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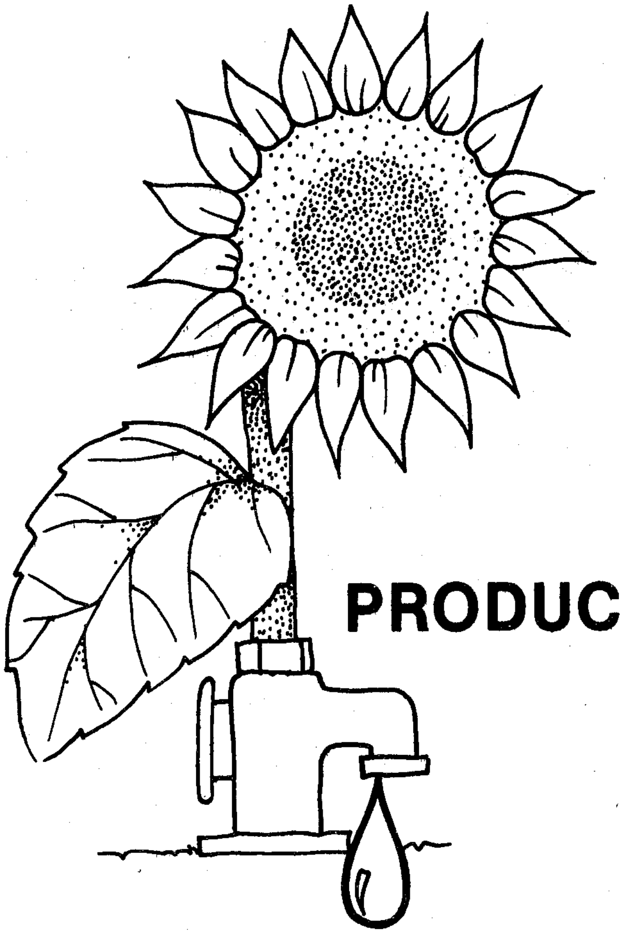

ECONOMICS OF PRODUCING SUNFLOWER FOR FUEL ON DIVERTED ACRES

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FOREWORD

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HIGHLIGHTS

The economics of a program to produce sunflower for fuel on land idled under government acreage diversion programs is analyzed. Under the proposed program, savings in government payments to idle land would be used to subsidize sunflower oil for blending with diesel fuel. The subsidy necessary to make sunflower oil competitive with diesel fuel (price of $1.05 per gallon) could not be financed out of reduced government payments to idle land for the average producer in east central North Dakota. However, producers with higher yields and lower costs may be attracted to the program. The program has greater potential in the Corn Belt where higher sunflower yields are obtained and reduced benefits occur from summer-fallowing land. The results are fairly stable with respect to the price of sunflower and sunflower oil. A real increase in diesel fuel price, all other factors held constant, would make the program more economically feasible. Program adoption would be constrained by the excess capacity existing in the sunflower crushing industry. Currently there is excess crushing capacity for the production from an additional 1.9 million acres of sunflower. Assuming the program attracted one million acres in North Dakota, business activity would increase by an estimated $131 million.

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Background

Two areas of recurring national concern are farm and energy policy. Energy shortages and the awareness they have caused are relatively recent compared to the long history of agricultural income gyrations. Present conditions may provide an opportunity to launch a program which addresses both problems. This report presents and analyzes the economics of a proposal to use surplus agricultural resources to augment liquid fuel supplies. Land diverted from production of surplus crops would be used to produce sunflower for oil to blend with diesel fuel. The savings in government payments to idle land would be used to subsidize the price of sunflower oil to make it competitive with diesel fuel. The proposed program would not result in more governmental spending than existing acreage diversion programs.

The potential advantages of using land idled under government programs to produce sunflower oil for diesel fuel are: (1) no additional government expenditures, (2) reduced use of petroleum, an exhaustible resource, (3) improvement in U.S. balance of payments through reduced petroleum imports, (4) increased use of sunfower oil crushing capacity which is currently at a low level of utilization, and (5) increased business activity in affected rural communities.

The report begins by briefly reviewing the agricultural policy and energy situations. This is followed by a discussion of physical and economic constraints to using vegetable oil for fuel. The second section of the report analyzes the economics of an option to produce sunflower for fuel instead of idling land to reduce production of surplus crops. The advantages of sunflower over other oilseed crops and the subsidies needed to make sunflower oil competitive with diesel fuel are presented first. Next the profitability for farmers to produce sunflower for fuel instead of idling land to receive government payments are compared. The report subsequently looks at available processing capacity, effects of additional production on prices, and secondary benefits of the substitution of sunflower oil for fuel on land idled under government programs. The final portion of the report looks at administration of the proposed program.

Agricultural Policy

Initially, U.S. agricultural policy sought to develop America's bountiful agricultural resources through land settlement programs, agricultural research support, and education to encourage farmers to adopt

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technological improvements. However, in the economic depression of the 1930s price support programs were initiated to stabilize and increase farm income.

Excessively low farm prices from productivity increases outstripping demand has been a chronic problem in the years since the depression. Reducing supply and/or increasing demand are the two means of exerting upward pressure on prices in a free market. The major tools the Department of Agriculture uses to support farm income are nonrecourse loans, commodity purchases, direct payments and land diversion. The following list of programs shows the diversity and complexity of governmental attempts to stabilize prices: nonrecourse loans, acreage allotments, marketing quotas, cropland set-aside or diversion, commodity storage, international commodity agreements, food for peace, and marketing agreements and orders. In all these programs governmental resources are expended in attempting to adjust farm income to acceptable levels.

Land diversion has been used intermittently since the 1930s as a means of bolstering prices of farm commodities by reducing output. Land diverted from crop production normally could not be harvested for hay or grazed until after the normal grazing season. Acreages diverted under various programs in selected years are summarized in Table 1.

TABLE 1. LAND IDLED BY GOVERNMENTAL PROGRAMS AND TOTAL U.S. CROP ACREAGE, SELECTED YEARS

Year	Total Acreage Used for Crops[a]	Idled by Programs	% Idled By Programs
	------------million acres	--------------	
1964	335	55	16
1969	333	58	17
1974	361	3	1
1979	379	12	3
1983	360	82	23

[a] Includes harvested acreage plus summer-fallowed land.

SOURCE: USDA, 1981.

The latest strategy used to shrink surpluses and augment farm income is the payment-in-kind (PIK) program. The PIK program supplements farm income stabilizing devices contained in the 1982 Agriculture and Food Act. Farmer participation in the current program is at record levels. Under the 1983 farm program, farmers have signed up to idle 6,423,911 acres in North Dakota. This represents 27 percent of the total cropland planted in 1982. Nationally 82,300,000 acres or 23 percent of planted acres have been placed in a diversion program. Acres actually diverted may be somewhat less since farmers not in the PIK program could withdraw from the acreage reserve program. Under the wheat program North Dakota farmers intend to divert 5,380,631 acres at a cost of about $427,260,000 in diversion and deficiency payments, plus the market value of the wheat payments-in-kind.[1] Even with some noncompliance with sign up, the 1983 program will idle more cropland than any previous program.

Energy Situation

Increasingly scarce energy supplies and environmental concerns of the past two decades have forced the U.S. economy to adjust to higher energy costs. The number of years domestic oil, natural gas, and coal can be supplied at 1980 extraction rates is given in Table 2. Department of Energy

TABLE 2. NUMBER OF YEARS THAT SELECTED DOMESTIC ENERGY RESOURCES CAN SUSTAIN PRODUCTION AT 1980 EXTRACTION RATES

Resources	Years of Production Remaining at 1980 Rate of Output
Crude Oil	
Proved	10
Indicated and Inferred	9
Undiscovered Recoverable	28
Natural Gas	
Proved	11
Inferred	9
Undiscovered Recoverable	32
Coal	
Recoverable	286
Demonstrated	572
Additional Resources	2,035

Definitions:
Proved Reserves--crude oil and natural gas resources currently known and in production
Indicated Reserves--reserves known to be producible with secondary recovery techniques
Inferred Reserves--known to exist but not yet developed
Undiscovered Recoverable--reserves not yet found
Recoverable Reserves--the portion of demonstrated coal reserves which can technically, economically, or legally be recovered
Demonstrated Reserves--coal resources for which definite physical measurements have been made
Additional Resources--coal reserves known to exist, but not measured

SOURCE: U.S. Department of Energy, 1982.

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[1] Values per bushel used to calculate payments for PIK wheat, diversion, and deficiency payments are \$3.70, \$2.70, and \$.65, respectively. Average accepted whole base bid of 80 percent was estimated from a survey of ASCS offices.

estimates indicate that U.S. domestic oil and gas supplies are limited to about 50 years, but coal should remain abundant for centuries.

Coal and nuclear power are projected to fill the gap between decreasing gas and oil supplies (Figure 1). Energy sources in the "other" category are not expected to increase in relative significance.

Table 3 reflects a continuation of the current oversupply of oil followed by an increasing undersupply. Real prices are projected to drop from 1980 to 1985, then escalate. Dependency on imported oil is expected to increase. The portion of total U.S. oil supplies from foreign sources is expected to increase from 40 percent in 1982 to 47 percent in 1990 [U.S. Department of Energy, 1983]. This will increase payments for foreign oil by $39 billion in 1982 dollars, assuming midprice projections.

The last decade has seen petroleum markets fluctuate from shortage to glut. Basic causes were the market power exuded by OPEC, consumer conservation, and expanded exploration because of higher prices. These market fluctuations do not alter the nonrenewable nature of petroleum and the eventually higher cost of liquid energy. Unfortunately, current market conditions sometimes result in prices that betray a resource's future scarcity. It is in this context that development and use of substitutes languish.

Vegetable Oil for Fuel

Physical Properties

The 12 vegetable oils listed in Table 4 constitute more than 95 percent of annual world vegetable oil production [Swern, 1979]. The four dominant oilseeds in the U.S. are peanut, sunflower, cottonseed, and soybean.

Vegetable oils, in general, are water-insoluble substances of plant origin which consist predominantly of glyceryl esters of fatty acids, so-called triglycerides. Structurally, a triglyceride is one molecule of glycerol esterified to three molecules of long-chain monocarboxylic acids (fatty acids). The resulting triglyceride or vegetable oil molecule has a carbon chain which is much longer than the carbon chain of a diesel fuel molecule.

Differences in physical and chemical properties of vegetable oils, compared to diesel fuel, should be given some consideration before evaluating the use of vegetable oils as fuels for compression ignition engines. These differences vary in degree between the various types of vegetable oils. Table 5 lists some of the important fuel-rated properties of crude filtered sunflower oil compared to No. 2 diesel fuel.

