	91.45	$.390
1971	$.364	96.01	$.379
1972	$.361	100	$.361
1973	$.388	105.75	$.367
1974	$.532	115.08	$.462
1975	$.567	125.79	$.451
1976	$.590	132.34	$.446
1977	$.622	140.05	$.444
1978	$.626	150.42	$.416
1979	$.857	163.42	$.524
1980	$1.191	178.42	$.668
1981	$1.311	195.6	$.670
1982	$1.222	207.38	$.589
1983	$1.157	215.34	$.537
1984	$1.129	223.44	$.505
1985	$1.110	230.59	$.481
1986	?	?	?

Source: U.S. DOE "Annual Energy Review"

Figure 6

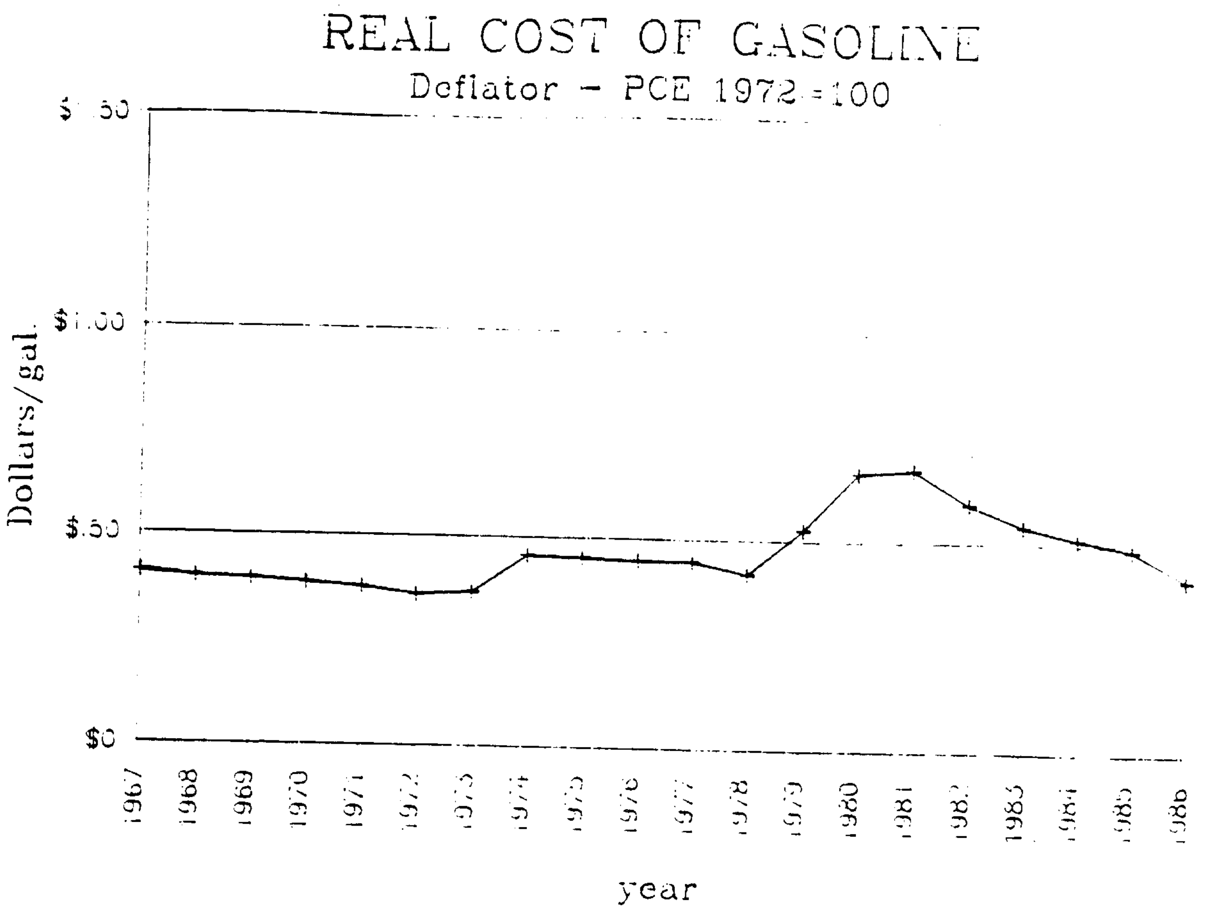


Table 6

YEAR	AVE RETAIL GASOLINE PRICE	PCE	PCE ADJUSTED PRICE
1967	$.332	81.4	$.408
1968	$.337	84.6	$.398
1969	$.348	88.4	$.394
1970	$.357	92.5	$.386
1971	$.364	96.5	$.377
1972	$.361	100	$.361
1973	$.388	105.7	$.367
1974	$.532	116.4	$.457
1975	$.567	125.3	$.453
1976	$.590	131.7	$.448
1977	$.622	139.3	$.447
1978	$.626	149.1	$.420
1979	$.857	162.5	$.527
1980	$1.191	179	$.665
1981	$1.311	194.5	$.674
1982	$1.222	206	$.593
1983	$1.157	213.6	$.542
1984	$1.129	220.4	$.512
1985	$1.110	227.45	$.488
1986	?	?	?

Source: U.S. DOE "Annual Energy Review"

In recent years, the cars making up the nations fleet have increased in fuel effiency. In 1967 the average car got 13.93 MPG . This decreased to 13.1 MPG in 1973 and has since improved to 16.94 MPG in 1984. Average MPG will continue to increase as more fuel efficient cars come into the fleet and "gas guzzlers" are replaced. This increase in fuel economy significantly impacts the revenue from the state and federal fuel tax and compounds the impact of gasohol fuel tax reductions. This decline in real gasoline prices, the improvement in automoble mileage, and the current outlook for petroleum supplies all tend to mitigate or partially negate the frequently stated argument that ethanol is needed to halt rising gasoline prices and/or to extend the life of the worlds petroleum reserves.

Ethanol has been used in motor fuel for a number reasons that include:

1) Larger margins or lower costs than gasoline due to state and federal tax subsidies

2) Octane enhancing qualities

The increased margins and how changes in prices affect these margins are best evaluated by looking at cost comparisons at different price levels for gasoline and ethanol. Table 7-18 gives the the price differential/gal. for gasoline prices of \$.85, \$.76, \$.594, and \$.455 and ethanol prices of \$1.70, \$1.55, and \$1.40. The difference goes from +\$.045/gal with gasoline at \$.85 and ethanol at \$1.40. to -\$.025/gal with \$.455 gasoline and \$1.70 ethanol. For every \$.01/gal. difference (+ or -) between the price of gasoline and ethanol, the blended fuel price differential is \$.001/gal (+ or -).

Table 7

COST DIFFERENTIAL OF GASOLINE VERSUS GASOHOL

Wholesale Cost		Gasoline	Gasohol
Gasoline	$.860	$.86	$.774
Ethanol	$1.700		$.170
--Product Subtotal--		.86	.944
Federal tax	$.090	$.09	$.03
State tax	$.170	$.17	$.13
Total		$1.120	$1.104
	Price difference/gal		$.016

Table 8

COST DIFFERENTIAL OF GASOLINE VERSUS GASOHOL

Wholesale Cost		Gasoline	Gasohol
Gasoline	$.760	$.76	$.684
Ethanol	$1.700		$.170
--Product Subtotal--		.76	.854
Federal tax	$.090	$.09	$.03
State tax	$.170	$.17	$.13
Total		$1.020	$1.014
	Price difference/gal		$.006

Table 9

COST DIFFERENTIAL OF GASOLINE VERSUS GASOHOL

Wholesale Cost		Gasoline	Gasohol
Gasoline	$.594	$.59	$.535
Ethanol	$1.700		$.170
--Product Subtotal--		.594	.7046
Federal tax	$.090	$.09	$.03
State tax	$.170	$.17	$.13
Total		$.854	$.865
		Price difference/gal	$-.011

Table 10

COST DIFFERENTIAL OF GASOLINE VERSUS GASOHOL

Wholesale Cost		Gasoline	Gasohol
Gasoline	$.455	$.46	$.410
Ethanol	$1.700		$.170
--Product Subtotal--		.455	.5795
Federal tax	$.090	$.09	$.03
State tax	$.170	$.17	$.13
Total		$.715	$.740
		Price difference/gal	$-.025

Table 11

COST DIFFERENTIAL OF GASOLINE VERSUS GASOHOL

Wholesale Cost		Gasoline	Gasohol
Gasoline	$.850	$.85	$.765
Ethanol	$1.550		$.155
--Product Subtotal--		.85	.92
Federal tax	$.090	$.09	$.03
State tax	$.170	$.17	$.13
Total		$1.110	$1.080
	Price difference/gal		$.030

Table 12

COST DIFFERENTIAL OF GASOLINE VERSUS GASOHOL

Wholesale Cost		Gasoline	Gasohol
Gasoline	$.760	$.76	$.684
Ethanol	$1.550		$.155
--Product Subtotal--		.76	.839
Federal tax	$.090	$.09	$.03
State tax	$.170	$.17	$.13
Total		$1.020	$.999
	Price difference/gal		$.021

Table 13

COST DIFFERENTIAL OF GASOLINE VERSUS GASOHOL

Wholesale Cost		Gasoline	Gasohol
Gasoline	$.594	$.59	$.535
Ethanol	$1.550		$.155
--Product Subtotal--		.594	.6896
Federal tax	$.090	$.09	$.03
State tax	$.170	$.17	$.13
Total		$.854	$.850
	Price difference/gal		$.004

Table 14

COST DIFFERENTIAL OF GASOLINE VERSUS GASOHOL

Wholesale Cost		Gasoline	Gasohol
Gasoline	$.455	$.46	$.410
Ethanol	$1.550		$.155
--Product Subtotal--		.455	.5645
Federal tax	$.090	$.09	$.03
State tax	$.170	$.17	$.13
Total		$.715	$.725
	Price difference/gal		$-.010

Table 15

COST DIFFERENTIAL OF GASOLINE VERSUS GASOHOL

Wholesale Cost		Gasoline	Gasohol
Gasoline	$.850	$.85	$.765
Ethanol	$1.400		$.140
--Product Subtotal--		.85	.905
Federal tax	$.090	$.09	$.03
State tax	$.170	$.17	$.13
Total		$1.110	$1.065
	Price difference/gal		$.045

Table 16

COST DIFFERENTIAL OF GASOLINE VERSUS GASOHOL

Wholesale Cost		Gasoline	Gasohol
Gasoline	$.760	$.76	$.684
Ethanol	$1.400		$.140
--Product Subtotal--		.76	.824
Federal tax	$.090	$.09	$.03
State tax	$.170	$.17	$.13
Total		$1.020	$.984
	Price difference/gal		$.036

Table 17

COST DIFFERENTIAL OF GASOLINE VERSUS GASOHOL

Wholesale Cost		Gasoline	Gasohol
Gasoline	$.594	$.59	$.535
Ethanol	$1.400		$.140
--Product Subtotal--		.594	.6746
Federal tax	$.090	$.09	$.03
State tax	$.170	$.17	$.13
Total		$.854	$.835
	Price difference/gal		$.019

Table 18

COST DIFFERENTIAL OF GASOLINE VERSUS GASOHOL

Wholesale Cost		Gasoline	Gasohol
Gasoline	$.455	$.46	$.410
Ethanol	$1.400		$.140
--Product Subtotal--		.455	.5495
Federal tax	$.090	$.09	$.03
State tax	$.170	$.17	$.13
Total		$.715	$.710
	Price difference/gal		$.006

The second major reason often given for ethanol use is its octane enhancement characteristics. There are several different available additives that can be used to modify the charateristics of gasoline. The most common product used for octane enhancment has been tetra-ethyl lead. The health risks from exposure to tetra-ethyl lead has caused the Environmental Protection Agency to mandate a reduction in lead. This mandated reduction will increase the demand for other octane raising products and techniques.

> " Because of its high octane rating of 110-112, ethanol can be used inplace of tetra-ethyl lead to increase the octane rating of unleaded gasoline. At current ethanol prices and with the current Federal subsidy, it would cost about 1 cent per gallon to increase the octane rating of unleaded regular gasoline by 1 octane number. This compares with 2 cents for TBA, 1.2 cents for toluene, and 1.1 cents for MTBE. Methanol is the cheapest octane-enhancer. Net cost is less than one cent a gallon per octane number. However, current law prohibits producing blends containing more than 5-percent methanol. Reforming also is a relatively low-cost alternative, adding 0.4 to 0.8 cents per octane number per gallon. This shows that U.S.-produced ethanol, with the subsidies, is currently price competive with some octane-enhancement alternatives "
>
> _/6 p.18

Reforming or the additional refining of the gasoline may be the most important method in the long run but requires both capital expenditures and/or retrofitting exsisting refineries.