Ignition quality or the cetane number of vegetable oils has been reported to be from 28.3 [Ramdeen et al., 1981] to 41.5 [Southwest Research Institute, 1980], compared to the minimum cetane number of 40 for No. 1-D and No. 2-D diesel fuels, specified by ASTM D975. In general, cetane numbers for the vegetable oils have been reported as being lower than diesel fuel.

Another important difference appears in the heat of combustion, or energy content. Vegetable oils contain 5 to 18 percent less energy than

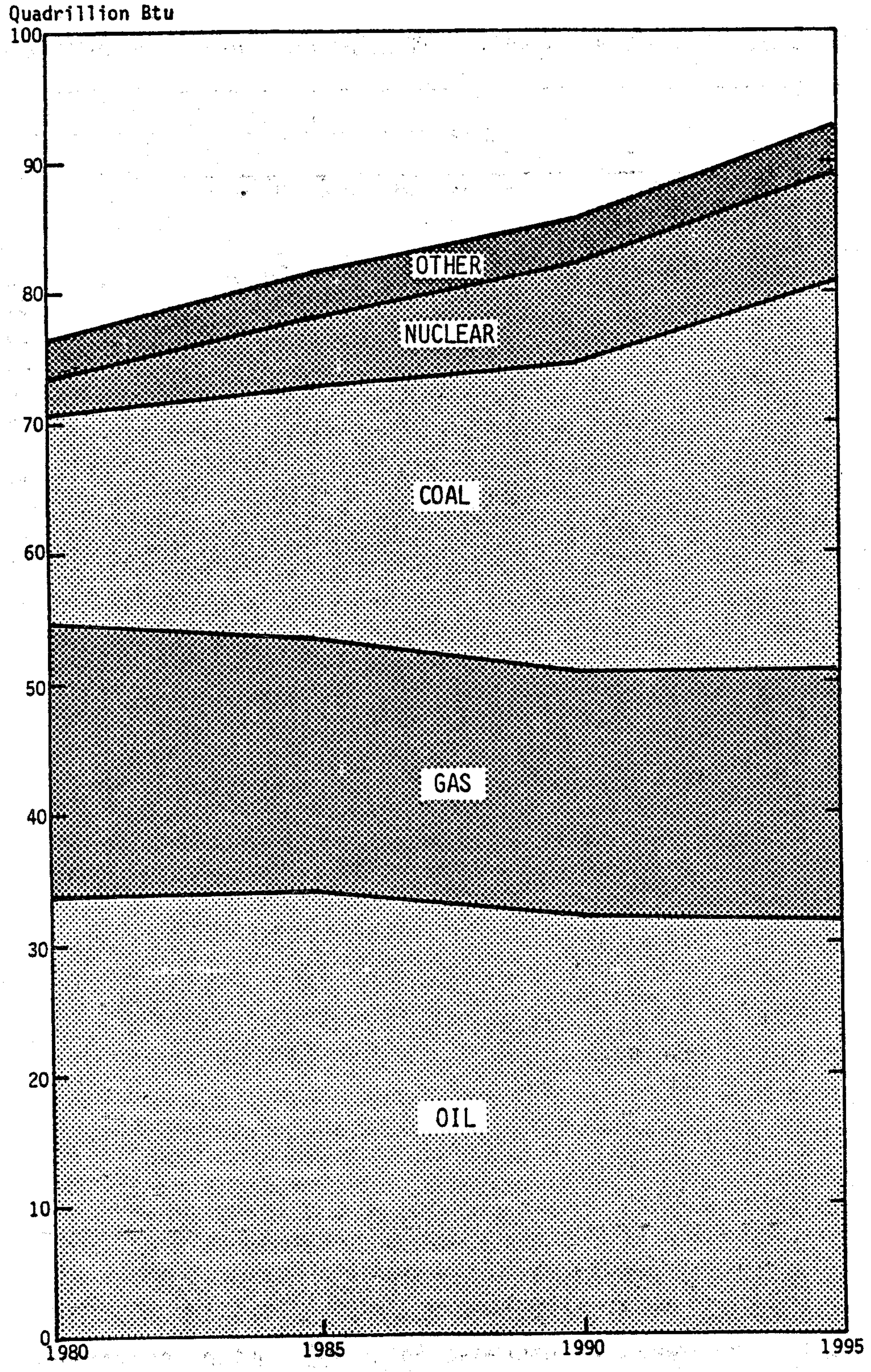

Figure 1. Energy Consumption Projections for the United States for Selected Years, by Energy Type

SOURCE: U.S. Department of Energy, 1982.

TABLE 3. WORLD CRUDE OIL PRICES PER BARREL, 1979-1990

Year	Price Case Low	 Middle	 High
	------real 1982 dollars per barrel------		
1979	27.48	27.48	27.48
1980	39.32	39.32	39.32
1981	39.27	39.27	39.27
1982	33.59	33.59	39.55
1983	28.00	30.00	32.00
1984	23.00	26.00	30.00
1985	21.00	25.00	34.00
1986	21.00	28.00	38.00
1987	22.00	32.00	41.00
1988	24.00	34.00	43.00
1989	26.00	36.00	45.00
1990	28.00	37.00	48.00

SOURCE: U.S. Department of Energy, 1983.

TABLE 4. OIL-BEARING MATERIALS AND THEIR OIL CONTENT

Oil-Bearing Material	Oil Content
	(percent)
1. Copra	65-68
2. Babassu	60-65
3. Sesame Seed	50-55
4. Palm Fruit	45-50
5. Palm Kernel	45-50
6. Goundnut (peanut)	45-50
7. Rapeseed	40-45
8. Sunflower Seed	35-45
9. Safflower Seed	30-35
10. Olive	25-30
11. Cottonseed	18-20
12. Soybean	18-20

SOURCE: Swern, 1979.

diesel fuel. The amount of decrease in energy content compared to diesel fuel is dependent on the type of vegetable oil.

Probably the greatest physical difference between the vegetable oils and diesel fuel is their viscosities. Viscosity is critically dependent on temperature, and the viscosity of vegetable oils is more seriously affected by temperature than that of diesel fuels. Vegetable oils are about 10 times more viscous than diesel fuel at 40°C and about 30 times more viscous at 0°C.

TABLE 5. FUEL PROPERTIES OF DIESEL FUEL AND SUNFLOWER OIL

Property	No. 2 Diesel Fuel	Sunflower Oil, Crude/Filtered
Density, kg/mm^3	847	921
Gross Heating Value, kJ/L	38,400	36,600
Cetane Rating	48	28
Viscosity, mm^2/s		
0°C	6.4	188
38°C	2.4	34
Pour Point, °C	-50	-9
Cloud Point, °C	-17	-7

SOURCE: Kaufman, et al., 1981.

Figure 2 shows the relationship between viscosity and temperature for sunflower oil and diesel fuel.

Other physical property differences of vegetable oils include higher specific gravities along with higher flash, cloud, and pour points. Higher specific gravities result in greater densities and weight per unit volume. A higher flash point reduces fire hazard. Higher cloud and pour points may become a limitation for the use of vegetable oils in colder climates.

Engine Tests

Encouraging results have been obtained in short-term testing of modern diesel engines fueled with vegetable oils. Short-term testing usually lasts only several minutes to several hours. The results of a number of postwar short-term engine tests on straight oilseed fuels were summarized by Quick (1980). The short-term tests showed that power output, torque, and brake thermal efficiency on oilseed fuels equalled or were close to that of diesel fuel. Fuel consumption was invariably higher because of the lower energy content of the vegetable oil.

The short-term combustion performance in an essentially unmodified diesel engine has been without incident. However, many researchers of vegetable oil fuels have found that the relatively poor thermal stability of vegetable oil leads to a buildup of deposits in the combustion chamber, especially injector nozzle coking, in long-term tests. The resultant degradation in fuel atomization and combustion efficiency leads to further problems such as piston ring sticking, crankcase oil dilution, and gelation of the lubrication oil resulting in engine failure.

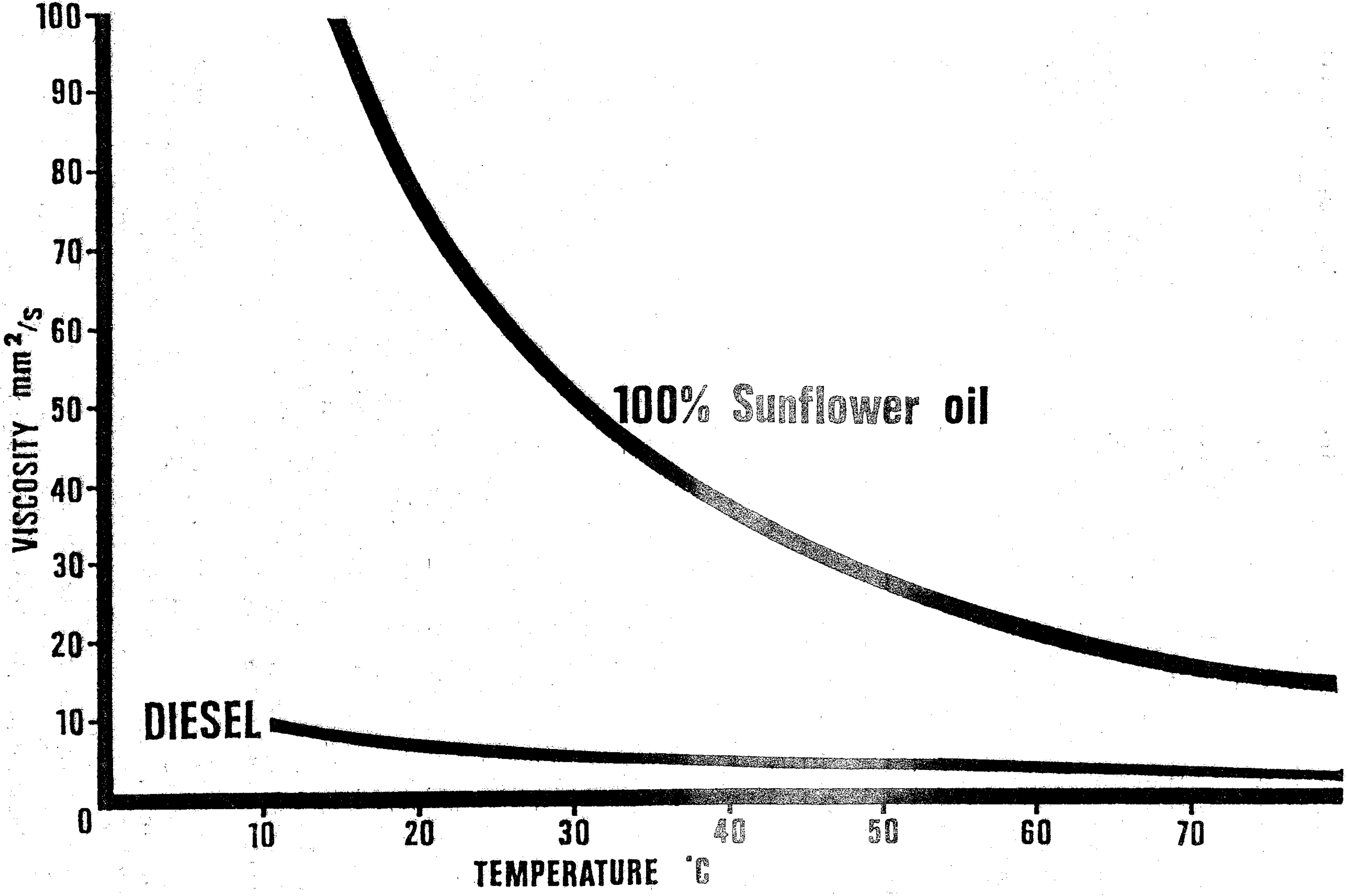

Figure 2. Relationship Between Viscosity and Temperature for Sunflower Oil and Diesel Fuel