In Minnesota the production of ethanol for highway fuel use is highly subsidized. The federal goverment grants an effective subdidy of .60/gal. while Minnesota adds an addition $.40/gal for a total of $1.00/ gal. In addtion, tax credits and loan guarantees were granted to constuct production facilities.

Gasohol subsidies do not appear to have benefited consumers through lower prices at the gasoline pump. This is because the large ethanol producers price their product on a delivered basis and can set the price of ethanol differently in each state depending on the amount of subsidy. They set the price so that if it is profitable to sell in a state at all, the delivered price in that state will be set just low enough, after subsidy, to compete with gasoline. Thus any excess subsidy will go to the alcohol producer and not the comsumer.

The increase in ethanol useage is a result of these subsidies and raise two important issues for the Minnesota farm ecomony. The first is the impact of ethanol production on the price paid for basestocks such as corn, sorghum, and wheat. The second related issue is the impact price on feeds that may be displaced by the increase of ethanol feed by-products on the market. With increased ethanol production the make-up of livestock feed will change and less soybean meal will be needed.

The feedstock that is of greatest interest to Minnesota is corn, in the general category of starches. The potential ethanol yields of various crops can be found in the following table.

Table 19. Ethanol yields of Various Crops

Crop	Unit	Ethanol Yield
Barley	bu.	2.05 gals.
Oats	bu.	1.05 gals.
Corn	bu.	2.50 gals.
Wheat	bu.	2.45 gals.
Potatoes	bu.	1.11 gals.
Sugar Beets	bu.	.72 gals.
Sugar Cane	ton	15.2 gals.

Sources: Litterman et al. Economics of Gasohol p. 4
Solar Energy Research Institute Ethanol Fuels Reference Guide p.v

The basic structure of corn has three parts. The outer layer is hull and bran which is fiber, minerals and protein. The endosperm contains starch and protein and makes up the bulk of the kernel. The third part is the germ were oil and protein are found. The two processing methods for producing ethanol from corn are wet milling and dry milling. Dry milling is the less capital intensive method. Grain is ground up, mixed with water and cooked, and then fermented. Because corn is composed of more than starches (ie. protein, oil, minerals) and not all the starch is converted to ethanol, a portion of the corn is left for feed uses. This is called distillers dryed grain with soluables (DDGS). In the wet milling process the parts of the corn that are unfermentable are removed prior to the convertion of the starch into ethanol. Both methods yield about 2.5 gallons of ethanol and 17 pounds of by-product feed per bushel of corn.

Cost of Ethanol Production

Table 20 from Schrader et al. shows the estimates cost of ethanol production for a 50,000,000 gallon a year state-of-the-art plant for various corn prices. This plant would use a dry milling process. Cost of production ranges from $1.10 a gallon when corn is $1.52 a bushel to $1.78 a gallon when corn is $4.06 a bushel. The ethanol cost at the plant is $1.51 a gallon when corn is $3.05 per bushel.

Table 21 is from another study (Gill et al. Status of the U.S. Ethanol Market). This table shows production cost for a range of plant sizes. Note that there are significant economies of scale with costs declining from $2.01 a gallon for a 10 million gallon a year plant to $1.57 and $1.54 for 40 and 60 million gallon a year

Table 20

Cost of Producing Ethanol From Corn

50,000,000 gallon plant

Corn Price ($/BU)	Corn Cost ($/gal)	By-product Credits ($/gal)	Net Corn Cost ($/gal)	Amortized Fixed Cost Plus Operating Cost ($/gal)	Minium Ethanol Price ($/gal)
1.52	.60	.26	.34	.76	1.10
2.03	.80	.34	.46	.76	1.22
2.54	1.00	.38	.62	.76	1.38
3.05	1.20	.45	.75	.76	1.51
3.57	1.40	.49	.91	.76	1.67
4.06	1.60	.58	1.02	.76	1.78

Source: Converted from $/liters to $/gallon from:
"A Review of Selected Technical and Economic Relationship for Sweeteners and Fuel Alcohol" Schrader and Tyner
Department of Agricultural Economics, Purdue University

Table 21

Cost per gallon of corn-based ethanol production 1/

Cost	Ethanol plant size (million gallons)						
	10	20	40	60	80	100	120
Energy	.30	.30	.30	.30	.30	.30	.30
Other Direct	.17	.10	.07	.07	.06	.06	.06
Indirect	.24	.18	.13	.12	.12	.10	.10
Capital recovery	.74	.60	.51	.47	.44	.41	.40
Feedstock 2/	1.15	1.15	1.15	1.15	1.15	1.15	1.15
Byproduct credit 3/	-.59	-.59	-.59	-.59	-.59	-.59	-.59
Total	2.01	1.74	1.57	1.54	1.46	1.42	1.42

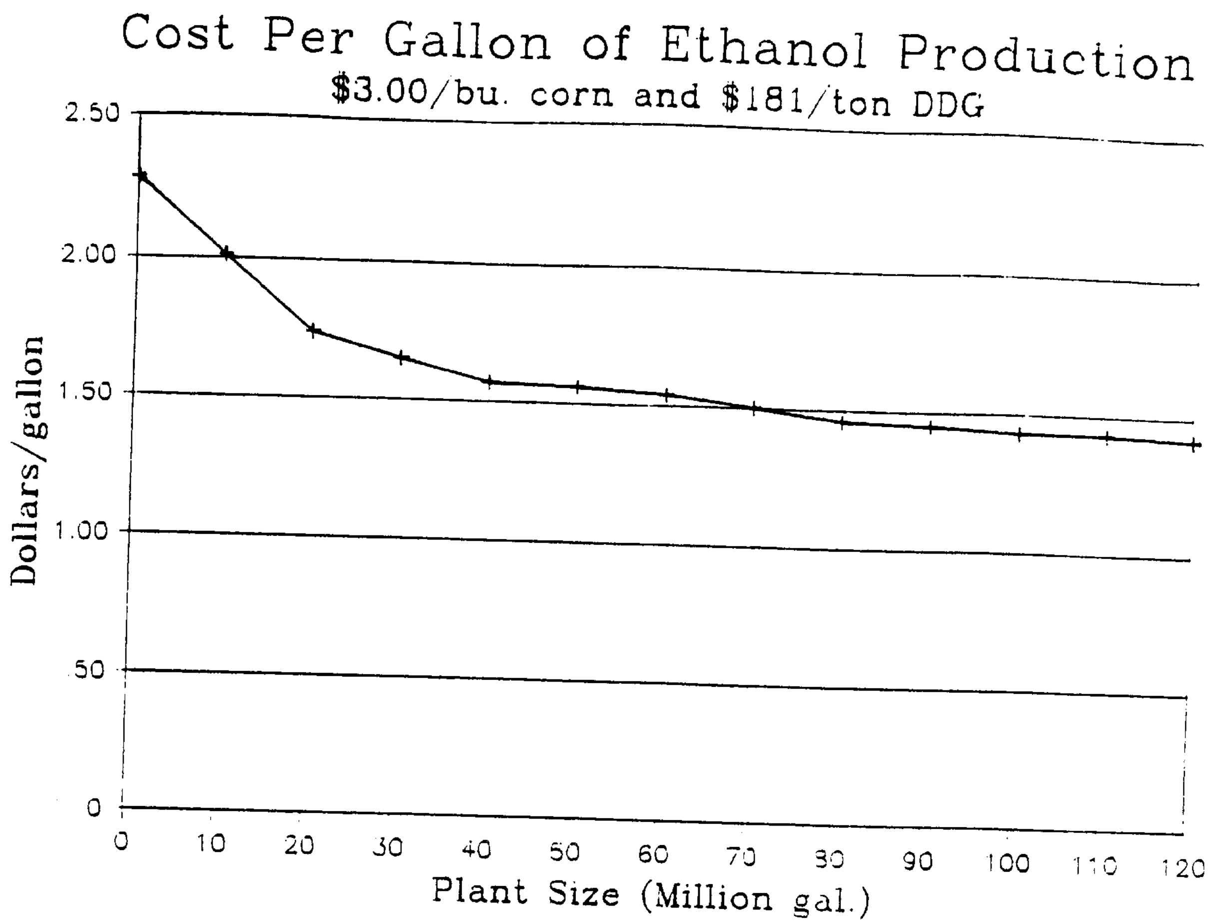
1/ 2.6 gal ethanol and 16.8 pounds of DDG
2/ corn @ $3.00/bu.
3/ DDG = $181/ton
Source: USDA "Status of The U.S. Ethanol Market" Gill, M and Allen, E

plants. Lesser economies of scale exist out to the 100 million gallons a year size plant. These cost are based on #3.00 a bushel corn and $181 a ton DDG. Figures 7-9 are adapted from Table 21 and show production cost for differnt plant sizes for 3 combinations of corn and DDG prices. Figure 9 reflexs current Illinois price levels of $2.40 a bushel corn and $115 per ton DDG. Note that production cost are almost equal to those in Table 21 ranging from $2.00 to $1.41 at 100 million gallon a year or more annual capacity. An additional point to give attention is that the corn price would have tobe near $1.50 per bushel for a large scale plant to produce ethanol near the 1985 retail price of gasoline of $1.11 per gallon. Ethanol production cost will exceed $1.40 per gallon at any corn price level generally acceptable to farmers.

Energy-Balance

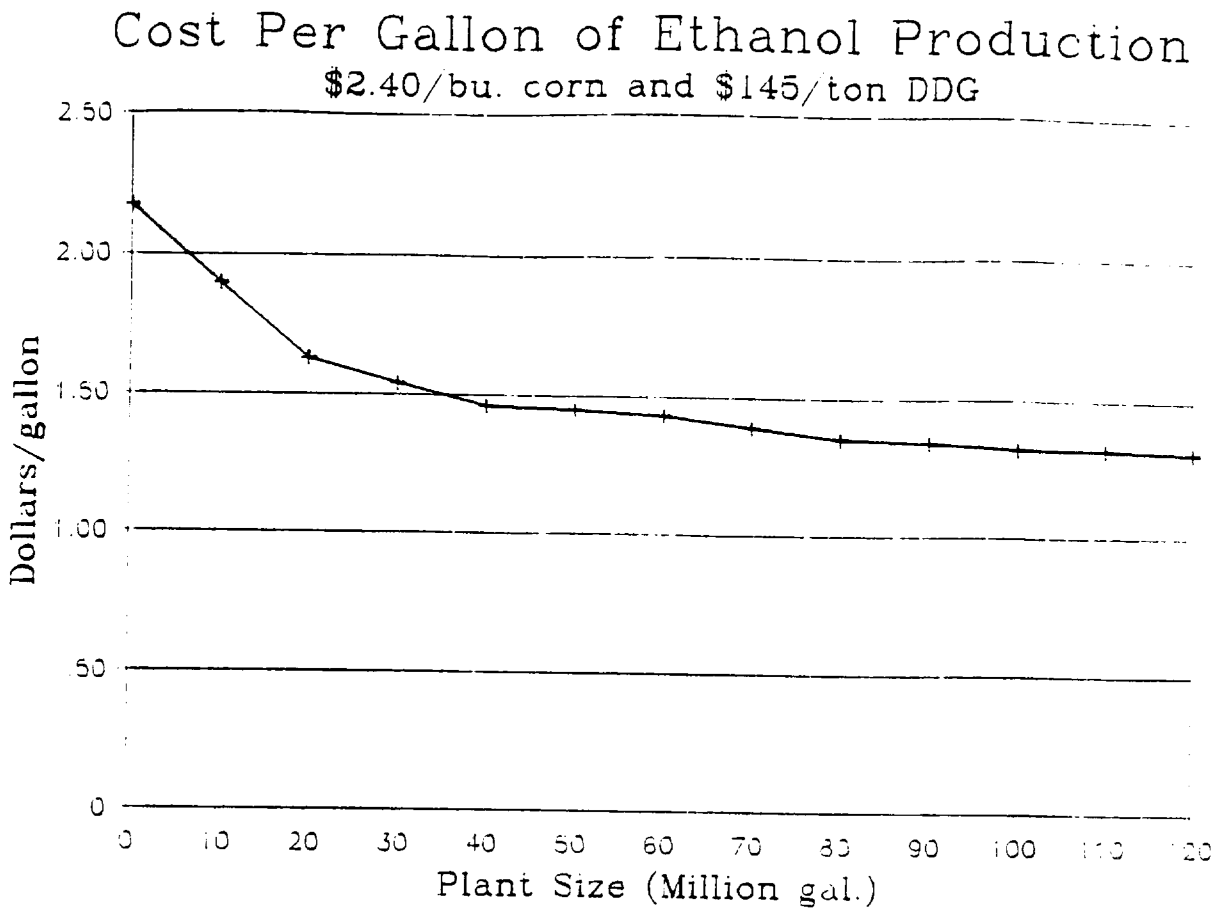
The use of corn to produce ethanol has impacts on the food, feed, and fuel complex. A major area to be considered is that of energy balance. That is comparing the BTU content of the energy sources used to produce the ethanol with the BTU's content of the ethanol and its by-products. On the input side there is the energy required to produce the corn (fertilizer, pesticides, planting, cultivating, harvesting, drying, ect.) and the energy to convert the grain to ethanol (grinding, augering, cooking, distilation, etc.) and the energy to dewater or dry by-products. This approach was used by Litterman et.al. Economics of Gasohol with the following findings. The energy ratio calculated by two methods yield values of .636 and .43. It takes more energy to produce the ethanol than the ethanol provides.