Almost all farm tractors in the U.S. are powered by the direct injection diesel engine which is more fuel efficient than the previous indirect injection diesel engine. Some success has been achieved in using vegetable oils in the indirect injection diesel engine [USDA, 1983]. However, since the cost of modifying current engines would be prohibitive, the major emphasis in recent investigations has been in modifying the fuel. Three major proposals have been made to alleviate the problems associated with the use of vegetable oils as fuel.

First, heating the vegetable oils will reduce their viscosity to near that of diesel fuel (Figure 2). At 145°C the viscosity of vegetable oils is about 4.0 mm^2/s. However, heating the fuel does require engine modifications.

Second, another method of changing the physical properties of a vegetable oil to become more comparable with those of diesel fuel is to dilute the vegetable oil with other less viscous liquid fuels, thereby forming blends that have been termed hybrid fuels. The most popular hybrid fuel has resulted from blending vegetable oils with diesel fuel. Table 6 shows some of the properties of vegetable oil:diesel fuel blends. Engine problems are diminished although not always eliminated in vegetable oil:diesel fuel mixtures. Another approach has been to incorporate aqueous alcohol into vegetable oils in the form of microemulsions that have good fuel properties [Boruff et al., 1982 and Schwab et al., 1982].

A third means of changing the properties of a vegetable oil to be more comparable with those of diesel fuel is by chemically converting the vegetable oil to simple esters of methyl, ethyl, or butyl alcohols. The simple esters have viscosities roughly on the same order as diesel fuel and have much better volatilities compared to the original triglyceride [Pryde, 1981].

Economic Aspects

The U.S. has an absolute and comparative advantage in the production of several agricultural commodities. The idea of using abundant domestically produced commodities as substitutes for imported energy is appealing; however, economics dictate the use of a resource. Demand interacts with supply to form a price in a free market. The price reflects scarcity and acts to ration resources between alternative uses. Table 7 shows energy and cost relationships of agricultural and traditional energy sources.

Coal, followed by natural gas, are the most inexpensive energy sources listed even though agricultural prices were depressed during the time frame of the comparison. The price per BTU of agricultural commodities is comparable with liquid fossil fuels. However, considerable expense and energy use are involved in converting agricultural commodities into liquid fuels such as alcohol and vegetable oils.

Substitution of agricultural commodities for diesel fuel is attractive because diesel engines are more efficient than gas engines. A shift from gas to diesel consumption has extended petroleum supplies. Distillate fuel oil use is projected to increase from 2.87 million barrels a day in 1980 to 4.40 million barrels per day in 1995. Demand for motor gasoline is projected to decline from 6.58 to 4.40 million barrels per day in the same time frame [U.S. Department of Energy, 1982]. The chemistry of vegetable oil crops makes them better substitutes for diesel than other agricultural commodities.

TABLE 6. VEGETABLE OIL:DIESEL FUEL BLEND PROPERTIES

	Viscosity at 100°F	API Gravity	Flash Point	Pour Point	Cetane Number	Gross Heating Value
	mm^2/s	at 60°F	°F(°C)	°F(°C)		Btu/lb
Reference Diesel Fuel	3.46	32.0	159(71)	-58(-50)	44.3	19215
Peanut Oil						
25%	6.60	29.5		5(-15)	41.8	
50%	12.60	27.1	183(84)	16(-9)	40.5	
100%	39.51	22.7	622(328)	28(-2)	39.0	17045
Sunflower Oil						
25%	6.40	29.3		-4(20)	42.1	
50%	10.75	26.7	177(81)	-21(19)	40.8	
100%	33.45	21.9	608(320)	16(-9)	33.4	17010
Soy Oil						
25%	6.25	29.3		-13(-25)	43.6	
50%	11.28	26.7	179(82)	-21(-19)	41.9	
100%	32.31	21.9	597(314)	16(-9)	41.5	16770

SOURCE: Southwest Research Institute, 1980.

TABLE 7. ENERGY CONTENT AND COST OF SELECTED COMMODITIES

Commodity	BTU/Lb.	BTU/Cent[a]
Hard Red Spring Wheat	8,559	1,480
Barley	7,277	1,679
Corn	9,300	2,457
Sunflower, Oil Type	11,120	1,292
Coal, Bituminous	10,515	6,143
Natural Gas		2,976
Diesel	19,215	1,250
Gasoline	20,260	1,004

[a] Prices are October-December 1982 average.

HRSW = $3.47/bu., barley = $2.08/bu., diesel = $1.12/gal., gasoline = $1.24/gal., SF = $8.61/cwt., corn = $2.23/bu., coal = $34.71/ton

There are four major oilseed crops presently grown in the U.S. that could be used as a diesel fuel substitute or extender. Five-year average yields range from 806 pounds per acre for cottonseed to a high of 2,411 pounds per acre for peanuts (Table 8). Flaxseed is excluded because several studies have shown linseed oil unsuitable for use in diesel engines [Duke and Bagby, 1982]. Sunflower yields more oil than soybeans or cottonseed but has less than one-half the extractable oil per acre of peanuts.

TABLE 8. YIELD, EXTRACTABLE OIL, AND MEAL BY-PRODUCTS OF DIFFERENT OILSEED CROPS

Crop	Seed[a]	Extractable Oil[b]	Meal By-Product[c]
	- - - - - -	-lbs./acre-	- - - - - -
Cottonseed	806	129	363
Peanuts	2,411	964	964
Soybeans	1,787	320	1,424
Sunflower	1,238	477	693

[a] Five-year yield average from data in 1982 Agricultural Statistics.

[b] Percentages used to determine extractable oil are 16, 40, 17.9, and 38.5 for cottonseed, peanuts, soybeans, and sunflower, respectively.

[c] Percentages used to determine meal by-products are 45, 40, 79.7, and 56.0 for cottonseed, peanuts, soybeans, and sunflower, respectively.

SOURCES: USDA, ERS, 1983; USDA, 1982; Helgeson, et al., 1977; Butler, 1983; Duke and Bagby, 1982.

Few studies have investigated the energy consumed in producing and processing oil crops. A comparison of those studies in Table 9 indicates that sunflower is the most efficient "oil" crop. About four units of energy are produced for every unit of energy used in growing and processing sunflower.

TABLE 9. COMPARISON OF OILSEED ENERGY EFFICIENCY RATIOS FROM SEVERAL STUDIES

Oilseed	Study	Energy Efficiency Output per Input	Energy Efficiency Average Output per Input
Cottonseed	Broder et al.	0.17	2.16
	Fritsch et al.	2.36	
	Goering and Daugherty	3.94	
Peanuts	Hammond[a]	2.02	2.14
	Goering and Daugherty	2.26	
Soybeans	Hammond[a]	1.45	2.31
	Broder et al.	1.13	
	Fritsch et al.	1.46	
	USDA	3.26	
	Goering and Daugherty	4.27	
Sunflower	Helgeson and Schaffner	2.90	4.17
	Kaufman and Pratt	6.10	
	Goering and Daugherty	3.50	

[a] Processing energy is not included.

SOURCES: Broder, et al., 1982; Helgeson and Schaffner, 1982; Goering and Daugherty, 1981.

Caution should be used in interpreting the above results because procedures among studies were not consistent. This is evident from the large net energy deficit and moderate net energy gain reported from the cottonseed studies.

Physical quality differences among vegetable oils are not enough to greatly impede substitutability. Prices of vegetable oils differ by type but move in the same direction. April 1983 prices of vegetable oils are compared on a BTU equivalent basis in Table 10.

A common figure of 130,000 BTU per gallon was applied to all vegetable oils because test results approximate this figure. A range of 131,220 BTU for cottonseed oil to 131,672 for peanut oil was found in tests by Pride (1981). Broder et al. (1982) reported that sunflower had the lowest BTU content at 128,013 and peanut oil the highest at 133,024. Soybean oil, the least expensive vegetable oil, costs $.59 more for the BTU content of a gallon of diesel fuel, while peanut oil, the most expensive vegetable oil costs $1.10 more for the BTU content of a gallon of diesel fuel. An additional cost for

TABLE 10. PRICE AND BTU COMPARISON OF VEGETABLE OILS AND DIESEL FUEL

Oil	Price[a]	BTU Content	Price
	---------per gallon----------		per 140,000 BTU
Diesel	$1.05	140,000	$1.05
Cottonseed	1.73	130,000	1.86
Peanut	2.00	130,000	2.15
Soybean	1.52	130,000	1.64
Sunflower	1.72	130,000	1.85

[a] Average diesel price in the United States for January-March 1983, Ag. Prices. Vegetable oil prices are for April 27, 1983.

refining out gums and waxes and a retail markup should be added when considering vegetable oil as a diesel substitute.

Sunflower for Fuel on Diverted Acres

It is clear that unsubsidized vegetable oil cannot compete with diesel fuel at current market prices. However, it may be possible to make vegetable oil competitive with diesel fuel without incurring additional governmental outlay. Farm programs often offer inducements to producers to restrict production of surplus agricultural commodities. Oilseed crops are competitive with other crops on most agricultural land. Therefore, producers will accept smaller inducements to cut production of surplus commodities if they are allowed to shift acreage to oilseed crops for fuel. The savings in governmental payments for acreage diversion may be enough to subsidize vegetable oil to make it competitive with diesel fuel. Little or no effect on oilseed prices should occur, if a quantity of oil equal to oilseed production on diverted acres is removed from the commercial vegetable oil market for use as a diesel fuel substitute. However, oilseed prices may be affected if the oil meal produced depresses meal prices.