Figure 7



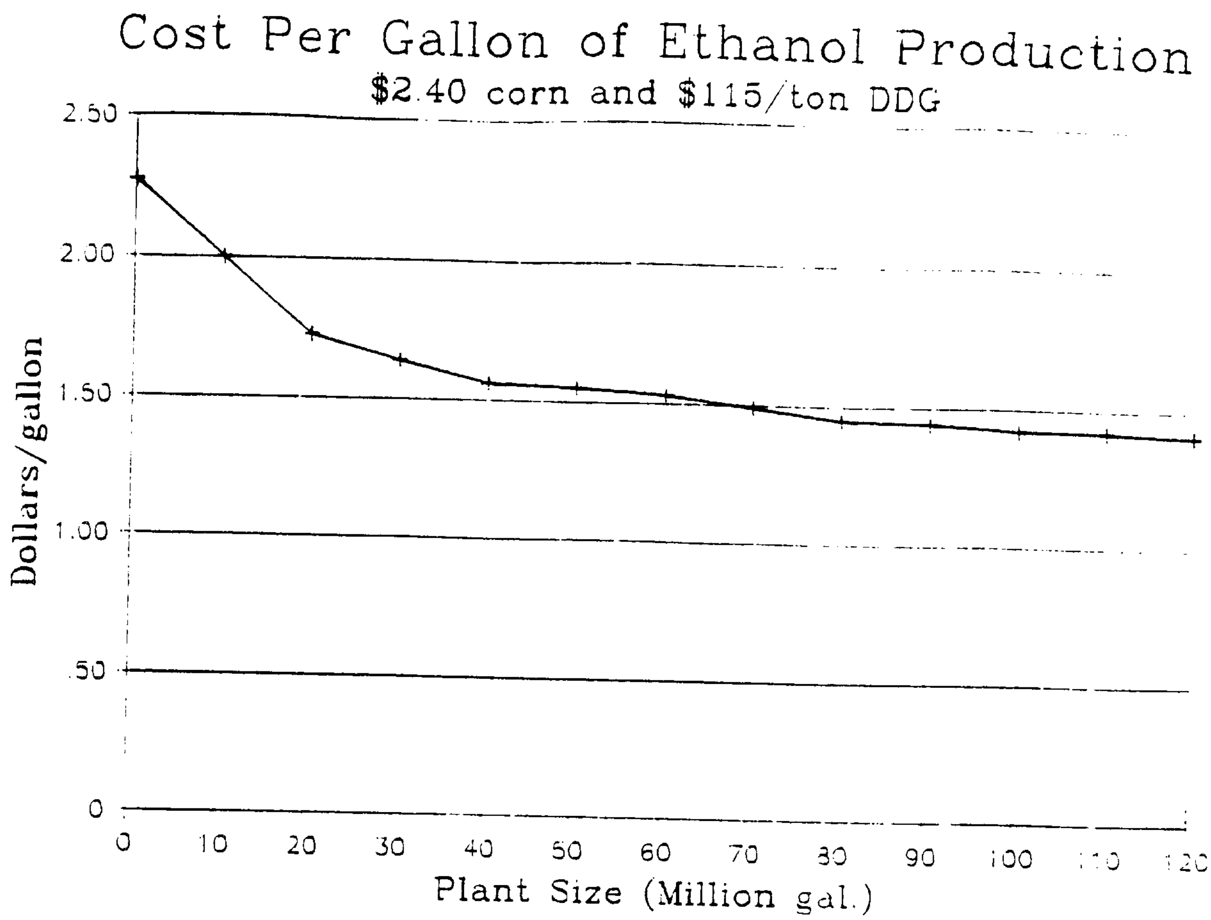
Adapted from: USDA "Status of The U.S. Ethanol Market"

Figure 8



Adapted from: USDA "Status of The U.S. Ethanol Market"

Figure 9



Adapted from: USDA "Status of The U.S. Ethanol Market"

Table 22. Energy Balance of Alcohol Production

Method 1

	BTU's (per gallon ethanol basis) 2.7 gal/bushel
Input	
Corn production (Minnesota)	39,945
Convertion to Ethanol	174,660
Total	-214,605-
Output	
Ethanol	84,400
DDGS(Distillers Dried Grains & Soluble)	52,000
Total	-136,400-

Ratio: Output/Input = 136,400/214,605 = .636

Method 2

Input	
Energy required to produce only the part of the corn converted into ethanol	22,277
Energy used for convertion	174,660
Total	-196,937-
Output	
Ethanol	84,400

Ratio: Output/Input = 84,400/196,937 = .43

Source: "Economics of Ethanol", Litterman et al.

By-products

Distillers' Dried Grains and Solubles (DDGD) is a major bu-product of ethanol production from corn. The yield of DDGS is between 6 and 7 lbs. per gallon of ethanol. The market price of this by-product depends on its value as a livestock feed. The economic impact on the agricultural sector depends on whether DDGS is priced as, and displaces other high protein feeds or if it is priced as a energy source displacing corn and other feed grains. The price received for the DDGS is an important factor of the cost of ethanol production.

DDGS is a potential source of both protein and energy if dry matter rations levels are not exceeded. The high fiber make-up of DGGS is suitable for ruminants and it can be used as a feed supplement for swine. However, because of the high fiber content and the lack of some amino acids it is not particularly well suited for monogastric animals like swine and poultry.

The value of DDGS in feeding steers was addressed by Black et al. by developing base diets for different animals with a least-cost linear programing model. The results for a 475 lb. steer are found in Table 23 and Figure 10. The ration in the left column is a least cost "reference" diet formulated by Michigan State University animal scientists that meets all nutrient requirments for the class of livestock being studied. The table indicates that if the ratio of the DDGS price per pound to the soybean meal (SBM) price per pound is less than 1.016, than a ration with 11.4% DDGS and 1.2% urea instead of SBM will be cheaper than the reference diet. Consequently, the feed value of a limited amount of DDGS can

Table 23

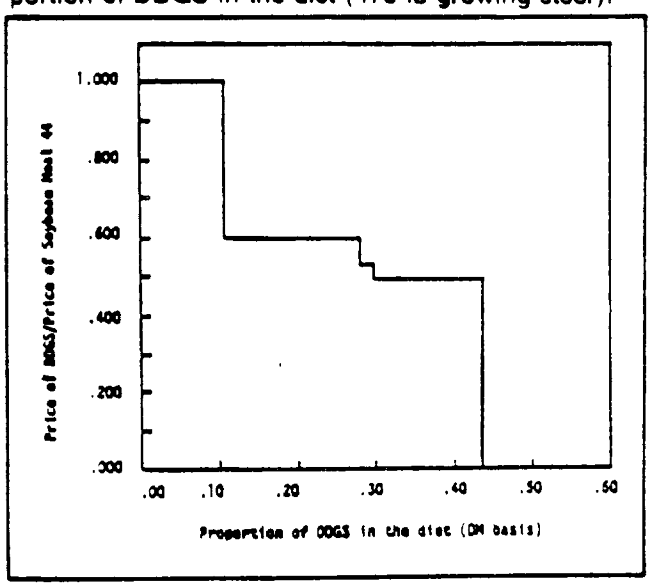
Impact of the DDGS Price on Proportion of Feed Ingredients (475 lb. steer)

INGREDIENT		PRICE OF DDGS/PRICE SBM			
	DDGS EXC.	1.016	.595	.519	.487
	----------PROPORTION OF DRY MATTER----------				
CORN SILAGE	.564	.564	.584	.582	.559
SHELLED CORN	.303	.304	.13	.119	--
SBM 44%	.126	--	--	--	--
DDGS	--	.114	.281	.295	.435
UREA	--	.012	--	--	--
LIMESTONE	.002	.003	.004	.005	.006
DICAL PHOSPH	.004	.004	--	--	--

Source: "Nutritional Requirements and Economic Value of Fuel Alcohol by-Products" Black et al.

Figure 10

Impact of the price of DDGS on the proportion of DDGS in the diet (475 lb growing steer).



be implicitly priced at 1.016 times that of soybean meal when it makes up 11.4% of the diet.

If the ratio of the DDGS price to SBM price is less than .595 then the proportion of DDGS in the ration would increase to 28.1%. Similarly , if the price ratio of the DDGS to SBM dropped to .487 or less then 43.5% of the new "least cost" ration would be DDGS. Note from the gragh the proportion of the DDGS will never be greater the .435 regardless of the price because of the need for roughage (such as corn silage) in the ruminate diet.

From a practical standpoint, at this weight of feeder steer, a limited amount of DDGS in the diet has a value slightly greater than that of SBM per pound. A limited amount of bypass protein from either DDGS or SBM is required. DGGS at 101.6% of SBM or less is a cost effective source of protein (11.4% of the ration). When the price ratio of DDGS drops to .595 that of SBM, it is economical to increase the DDGs in the ration to 28.1%. However, the additional DDGS substitutes for shell corn and is primarily an energy source. DDGS sell at a substantial discount from SBM, typically at between 60% and 75% that of SBM meaning it is priced at nearer the value as a substitute for corn rather than as a substitute for soybean meal. The next table and figure illustrates why. The reference diet in table and figure is for a 600 lb. steer. As long as the price of DDGS is more than 59.4% that of SBM, the "reference" diet in the left column is the cheaper ration. When the ratio of DDGS price to the SBM price is less than 59.4% , DDGS will make up 16.7% of the ration replacing urea as the protein source. The price ratio of DDGS to SBM is lower than in the 475 lb. steer case because at the

Table 24

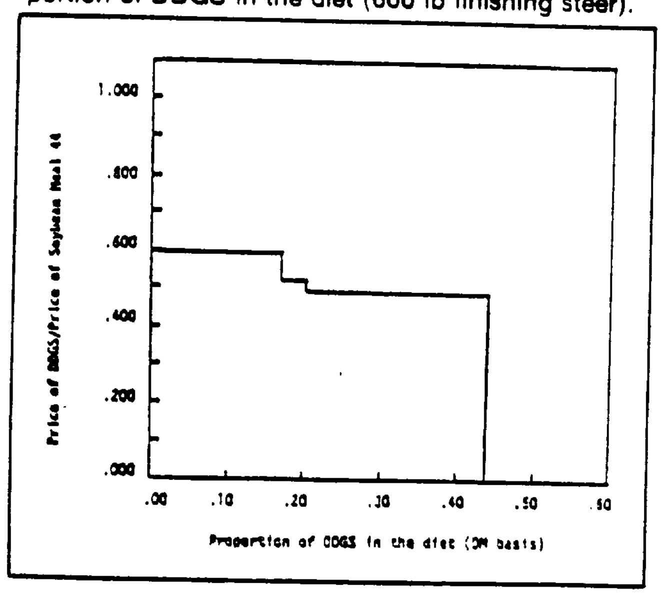
Impact of the DDGS Price on Proportion of Feed Ingredients (600 lb. steer)

INGREDIENT	DDGS EXC.	PRICE OF DDGS/PRICE SBM .594	.519	.487
	------PROPORTION OF DRY MATTER------			
CORN SILAGE	.581	.601	.597	.559
SHELLED CORN	.401	.228	.196	--
SBM 44%	--	--	--	--
DDGS	--	.167	.203	.435
UREA	.012	--	--	--
LIMESTONE	.001	.003	.004	.006
DICAL PHOSPH	.005	.001	--	--

Source: \"Nutritional Requirements and Economic Value of Fuel Alcohol by-Products" Black et al.