Selection of Sunflower

Sunflower may be the most practical of the major U.S. oilseeds[2] for applying the concept of using excess agricultural resources to produce a diesel fuel substitute. Not all oilseed crops are suitable for the joint purpose of reducing agricultural commodity surpluses and providing a diesel fuel substitute. Generally, a certain percentage change in the supply of an agricultural commodity causes an opposite and greater percentage change in price. Therefore, oilseed crop production for fuel may have seriously depressing effects on the prices of the nonoil products from oilseed crops. For example, a problem of disposing of

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[2] Rapeseed and safflower oil are two oilseeds that may also have potential as a diesel fuel substitute. However, only small acreages of these crops are presently produced in the U.S.

cotton fiber would result from growing cotton for cottonseed oil. Also, meal, not oil, is the main product of soybeans and cottonseed (Table 11). The amount of soybean oil necessary to satisfy 1980 Iowa farm diesel requirements with a 25 percent soybean oil:75 percent diesel mixture would result in 937,872 tons of soybean meal by-product. Processing sunflower to provide the same amount of fuel mixture would result in a by-product of only 189,228 tons of 44 percent protein meal (soybean meal) equivalent.

TABLE 11. VALUE OF OIL AND MEAL FROM PROCESSING 100 POUNDS OF SELECTED OILSEEDS

	Cotton	Peanuts	Soybeans	Sunflower
Oil				
Yield (lbs./cwt.)	16.00	40.00	17.85	38.50
Dollars per lb.	.192	.260	.1840	.220
Value ($)	3.07	10.4	3.28	8.47
Meal				
Yield (lbs./cwt.)	45.00	40.00	79.67	56.00
Dollars per ton	161.43	179.50	179.37	95.00
Value ($)	3.63	3.59	7.14	2.66
Total Value ($)	6.70	13.99	10.42	11.13
Percent of Value				
Oil	45.80	74.34	31.48	76.10
Meal	54.20	25.66	68.52	23.90

SOURCES: USDA, ERS, 1983; Helgeson, et al., 1977; Butler, 1983; Duke and Bagby, 1982.

Sunflower have an advantage over peanuts because they can be grown without specialized equipment in most arable areas of the United States. Farmers can use corn planters and grain drills for seeding and only a modest attachment to a combine grain head is necessary for harvest. Peanut oil is also the most expensive vegetable oil considered.

Sunflower Oil:Diesel Fuel Mixtures

Essentially unmodified diesel engines gave similar performances using straight vegetable oil as using diesel fuel during short-term tests by Quick (1980). However, raw vegetable oils contain gums and waxes which can cause undesirable fuel qualities. The minimum amount of refining of vegetable oil for use in diesel engines is degumming along with filtration to remove particulate matter [Bruwer et al., 1981]. The degumming process involves a centrifuging process using water to remove the gums. The cost of refining gums out of a pound of crude sunflower oil is about 2.25 cents.[3]

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[3] Industry sources, North Dakota, May 1983.

Waxes in sunflower oil cause crystallization at low temperatures. Preheating the fuel is one option of avoiding the added expense of refining out waxes by a chilling and crystal removal process. However, if the mixture of sunflower oil and diesel contains less than 50 percent of sunflower oil the waxes are absorbed in the diesel portion.

A sunflower oil:diesel fuel mixture containing from 10 to 30 percent degummed crude sunflower oil is considered a practical range for consumer acceptance. The fuel mixes will probably have to be priced somewhat less than straight diesel to allow a retail margin on the sunflower oil portion of the mix and to induce consumer acceptance. Currently manufacturers will not guarantee engines if a fuel mix containing vegetable oil is used. Therefore, the "hybrid" fuel will probably be limited to equipment not under warranty.

Sunflower oil has 92.9 percent of the energy value of No. 2 diesel fuel. The prices at which various mixtures would have the same cost per BTU as diesel fuel are illustrated in Table 12.

TABLE 12. PRICES PER GALLON OF SUNFLOWER OIL AND DIESEL FUEL HAVING THE SAME COST PER BTU OF ENERGY

Fuel Mix Sunoil:Diesel	Percent of Energy in Diesel Fuel	Equivalent Prices per Gallon on a BTU Basis
0:100	100	$1.050
10:90	99.3	1.043
20:80	98.5	1.034
25:75	98.2	1.031
100:0	92.9	.975

The subsidy on a gallon of sunflower oil to reduce its price on an energy equivalent basis to that of diesel can be determined by the following equation:

Subsidy per Gallon = Sunflower Oil Price per Gallon -.929 Diesel Price per Gallon (1)

Using spring 1983 prices, the subsidy per gallon of sunflower oil would need to be $.915 [1.89 -(.929) (1.05)].

As mentioned before, the subsidy would have to be somewhat more to obtain consumer acceptance. Subsidies on sunflower oil needed to reduce the price of various fuel mixtures to selected levels are given in Table 13.

TABLE 13. SUBSIDIES ON SUNFLOWER OIL THAT REDUCE THE PRICE OF SELECTED SUNFLOWER OIL:DIESEL MIXES TO SELECTED LEVELS

Fuel Mix Sunoil:Diesel	Price per Gallon of Sunflower Oil[a]:Diesel[b] Mix			
	$1.05	$1.03	$1.01	$ .99
	------subsidy needed per gallon of sunflower oil------			
100:0	.84	.86	.88	.91
25:75	.84	.92	1.00	1.08
20:80	.84	.94	1.04	1.14
10:90	.84	1.04	1.24	1.44

[a] Wholesale raw degummed sunflower oil at $1.89 per gallon (April 1983 price). Raw sunflower oil at 22.35 cents per pound plus 2.25 cents per pound for degumming (7.68 lbs. per gallon).

[b] Retail diesel price $1.05 per gallon.

The equation for determining the subsidy for various mixtures is as follows:

$$S = \frac{P_S A + P_D B - P_M}{A} \qquad (2)$$

where S = subsidy per gallon of sunoil
P_S = price of sunflower oil per gallon
P_D = price of diesel fuel per gallon
P_M = price of mixture of sunflower oil:diesel
A = proportion sunoil in mixture
B = proportion diesel in mixture

If price discounts on the fuel mixture are needed, a larger portion of sunflower oil in the mixture would reduce the subsidies required. A lower percentage of sunflower oil in the mix, on the other hand, may increase consumer acceptance due to quality, but would increase government subsidies for price discounts on the mixture. For example, to reduce the mixed fuel price by 1 cent on a 25:75 sunflower oil:diesel fuel mixture would require a 4 cent increase in the sunflower oil subsidy, while a 1 cent reduction in a 10:90 mixture would require a 10 cent increase in sunflower oil subsidy.

Farmer Participation

Adequate participation by farmers is necessary for a program to reduce production of surplus crops by growing sunflower for fuel. Participation rates are determined by the economic attractiveness of the program. Certain expenses such as general farm overhead, machinery ownership, land, and management costs are fixed for any given crop year. These costs are incurred irrespective of the mix of crops raised or acres diverted in a particular year. Therefore, anticipated return above variable costs is the figure used to compare cropping options in the short-run perspective of acreage diversion programs.

Farmers will produce whenever revenue is anticipated to exceed variable costs. Likewise, farmers will participate in an acreage reduction program if the inducement is greater than anticipated crop returns above variable costs of production. What if farmers are allowed to grow oilseed crops instead of idling the land in an acreage reduction program? Consider the options shown in Table 14.

TABLE 14. HYPOTHETICAL PER ACRE RETURNS AND COSTS OF THREE LAND USE OPTIONS

	Surplus Crop X	Oilseed Crop Y	Conservation Acre Set-Aside
Gross Returns	$180	$150	$15[a]
Variable Costs	80	70	10
Returns Above Variable Costs	$100	$ 80	$ 5

[a] Discounted value of future returns from an increase in available nutrients and soil moisture.

The producer in the above example needs a subsidy of at least $95 per acre to set aside his land, but would accept anything above a $20 per acre subsidy to shift land from surplus crop X to oil crop Y, a $75 per acre savings to the government. This savings could then finance a subsidy to vegetable oil for a diesel fuel substitute. Program success is contingent upon the ability of subsidized vegetable oil to compete with diesel fuel. Only the difference between the returns above variable costs of the oilseed crop and conservation acre is needed to determine the size of the subsidy for vegetable oil.

East Central North Dakota

The east central area of North Dakota is used to illustrate specific figures for comparing benefits and costs of idling land and raising sunflower. The 16 counties of this area, outlined in Figure 3, accounted for 40 percent of total U.S. sunflower production in 1981 and 1982 [North Dakota Crop and Livestock Reporting Service, 1981-82]. North Dakota, South Dakota, and Minnesota had a combined sunflower acreage of 3,783,000 in 1981 which accounted for 99.3 percent of U.S. production [USDA, 1982]. Average (1976-1982) yield of sunflower in this area is 1,170 pounds per acre.

Cropland idled in east central North Dakota is synonymous with summer fallow. Summer fallow that leaves 25 percent of the crop residue for soil cover is considered sufficient for soil conservation measures under the present farm program. Table 15 shows the average revenue and variable costs for sunflower, and fallow in east central North Dakota. Price, yield, and cost determination are explained in Appendix A. Farm operator labor is considered fixed for the crop year and is not included in variable costs.