Figure 11

Impact of the price of DDGS on the proportion of DDGS in the diet (600 lb finishing steer).



600 lb. weight there is a lower protein requirement as a percent of feed. The larger animal also has a reduced need for bypass protein, so the protein replaced in the reference diet by DDGS is urea, a cheaper source than SBM. If the ratio of the DDGS price to SBM price is less than 51.9% to proportion of DDGS increases to 20.3% of the ration. At prices for DDGS less the 48.7% of SBM, all the shelled corn is displaced and the new "least cost" ration go the the maximun of 43.5% DDGS of the ration. When utilized as a supplemental protein, for livestock that require bypass protein, DDGS is competitive with SBM when prices are about equal. DDGS has a feeding value as a source of energy about equal to corn, so when it is used for energy in a ration its ecomonic value is tied to corn. It is reasonable to expect that as larger quantities of DDGS are produced the price of DDGS will sell close to the prices of feeds presently used for energy and not sell as a high priced protein supplement.

Corn supply

The corn outlook for 1985/1986 and 1986/1987 is of record U.S. outputs faced by very large competing feed grain supplies in the rest of the world. Large stocks are depressing prices and storage availablitiy is tight and could deteriorate by the fall of 1986. World coarse grain production was over 845 million tons in 1985/1986 which was 4.5% over the record crop of 1984/85. This puts world ending stocks at record levels. U.S. corn supply, disappearances, and ending stocks are given in Table 25 for the marketing years 1982/83 through 1985/86. Low grain prices induce heavier feeding rates and slaughter weights which effect feed

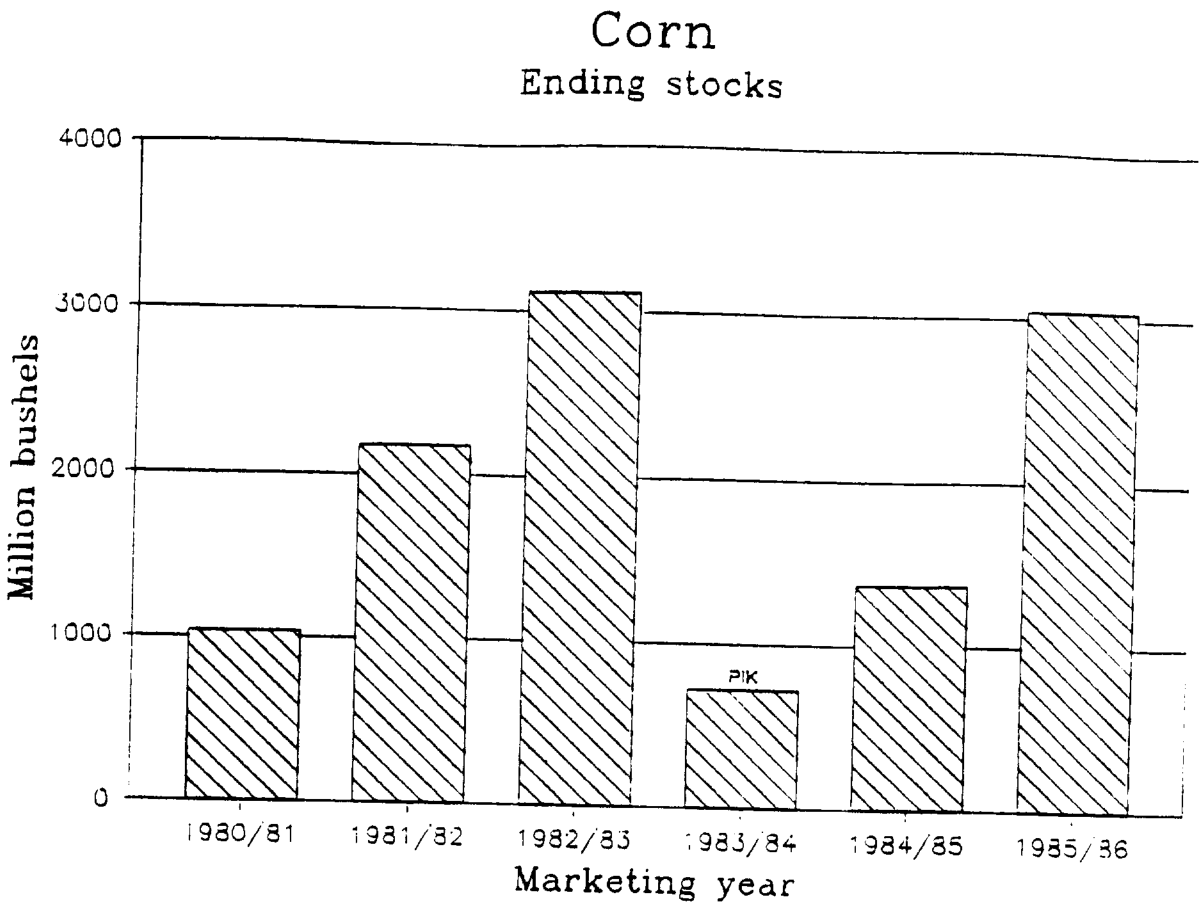
Table 25

Corn Supply and Disappearance for the United States
(million bushels)

	1982/83	1983/84	1984/1985	1985/86
BEGINNING STOCKS	2174	3119.8	720.5	1372.9
PRODUCTION	8236	4174.7	7656.2	8717
SUPPLY	10410	7294.5	8376.7	10089.9
FEED	4522.3	3735.9	4100.3	4300
EXPORT	1870.4	1865.2	1838.1	1625
SEED	14.5	18.9	19.4	20
WET MILLING				
HFCS	215	255	310	320
GLUCOSE & DEXTR	185	190	190	190
STARCH	135	145	145	150
ALCOHOL	130	150	150	170
DRY MILLING				
ALCOHOL	50	50	90	110
DRY-MILLED	168	164	161	160
DISAPPEARANCE	7290.2	6574	7003.8	7045
ENDING STOCKS	3119.8	720.5	1372.9	3044.9

Source: USDA "Feed Outlook and Situation Yearbook" Dec. 1985.
USDA "Agricultural Outlook" Jan-Feb, 1986.