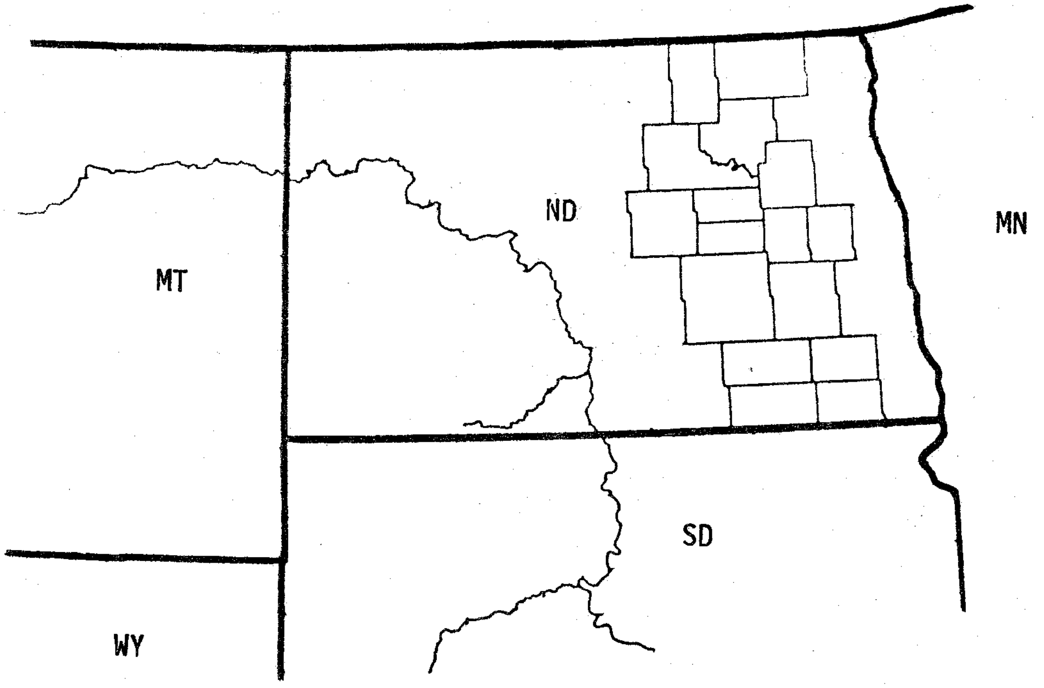

Figure 3. Location of Counties in East Central North Dakota Used to Compare Costs and Benefits of Sunflower for Fuel on Diverted Acres

TABLE 15. RETURNS AND VARIABLE COSTS PER ACRE OF SUMMER FALLOW AND SUNFLOWER PRODUCTION IN EAST CENTRAL NORTH DAKOTA, 1983 ESTIMATES

	Sunflower	Conservation Acre Fallow
Returns	$108.93	$24.80[a]
Variable Costs	51.66	9.49
Returns Above Variable Costs	$ 57.27	$15.31

[a] Value of increase in yield potential and the reduction in costs of production the year after fallow.

Fallow has a positive return because the value of reduced inputs and higher yields after fallow is more than the cost of summer fallow operations. There is no yield risk the year of fallow. The risk of raising sunflower is largely covered by including Federal All Risk crop insurance at the highest protection level as a variable cost.

Producers will be indifferent between accepting full payment for acreage set-aside and growing sunflower for fuel and accepting a $41.96 per acre reduction in governmental payments ($57.27 - 15.31 = $41.96). The government savings of $41.96 could subsidize the 58.6 gallons[4] of sunflower oil produced from the average acre of sunflower in east central North Dakota by 71.6 cents per gallon ($41.96/58.6 gal. = $.716). Current price of industrial grade sunflower oil and various sunflower oil:diesel mixtures with and without subsidies are illustrated for comparative purposes (Table 16).

TABLE 16. PRICE COMPARISONS OF SELECTED MIXTURES OF SUNFLOWER OIL AND DIESEL WHEN A SUBSIDY OF 71.6 CENTS PER GALLON IS APPLIED TO SUNFLOWER OIL

	Industrial Refined Sunflower Oil[a]	Sunflower Oil:Diesel Mixture			
		25:75	20:80	10:90	Diesel[b]
Current Price	$ 1.89	$ 1.26	$ 1.22	$ 1.13	$1.05
Subsidized Price[c]	1.17	1.08	1.07	1.06	1.05
Percent BTU Content of Diesel	92.9	98.2	98.6	99.3	1.00
Subsidized BTU Price[d]	1.26	1.10	1.09	1.07	1.05

[a] Wholesale degummed sunflower oil $1.89 per gallon.
[b] $1.05 per gallon.
[c] Sunflower oil subsidized at rate of 71.6 cents per gallon.
[d] Subsidized price divided by percent BTU content of diesel.

The 71.6 cents per gallon available to subsidize sunflower from the average government saving in set-aside payments is not enough to reduce the price of any fuel mixture below the diesel price. At least an 84 cent per gallon reduction in sunflower oil price is necessary for the prices of various fuel mixes and diesel to be equal (Table 13).

However, not all yields within an area are average. Also, important yield determinants not affecting variable costs such as timeliness of operations, weather, and land quality invalidate a strict proportional relationship between changes in variable costs and yield. When yields, variable costs, and the value of fallow do not vary proportionately, the amount of subsidy available per gallon of sunflower oil from different producers is not the same (Table 17).

No difference in the value of summer fallow within the area is assumed. The producer who expects a 1,600 pound sunflower yield would gain by accepting up to a $73.66 reduction in set-aside inducements to grow sunflower for fuel. This reduction could provide a 92 cent per gallon subsidy for the 80.2 gallons of sunflower oil produced, which is enough to make a sunflower oil:diesel fuel mix less expensive than straight diesel and about equivalent on a BTU of energy basis.

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[4] The product of 1,170 pounds sunflower and a .385 oil extraction rate is divided by 7.68 lbs./gal.

TABLE 17. SUNFLOWER OIL SUBSIDIES UNDER DIFFERENT PRODUCTIVITY LEVELS FROM REDUCTIONS IN SET-ASIDE INDUCEMENTS TO GROW SUNFLOWER FOR FUEL IN EAST CENTRAL NORTH DAKOTA, 1983

	Sunflower Yield (pounds/acre)		
	750	1,170	1,600
1. Gross Return from Sunflower[a]	$69.75	$108.93	$148.80
2. Variable Cost[b]	43.68	51.66	59.83
3. Return Above Variable Cost	26.07	57.27	88.97
4. Return Above Variable Costs of Summer Fallow	15.31	15.31	15.31
5. Reduction in Set-Aside Subsidy[c]	10.76	41.96	73.66
6. Sunflower Oil Yield Gallons/Acre	37.6	58.6	80.2
7. Available for Subsidy of Sunflower Oil Dollars/Gallon	.286	.716	.918

[a] Sunflower price 9.30/cwt.
[b] See Appendix B.
[c] Line 3. minus line 4.

Present price and cost situations in east central North Dakota make utilization of an option to grow sunflower for fuel on diverted acres feasible only by a few of the most profitable sunflower producers. Procurement of sunflower from other producers would necessitate additional governmental outlay.

Estimated costs and returns of sunflower and conservation acres for any area can be used to determine the subsidy per gallon of sunflower oil possible (Equation 3).

$$\text{Subsidy/Gal.} = \frac{[(\text{Price})\ (\text{Yield}) - (\text{Variable Cost})] - \begin{array}{c}\text{Return Above Variable}\\ \text{Costs of Conservation Acre}\end{array}}{\text{Yield}\ (.0501)} \qquad (3)$$

Price and yield are in pounds of sunflower. Yield and costs are in pounds and dollars per acre, respectively. The coefficient in the denominator transforms sunflower yield in pounds to gallons of sunflower oil.

Corn Belt

A program to subsidize sunflower oil for fuel from savings in reduced set-aside payments would probably be more successful in high yield areas, such as the Corn Belt. The reasons are high sunflower yields, low returns for conservation acres, and crop rotation considerations.

Returns above variable costs for sunflower are higher in the Corn Belt than in traditional sunflower areas. Harvested sunflower acreage of the 11 south central Minnesota counties averaged only 8,500 acres annually between

1978 and 1981, but yielded 1,622 pounds per acre [Minnesota Crop and Livestock Reporting Service, 1978-82]. Two-thousand-pound yields are not uncommon.

Benefits of fallow are less in the Corn Belt than traditional sunflower areas. An inverse relationship between net returns of fallow or conservation acres and the average productivity of an area exists for two reasons. Higher soil moisture accumulation due to fallow increases yield potential more in drier, lower-yielding areas than higher-yielding areas where moisture is generally sufficient. Costs of fallow increase for areas of higher precipitation because more expense in tillage operations and/or cover crops are necessary for weed and/or erosion control.

Agronomists suggest that sunflower should be grown but once every three years to help maintain insect and disease control. Some sunflower growing areas are close to or exceed this crop rotation limit. If sunflower for fuel is grown on wheat or feed grain base set-aside with no reduction in nonfuel sunflower, planting, disease and insect problems may be aggravated. If nonfuel sunflower acres are reduced to maintain the recommended crop rotation then additional planting of other crops may take place, possibly increasing crop surpluses. This crop rotation problem would be minimized in the Corn Belt where few acres of sunflower are currently produced.

Sunflower and Diesel Prices

Sunflower and sunflower oil prices move together although not always in a constant ratio to each other. The relation between sunflower and sunflower oil prices is influenced by export demand, sunflower meal prices, and the margins sunflower crushers are able to attain.

The higher the sunflower oil price, the greater the subsidy needed to make it competitive with diesel fuel. The higher the price of sunflower, the larger the savings in governmental program payments available to subsidize sunflower oil. These two effects offset each other so the price of sunflower has only a small effect on the economics of producing sunflower for fuel on diverted acres. The influence of sunflower and sunflower oil price levels on the proposed program are illustrated in Table 18.

TABLE 18. SUNFLOWER OIL SUBSIDIES UNDER TWO SUNFLOWER AND SUNFLOWER OIL PRICE LEVELS, EAST CENTRAL NORTH DAKOTA

Item	Low Prices April 26, 1983	High Prices August 23, 1983
Sunflower Price--Mpls. $/cwt.	$10.10	$14.50
Sunflower Oil Price--Mpls. $/cwt.[1]	.225	.340
Subsidy on Sunflower Oil Needed $/gal.[2]	.915	1.635
Subsidy on Sunflower Oil Possible $/gal.[3]	.685	1.564

[1] Price in east central North Dakota averages $.94/cwt. lower due to transportation and handling costs.

[2] See equation (1) page 20, diesel price of $1.05/gal.

[3] See equation (3) page 27.

The results presented in Table 18 indicate that the difference between the minimum subsidy needed and the subsidy that could be financed from savings in diversion payments actually is reduced at the higher sunflower and sunflower oil price level. However, at higher farm commodity prices there generally is no need for an acreage diversion program.

Diesel fuel price increases would make the substitution more economically advantageous. It would reduce the subsidy needed to make sunflower oil competitive with diesel. Higher diesel prices would, on the other hand, increase the cost of producing sunflower. The direct energy component of sunflower production represents only about 30 percent of variable production costs. Higher production costs would reduce the amount of savings in program payments to substitute sunflower for idle land but the impact would be small. As noted earlier, the Department of Energy projects no increase in the real price of crude oil until 1987 [U.S. Department of Energy, 1983].

Processing Capacity and Costs

The proposed vegetable oil for fuel program is an option to programs which support farm income. If programs to bolster farm income through cropland diversion are not necessary in the future then the funding needed to support a sunflower for fuel program may be prohibitive. Long-run uncertainty of funding discourages additional construction of capital-intensive commercial crushing plants for the purpose of processing oilseeds for fuel. Therefore, excess capacity would have to exist in the oilseed crushing industry to handle the oilseeds grown for fuel. Capital requirements for equipment to degum sunflower oil is relatively low. A need to purchase degumming equipment should not hinder acceptance of a sunflower for fuel program.

The existing crushing plants in North Dakota and Minnesota are capable of annually crushing 1,638,000 tons--the production from 2.7 million acres of sunflower (Table 19). Total domestic sunflower crush for 1981 and 1982 averaged 482,000 tons or 29.4 percent of commercial crushing capacity in North Dakota and Minnesota. Domestic sunflower plants have generally operated at less than capacity because export demand has mainly been for whole sunflower seeds, not sunflower oil.

Plant operation at less than full capacity results in higher average costs of production because fixed costs are averaged over a reduced output. The costs of a 1,000 ton per day crushing plant were estimated to show the relationship between plant utilization and average costs (Table 20). Additional demand for sunflower oil will enable sunflower plants to realize lower average costs of production.

Returns cover crushing costs when the value of sunflower oil and meal equals the value of sunflower seed plus crushing costs. At present sunflower seed, meal, and oil prices, crushing plants will break even between 50 and 75 percent of capacity (Table 21).

TABLE 19. ESTIMATED ANNUAL SUNFLOWER REQUIREMENTS AND YIELD FOR SUNFLOWER PROCESSING PLANTS IN NORTH DAKOTA AND MINNESOTA[a]

Plant	Location	Capacity[b]	Acres Required[c]	Annual Tonnage[b]	Output[b] Oil	Output[b] Meal
		tons/day	1,000 acres	-----1,000	tons------	
GTA	Minneapolis, MN	1,125-1,500	562	337.5	130	189
ADM	Red Wing, MN	638- 850	319	191.3	74	107
Cargill[d]	Riverside, ND	1,200	600	360.0	139	202
Midwest	Velva, ND	1,000	500	300.0	116	168
IS Joseph	Enderlin, ND	1,500	750	450.0	173	252
	TOTALS	5,463-6,050	2,731	1,638.8	632	918

[a] Average processing days/year = 300.
[b] Short tons.
[c] Based on 1,200 lbs. per acre yield.
[d] Plant can also process flaxseed.

TABLE 20. AVERAGE COSTS OF OPERATING A 1,000 TON PER DAY SUNFLOWER PLANT AT DIFFERENT LEVELS OF CAPACITY, 1983

	Percent of Capacity[a] 25	50	75	10
	--------dollars			--------
Average Costs ($/ton)				
Fixed	48.87	24.43	16.29	12.22
Variable	17.75	17.75	17.75	17.75
Total	66.62	42.18	34.04	29.97

[a] Assumes 300 crushing days per year.

SOURCE: See Appendix C.

Effects on Oilseed Meal and Diesel Fuel Markets

Growing sunflower for fuel will extend diesel fuel supplies but also exert a depressing affect on oilseed meal prices. Increased sunflower meal production would have a greater negative effect on the price of sunflower meal than other oilseed meals because different meals are not perfect substitutes for each other.

The sunflower acreage that could be utilized for fuel is limited to the excess capacity available in oilseed crushing plants. Operation of sunflower plants in 1981 and 1982 averaged only 29.7 percent of capacity (Table 19). An

TABLE 21. COSTS AND REVENUES OF CRUSHING SUNFLOWER AT SELECTED LEVELS OF PLANT CAPACITY,[a] 1983

	Percent of Capacity			
	25	50	75	100
	---------dollars/100 lbs. of seed crushed----------			
Crushing Cost[b]	3.30	2.10	1.70	1.50
Cost of Seed	9.30	9.30	9.30	9.30
Total Cost	12.60	11.40	11.00	10.80
Value of Meal[c] and Oil[d]	11.10	11.10	11.10	11.10
Return Above Costs	(1.50)	(.30)	.10	.30

[a] 1,000 ton per day capacity, 300 days per year.
[b] Derived from Table 19.
[c] Meal extracted from sunflower seed (.56) times price ($4.50/cwt.).
[d] Oil extracted from sunflower seed (.385) times price ($22.35/cwt.).

additional 1,912,000 acres of sunflower yielding 1,200 lbs./acre would be needed to operate plants at full capacity. Crushing plants for other oilseed crops could, with some modification, process sunflowers, also. Table 22 indicates the amount of the high protein meal and diesel fuel that could be produced from one, two, and three million acres of sunflower for fuel.

TABLE 22. INCREASES IN DOMESTIC OILSEED MEAL AND DIESEL FUEL SUPPLIES FROM GROWING SUNFLOWER FOR FUEL ON DIVERTED ACRES[a] AT SELECTED LEVELS

Millions of Acres	Percent of 1983 Acres Idled[b]	Protein Meal Produced[c]		Diesel Replaced[e]	
		1000 ton	% of Consumption[d]	1000 gal.	% of Farm Use[f]
1	1.2	214	1.0	55,885	1.8
2	2.4	428	2.0	111,770	3.7
3	3.6	641	3.0	167,655	5.5

[a] Sunflower yield of 1200 lbs per acre and sunflower oil and meal extraction rates of 38.5 percent and 56 percent respectively.
[b] Farmers signed up to idle 82,300,000 acres under the 1983 farm program.
[c] Forty-four percent protein equivalent.
[d] Estimate of 21,157 million tons domestically consumed in 1981.
[e] One gallon of sunflower oil replaces .92 gallon diesel fuel.
[f] Farm diesel requirements in 1981 was 3,055 million gallons.

SOURCES: USDA, SRS, 1982 and USDA, ERS, 1983.

Two million acres of sunflower would produce only 3.7 percent of farm diesel requirements. Farm diesel use is only about 3 percent of the total U.S.

diesel market. The effect on the diesel fuel market would be negligible. There could be an effect on diesel fuel suppliers in local markets. However, the impact on local diesel fuel suppliers need not be negative if they also handled the sunflower oil:diesel fuel mixture and maintained their usual marketing margins.

Two million additional acres of sunflower would add 2 percent to the total domestic oilseed meal market. However, oilseed meals are also exported, and domestic prices are closely related to the larger world market. Therefore the effect of the projected increase in sunflower meal on the overall oilseed meal market would be very small. The effect on the sunflower oil meal market could be more consequential. Two million more acres of sunflower would result in 672,000 tons of 28 percent protein meal. Total sunflower meal production in 1982 was only 220,000 tons. A tripling of sunflower meal production would, in the short run, lower its price relative to soybean oil meal, its major competitor. However, the protein quality in sunflower meal is nearly as high as soybean meal. The percentage of the digestable protein in sunflower meal usable as a protein by an animal is 58 percent compared to 61 percent for soybean meal and only 53 percent for cottonseed meal [Allen, 1983]. In 1982 the protein in 28 percent sunflower meal sold for 89 percent of the value of the protein in soybean meal. Since sunflower meal's overall nutritive value is 95 percent (58/61) of soybean meal, it is not likely sunflower meal prices would remain much below this present relation to soybean meal.

The previous analysis assumed that additional sunflower meal produced would be allowed to flow into commercial markets. Also, it has been assumed that sunflower meal prices would not be significantly affected. However, in order to gain acceptance of raising sunflower on diverted acres, it may be necessary to divert the sunflower meal as well as the sunflower oil to an alternative use.

A price of sunflower meal in a nonfeed use is approximated by the value of the meal for uses such as fertilizer and burning in power plants as a replacement for coal. The estimated value of sunflower oil meal in these alternative uses is summarized in Table 23.

It appears that using the meal as fertilizer is its best alternative. Since the meal is more costly to handle than conventional fertilizer, its value may be overstated. For purposes of analysis $25.00/ton will be used as the nonfeed value of the sunflower meal.

A greater reduction in governmental program payments to switch idle land to sunflower would be necessary if both the oil and meal were subsidized. The subsidy on sunflower oil to make it equivalent to diesel fuel on a BTU basis was calculated to be $.915 per gallon ($1.89 - .975) or .119 per pound (.915/7.68 lbs./gal.). The subsidy on meal would be $70.00 per ton ($95 -$25) or $.035 per pound. The reduction in governmental payments needed to offset the subsidy cost is summarized in Table 24.

The subsidy to both oil and meal would cost $76.53 per acre for the average yield in east central North Dakota. Subtracting the $.065 per pound combined subsidy from the April 1983 sunflower price of $.093 leaves a net of only $.028 a pound. It would not be economic for even the most efficient producers to accept this large a reduction in governmental farm program payments to grow sunflower instead of idling land.

TABLE 23. FERTILIZER AND FUEL VALUE OF SUNFLOWER OIL MEAL AND HULLS

Product Values[a]	Lbs./Ton	Price/Lb.	Value/Ton
Fertilizer Value			
Nitrogen	86	$.19	$16.34
Phosphorous	46	.21	9.66
Potassium	24	.13	3.12
			$29.12
Fuel Value	1000 BTU/ton	Value/1000 BTU[b]	
Meal and Hulls	14,970	.00165	$24.70

[a] Hofman, V., W. E. Dinnusson, D. Zimmerman, D. Helgeson, and C. Fanning, Sunflower Oil as a Fuel Alternative, Cooperative Extension Service, North Dakota State University, Fargo.
[b] Based on bituminous coal at $34.71 per ton.

TABLE 24. SUNFLOWER OIL AND SUNFLOWER MEAL SUBSIDIES NEEDED TO DIVERT PRODUCTS TO FUEL AND FERTILIZER USES

	Sunflower Oil	Sunflower Meal	Total
Subsidy per lb.	$ .119	$ .035	--
Percent of Seed	38.5	56.0	94.5[a]
Subsidy per lb. of Seed	.0458	.0196	.0654
Yield per Acre	1170	1170	1170
Subsidy per Acre	$53.60	$22.93	$76.53

[a] Excludes 5-1/2 percent shrink.

Secondary Benefits

The production of sunflower for fuel instead of idling the land would result in increased business activity in the affected rural communities. Benefits would occur to the suppliers of agricultural inputs, such as fertilizer, seed, pesticides, and machinery services. The increased volume of sunflower marketings and sunflower crushing would also be beneficial to the agricultural marketing sector. Farmers would only participate in the program if they expected equal or improved incomes. On average, therefore, farmer income would also be improved.