Figure 12


Corn
Ending stocks
4000
3000
2000
1000
0
Million bushels
PIK
1980/81
1981/82
1982/83
1983/84
1984/85
1985/86
Marketing year

disappearances. Another impact of feed disapperances comes from the changes in production of poultry (+) and red meat (-). The increases in use of high-fructose corn syrup (HFCS) has leveled off and will likly increase at more moderate rates unless major policy changes occur in the sugar sector. The level of carryout corn stocks in 1985/1986 is over 3 billion bushels, near the pre-PIK record of 1982/1983. This means that corn will sell at or near the price support levels of $1.92/bushels, which is the effective national loan rate for corn, unless demand can be increased 1.5 to 2 billion bushels from current projections.

Price Impacts of Ethanol Production

The price impacts of ethanol production are complex due to significant changes and ajustments that take place in the highly interdependent agricultural sector. An increase in the demand for corn reduces stocks and has a positive price effect. When corn prices rise relative to soybean prices, one effect is that corn production is substitued for soybean production and major changes occur in the livestock feed markets. However, it is important to remember that a bushel of increased corn demand for ethanol production only removes about 2/3 of a bushel from the potential feed supply because the by-product re-enters the feed market.

All of these changes are occuring in an evironment of large carryout levels for corn - with the bulk of these either government-held stocks or in loan program inventories so that the outlook is for corn prices to remain near the support price this year at any possible level of ethanol demand. Two studies that have made estimates of the impact of the ethanol industry on agricultural prices are presented next.

The U.S. General Accounting Office (GAO) report Importance And Impact Of Federal Alcohol Fuel Tax Incentives used an USDA econometric simulation model (FAPSIM) to estimate the ethanol production impact on agricultural prices for projected production levels to the year 1990. The estimated prices for corn and soybeans along with the percent changes in consumer food prices and dollar increase in net farm income are presented in Table 26. With a level of corn demand at 228 million bushels the price impact is estimated to be a $.08 per bushel increase for corn and a $.10 a bushel decrease for soybeans. These adjustments were projected to increase net farm income by $689 million with an associated increase of comsumer food prices by .03%. When the level of demand was increased to the 380 million bushel level the price changes for corn and soybeans were +$.15/bu. and -$.21/bu. respectivly.

The second study, Economic Impacts of Corn Utilization in the Sweetener and Fuel Alcohol Indusrtries by Hauser et.al. at the University of Illinois, examined short- and long-range impacts on average corn prices for increases in corn demand. Short-run price impacts from corn demand for the period of 1981-1983 were estimated from increases in demand of 49 million bushels in 1981 and 62 million additional bushels in 1982 and 1983. The short-run changes were $.037/bu. in 1981, $.034/bu. in 1982 and $.034/bu. in 1983, for a total short-run price change of $.105/bu for the three year period. The short-run increase, in price per bushel of corn, for the total corn demand of 456 million bushels estimated for 1983 was $.251. Hauser et.al. state that the following caution must be

Table 26

SELECTED AGRICULTURAL IMPACTS OF ETHANOL PRODUCTION

	1982	1983	1984	1985	1986	1987	1988	1989	1990
ETHANOL mil. gals.	210	400	500	600	700	800	900	950	1000
CORN USED mil. bu.	78	152	190	228	266	304	342	361	380
PRICE AND INCOME EFFECT									
CORN CENTS/BU. (1981 baseline = $2.45/bu.)	+4	+4	+6	+8	+8	+11	+12	+14	+15
SOYBEANS CENTS/BU. (1981 baseline = $6.01/bu.)	-6	-7	-9	-10	-12	-14	-14	-14	-21
Food Prices % CHANGE	0	+.04	+.03	+.05	+.10	+.15	+.24	+.30	+.35
NET FARM INCOME (billion $) (1981 baseline = $17 billion)	-.049	+.393	+.714	+.689	+1.096	+1.630	+2.252	+3.221	+3.597

Source: "Importance And Impacts of Federal Alcohol Tax Incentives, U.S. General Accounting Office recognized when interpreting these short-run impacts.

> "..our estimates are based on an assumption that prices change freely in the market. Where a price floor or ceiling is effective, an increase in demand will not have the full price impact as indicated. Price limits that are potentially relevant to our analysis are caused by goverment loan and price programs which effectively set price floors. Second, the price impacts imply that there is no responce by corn producers and users after the price increase transpires. That is, the price impacts are determined while holding everthing else constant. This is not realistic." _/2 p.7

Two different models were used to estimate long-run impacts for different levels of increased corn demand. The first estimates were made using a simultaneous equation model (POLYSIM) that attempts takes into account the impacts of demand changes on such factors as crop prices, exports, carryout, acres planted of various crops, etc. The levels of increase demand used were 173 and 456 million bushels of corn. An assumption of the analysis was the corn used for ethanol would have the same substitution and price effect as corn used for HFCS. The long-run estimate for an increase in corn demand of 173 million bushels of corn was reported to be $.051/bu. and $.13.2/bu. at the 456 million bushel level of demand increase. A second method was also used to produce long-run price effects for increases in the demand for corn. The second method used price-impact multipliers developed by Womack et al. along with POLYSIM variable changes as a result of increases in ethanol and HFCS use. The results from using this model was long-run price increase of $.068/bu. and $.196/bu at additional demand levels of 173 million bushels and 456 million bushels.

Conclusions

Ethanol Production for motor fuel is uneconomic unless substantial subsidies are made available. Ethanol production has a negative energy balance in that more energy is consumed in producing feedstocks, processing and distilling than is available in the end product. At current levels of ethanol production, if large grain surpluses did not exsist, it is estimated that the U.S. farm price is increased $.07 per bushel. However, Huge surpluses of corn and grain currently exist and farm prices are determined by the loan level. Corn used for ethanol production, when surpluses exist, reduces the Federal government cost of holding surplus grain but has little influence on farm prices. Subsidizing ethanol production is an ineffective way to assist farmers. Farmers are encouraged by high target and support prices to produce corn in surplus quantities. Then ethanol production is heavily subsidized to reduce the surplus corn stocks. It would appear that a system of direct payments to assist agriculture would be much easier to target and much more efficient.

Minnesota has limited resources to devote to roads, research and aid to farmers. The state should withdraw from subsidizing ethanol production and deploy its' funds where they can be used effectively. If fuel tax funds are to be used to develop alternative energy sources and/or aid farmers, they would be better spent on such things as energy conservation and research programs, direct aid to distressed farmers and agricultural research programs.

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