Input-output analysis can be used to estimate the effect of the proposed program on economic activity in affected areas. The procedure used estimates the gross business volume change in an area resulting from a change in output in one sector of the economy. In this case the difference in expenditures in producing sunflower can be compared to expenditures on diverted acres.

An estimate of the effects of the program on business activity is illustrated using the budgets comparing sunflower production costs with acreage diversion for east central North Dakota. The per acre direct expenditures for sunflower production are $51.36 greater than for diverted acres. When this expenditure is spent and respent throughout the economy it results in an increase of $131.00 per acre in gross business volume or a multiplier effect of 2.55 [Hertsgaard, 1977]. For example, if this program attracted 1 million acres in North Dakota in 1983, the total effect on the local economy would be approximately $131 million (1,000,000 X $131/acre). This assumes the expenditure difference for east central North Dakota would be representative of the entire state. The above figures do not include the direct and secondary benefits to the local grain merchandisers, grain transportation system, and sunflower processors.

Program Administration

Administration of the sunflower for fuel program will require estimating the supply and demand of sunflower oil for fuel. Altering the subsidy to farmers for growing sunflower for fuel and the subsidy on the sunflower oil for fuel are means of adjusting supply and demand, respectively. Limiting funds available for sunflower oil subsidies to the amount of savings from reduced set-aside payments provide a constraint. Under this constraint, success is contingent upon the government's ability to administer the program to participants and bring supply and demand of the sunflower oil as a diesel substitute into equilibrium.

Sunflower Market Channels

Procurement of oilseeds, processing of oilseeds, and distribution of vegetable oil are necessary parts of any program to substitute vegetable oil for diesel fuel. The simplest and least expensive way of administering this program is to rely on existing market channels wherever possible.

Traditional sunflower stock movements are illustrated in Figure 4. Farmers could receive reduced farm program payments to grow sunflower for fuel but sell sunflower through normal market channels. Subsidization of sunflower oil for fuel could be applied toward the end of the market sequence, at some point from the crusher to retailer. Government tabulation of sunflower seed production for fuel, at the farm level would gauge the amount of sunflower oil to be subsidized for fuel near the end of the market "pipeline."

The sunflower for fuel program should not be a disruptive influence on the market price of sunflower seeds. Most of the value of sunflower seed is derived from its oil. The amount of sunflower oil subsidized and used for fuel will approximate the oil production from sunflower seeds grown for fuel.

Payment to Farmers

A complicating factor in administering a farm program is that all farmers do not have "average" yields and costs. A method is needed to vary payments according to farm productivity. The 1983 farm program uses the past yield history of a farm in determining set-aside inducements. For example, a

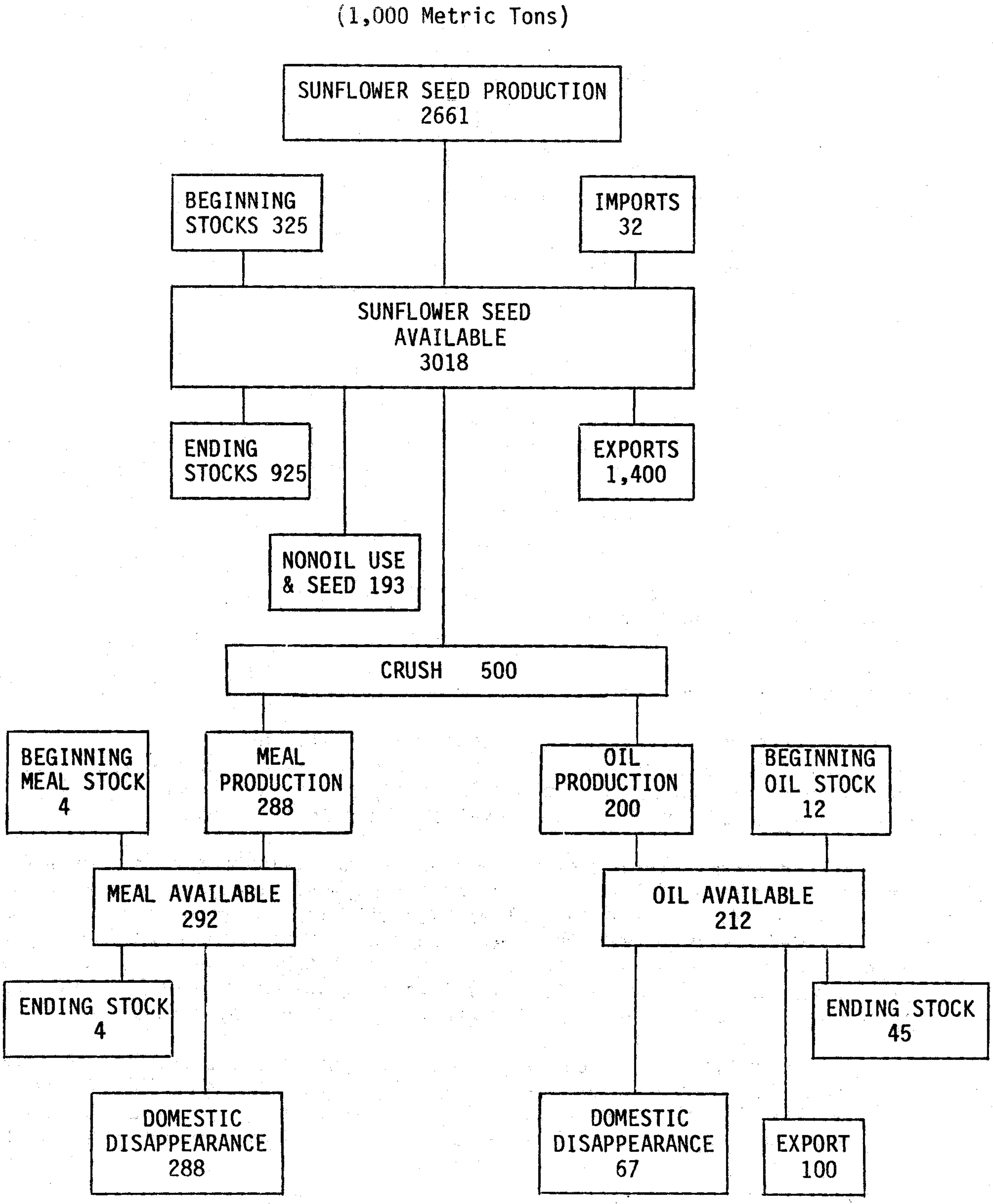

Figure 4. Sunflower Supply and Disappearance in 1982

SOURCE: USDA, ERS, 1983.

farm which has high production per acre is given a high inducement per acre to idle land.

The reduction in set-aside inducements for participating in a sunflower for fuel program must also vary according to yield yet maintain a relatively stable subsidy for sunflower oil. The payment reduction could be calculated at a dollar rate times sunflower yield to account for variations in yield among farms. The "dollar rate" is determined by dividing the average yield into the average return above variable costs. For example, in east central North Dakota a payment reduction of $41.97/11.70 cwt. or $3.59/cwt. times the sunflower yield approximates the breakeven point between participating in a program to idle acres or divert acres to sunflower for fuel. Reduction in inducements to idle land under this method of calculation can finance the same per gallon subsidy rate on sunflower oil regardless of sunflower yields. However, at any specific sunflower oil subsidy the program will tend to be more profitable for farmers with higher than average yields because increased yields are usually accompanied by a less than proportional increase in variable costs (Table 11).

The same procedure currently used for wheat and feed grains to assign yields to individual farmers in a county could be used for sunflower. Data are readily available on average sunflower yields in sunflower producing counties.

An alternative method using wheat or feed grain yields as an indicator of sunflower yields would produce similar results if the indicator yield varied proportionately with sunflower yields. For our east central North Dakota example, a per acre payment reduction equal to $41.97/28 bu. average wheat yield or $1.50/bu. times the farmer's wheat yield could be used.

Example Procedure

The procedures for diverting sunflower oil to blend with diesel fuel need not be complex. One concern would be to prevent the sunflower oil from returning to commercial channels after the subsidy is paid and before it is blended with diesel fuel. Once the sunflower oil has been blended with diesel, it would effectively be committed to the fuel market. The other concern is to provide a mechanism to assure that the market for the subsidized sunflower oil for fuel would be sufficient to remove the amount farmers would produce. The following steps outline one simple procedure. The actual mechanics used would need to be worked out between USDA, sunflower oil processors, and the diesel fuel industry.

1. Provision of the sunflower for fuel alternative for diverted acres and the sign-up period would be announced to farmers along with other governmental program provisions. Farmers would receive information on normal sunflower yield for their farm, acres eligible, and the rate of reduction in program payments for sunflower instead of acreage diversion.

2. At the close of the sign-up, total normal production of sunflower for fuel on diverted acres would be determined. This potential production would be converted to gallons of sunflower oil potentially available for fuel use.

3. Diesel fuel handlers would be asked to specify the amount of sunflower oil they would buy at the announced subsidy. Diesel handlers at all levels from petroleum refiners to local bulk dealers could be eligible to participate. If the quantity desired is more than indicated production, each handler would be reduced by the necessary percentage. If diesel handlers undersubscribe, growers would be notified to reduce their acres of sunflower for fuel by the appropriate percentage. Fuel handler quantity bids need to be irrevocable commitments made prior to sunflower planting time. Handlers may want to hedge these commitments by taking positions in the vegetable oil and petroleum future markets. An alternative to reduce the risk for fuel handlers would be for the government to make the subsidy an amount based on the difference between diesel prices and sunflower oil prices. For example, the subsidy could be 1.2 (sunoil price minus diesel price).

4. After harvest, diesel handlers would be able to purchase the sunflower oil from processors or refiners at the going market price. Most handlers would probably buy sunflower oil from refiners with some gums and waxes removed but some larger entities may buy the crude sunflower oil and do their own further treatment for fuel use. After the sunflower oil has been blended with diesel fuel, the handler can receive the subsidy by furnishing ASCS the following information: (a) receipt of the amount of sunflower oil purchased; (b) a signed statement stating that it has been blended with diesel fuel in a stated ratio; and (c) receipt showing sale of the blended fuel. If the blending is done by wholesalers the sales would be to retailers. If retailers do the blending, the sales receipts would have to be to final consumers.

The above procedure is not given with the idea that it is necessarily the best. Several other alternatives should be explored. One would be to pay the subsidy to the crusher or refiner instead of the diesel fuel handler and adulterating the sunflower oil to make it useable only for fuel at the crusher or refiner level. Another idea for matching supply and demand would be to take bids from fuel handlers on the amount they would purchase at several levels of subsidy. A bid procedure could also be set up for farmers to indicate the acreage of sunflower for fuel they would grow at various reductions in governmental payments. The supply and demand could then be matched to find a level of subsidy at which the quantities that fuel dealers would purchase and farmers would produce are equal.

Appendix A

Budgets

Budgets of variable costs and returns for sunflower and summer fallow were constructed for east central North Dakota. Fertilization recommendation charts and seven years of soil test results from east central North Dakota were used to determine fertilizer rates. Fertilizer prices are derived from diammonium phosphate (18-46-0) at $246/ton, urea (46-0-0) at $209/ton, and anhydrous ammonia at $223/ ton. The price of $1.05/gallon for diesel and $1.15/gallon for gas are the average prices paid by North Dakota farmers in the first three months of 1983. Monthly investment in variable costs was tabulated to the harvest month at 13.9 percent annual interest.

Sunflower Budget

The seven-year (1976-1982) average sunflower yield for east central North Dakota is used. Price is Duluth bid on 1983 crop minus the average (January 1981-March 1983) basis between Duluth price and price received by North Dakota farmers.

Several sunflower production cost survey results were analyzed in constructing a cost budget for sunflower production in east central North Dakota. Average variable production costs from 77 farms in the Red River Valley and 453 North Dakota farms outside of the Red River Valley served as guideposts. Input use in North Dakota generally declines from the east (Red River Valley) to the west because moisture becomes an increasingly limiting factor. Therefore, all variable costs for east central North Dakota in Appendix Table A1 lie between the Red River Valley average and the average for the rest of North Dakota.

The technology base for pesticide, machinery, and custom work utilization is from a survey of 42 sunflower producers in central and eastern North Dakota. Custom work and drying rates are from a 1982 North Dakota survey. Machinery prices are inflated to 1983 dollars for repair cost calculation. Crop insurance is the average rate paid in six representative counties to guarantee 75 percent of the average yield at $9.50/hundredweight.

Summer Fallow Budget

Costs and returns of wheat grown on summer fallow and continuous crop were compared to determine the return above variable costs of fallow. The five-year (1978-1982) average wheat yield under continuous cropping in east central North Dakota is 26.93 bushels per acre. The yield difference of wheat grown on fallow and nonfallow for each county was weighted by the county wheat acreage total to determine average yield differences for years 1978 to 1982. Wheat grown on fallow averaged 4.63 bushels an acre more than wheat grown on continuous crop. The average farm price of wheat in 1983 is forecast by World Agricultural Supply and Demand Estimates at $3.70/bushel. Soil test results from 1972 to 1981 show there is about 50 more pounds of soil nitrogen in fallow ground than continuous cropping. However, costs of applying only 35 more pounds of nitrogen on continuous cropping than fallow are incurred because of lower yield goals on continuous crop due mainly to soil moisture differences. Pesticide expense on fallow and continuous crop are indexed from averages of 1982 records on 146 and 416 North Dakota farms, respectively. Machinery use and costs are updated from a 1980 study that compared fallow and continuous crop wheat production in east central North Dakota.

APPENDIX TABLE A1. SUNFLOWER REVENUE AND VARIABLE COSTS FOR EAST CENTRAL NORTH DAKOTA, 1983

	Unit	Quantity	Price	Value
Revenue				
Sunflower	cwt.	11.70	$ 9.31	$108.93
Variable Costs				
Seed	lbs.	4	1.70	6.80
Nitrogen	lbs.	20	.191	3.82
Phosphorus	lbs.	20	.214	4.28
Pesticide				7.49
Custom Work				2.47
Drying	cwt.	5.85	.286	1.67
Fuel & Lube				9.43
Repair				7.84
Crop Insurance				5.41
Interest Expense			.139	2.45
Total				$ 51.66
Returns Above Variable Costs				$ 57.27

APPENDIX TABLE A2. INCREASES (DECREASES) IN VARIABLE COSTS AND REVENUE FROM SUMMER FALLOW IN EAST CENTRAL NORTH DAKOTA, 1983

	Costs		Revenue
Fallow Year			
Fuel and Lube	$5.83		
Machinery Repair	3.43		
Interest Expense	.23		
Year After Fallow[a]			
Nitrogen	(4.76)		
Pesticide	(.63)		
Fuel and Lube	(2.74)		
Machinery Repair	(1.22)		
Yield			$17.13
Discount[b]	.16		(1.52)
Totals	$ .30		$15.61
Net Return (Cost) of Fallow		$15.31	

[a] Difference in costs and returns between wheat produced on fallow and recropped land.

[b] Rate of 8.9 percent applied to discount cost and revenues in year after fallow to value in fallow year.

Appendix B

Variable Cost of Each Pound Difference Between Nonaverage and the 1170 Pound Average Sunflower Yield in East Central North Dakota, 1983

The total variable costs in Appendix A for the average sunflower yield of 1170 pounds per acre in east central North Dakota is $51.66. Total variable cost is directly related to yield. The assumption that 50 percent of sunflower produced are dried after harvest is maintained for nonaverage yield. Sunflower fertilization recommendations for North Dakota indicates a 1:20 ratio between available nitrogen and yield, and a 1:60 ratio between P_2O_5 and yield over a large range of sunflower yield.

All variable costs do not change proportionately to yield. Record keeping results from 301 sunflower growers in North Dakota and western Minnesota did not indicate a direct relationship between pesticide expense and yield. Therefore, it is assumed that pesticide expense does not change when yields are different than average. These farm record results were used to estimate the repair and fuel costs for the yield difference between nonaverage and average sunflower yield.

APPENDIX TABLE B1. ESTIMATED COST DIFFERENCE PER POUND BETWEEN AVERAGE AND NONAVERAGE SUNFLOWER YIELD IN EAST CENTRAL NORTH DAKOTA

Item	Quantity	Price	Cost Per Pound of Sunflower Yield Greater or Less than 1170 Pounds
N	.05	$.227	$.0114
P	.0167	.214	.0036
Drying	.5	.0029	.0014
Fuel and Repair			.0017
Interest on Operating Capital		13.9%	.0009
Total			$.019

Appendix C

Estimated Annual Operating Cost of 1000 Ton Per Day Sunflower Crushing Plant, 1983

Procedures used in calculation are from 1975 sunflower crushing plant cost estimates by Helgeson, et al., 1977. This study is referred to as "1975 study" in Appendix Table footnotes. Physical plant costs originate from 1980 figures given by an industry source. A $2.73 million dollar boiler that burns sunflower hulls for fuel is included in service and auxillary cost. The price indexes used are from the 1983 *Economic Report of the President*.

APPENDIX TABLE C1. FIXED COSTS OF 1000 TON PER DAY SUNFLOWER CRUSHING PLANT, 1983

	Depreciation Rate	1983[1]	Depreciation	Fixed Cost
		mill. $	---$---	
1. Storage Facilities	25 yr. (4%)	5.94	237,600	
2. Processing Dpt.	15 yr. (6.7%)	8.91	596,970	
3. Product Storage & Shipping	25 yr. (4%)	2.85	114,000	
4. Service & Auxillary	20 yr. (5%)	3.80	190,000	
5. Cost of Instalation & Freight		3.57		
6. Land & Prep		1.50		
Total Plant Cost		26.57		
7. Total Annual Depreciation				1,138,570
8. Interest on Capital				1,660,625
9. Salaries				108,814
10. Administrative				210,515
11. Insurance				132,480
12. Property Taxes				311,731
13. Building Maintenance				102,400
Total Fixed Costs				3,665,135

1-5. 1980 plant costs from industry source are indexed to 1983 dollars using capital equipment price index (1.1886).
6. 60 acres land at $8,000/acre and $1,000,000 for land preparation.
7. Depreciation rates from 1975 study are used.
8. Interest rate of 12.5 percent (4/19/83 Bank of North Dakota) applied to average plant investment.
9. Nonagricultural labor price index (1.728 multiplier) used to index 1975 salaries to 1983 dollars.
10. 1975 study administration costs to total plant investment ratio is applied to 1983 plant investment est.
11. 1975 study rate of $6 per $1000 plant investment (excluding installation, freight, land and land preparation) is applied to 1983 plant investment (excluding installation, freight, land and land preparation).
12. 1975 study property tax to total plant investment ratio is applied to 1983 plant investment est.
13. 1975 study rate of 2 percent of cost of buildings is used. Percentages of 72, 5.1, 0, and 12 are applied to 1983 costs of storage facilities, processing department, load out and shipping, and service and auxillary, respectively, to determine cost of buildings. Percentages were determined by the relation of building to equipment and machinery costs in 1975 study.

APPENDIX TABLE C2. VARIABLE COSTS OF 1000 TON PER DAY CRUSHING PLANT, 1983

Item	Dollars per Ton
1. Wages	$ 2.52
2. Social Security Expense	.81
3. Electricity	3.60
4. Water	.16
5. Fuel (coal to cost out sunflower hulls)	1.13
6. Solvent	.44
7. Repairs and Maintenance	3.76
8. Interest on Seasonal Capital	4.14
9. Insurance on Inventory	.18
10. Inventory Loss	.59
11. Product Selling Expense	.42
Total Variable Cost	$17.75

1. Nonagricultural labor price index (1.728 multiplier) used to index 1975 wages to 1983 dollars.
2. 32 percent of wages (same % used in 1975 study).
3. Average commercial rate of $.05/KWH (NSP 4/19/83) applied to 1975 study requirement.
4. Local (Fargo) rate of $.95/1000 gal. applied to 1975 study requirement.
5. Sunflower hulls used but cheapest alternative (coal at $34.71/ton) is applied to 1975 study BTU requirement.
6. 1975 hexane price is indexed to 1983 dollars using chemical price index (1.5976 multiplier).
7. 1975 study rate of 6 percent of initial machinery and equipment cost including installation and freight. Percentages of 28, 94.9, 100, and 80 are applied to 1983 costs of storage facilities, processing departments, load out and shipping, and service and auxillary, respectively, to determine costs of machinery and equipment. Percentages were determined by the relation of building to machinery and equipment costs in 1975 study.
8. An interest rate of 13.9 percent is charged against the 1975 study estimate of average stocks (16 percent of the annual raw product volume of sunflower) valued at $9.30 per 100 lbs.
9. 1975 study rate of $6 per 1000 valuation of average inventory. Average inventory valued at $9.30 per 100 lbs.
10. 1975 study rate of 2 to 4 per loss of average stock (16 percent of total crush) valued at $9.30 per 100 lbs.
11. Cost in 1975 study is indexed to 1983 dollars using GNP implicit price deflator (1.675 multiplier).

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