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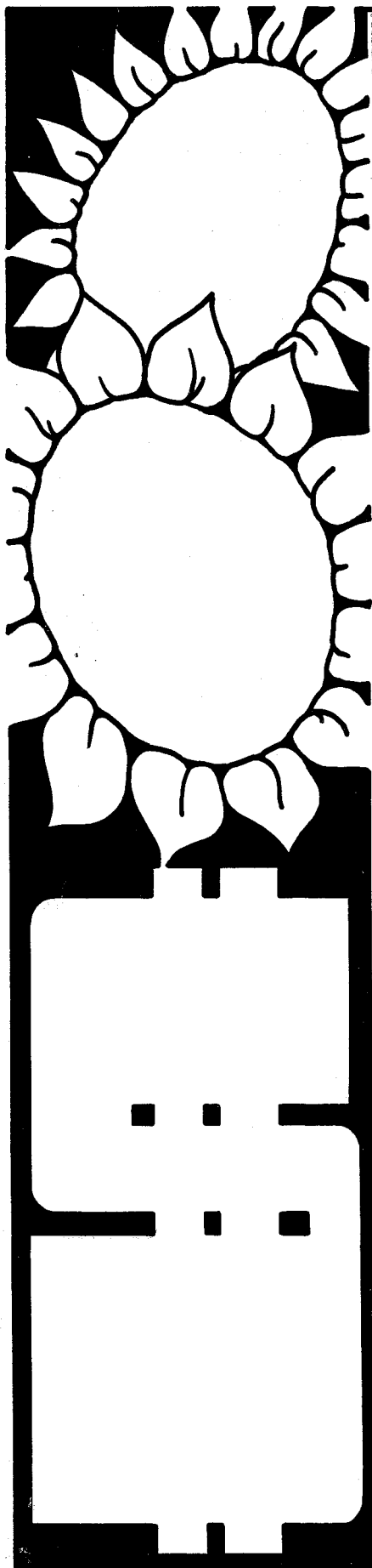
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An Economic Analysis of Intermediate-Sized Sunflower Processing Plants

**LeRoy W. Schaffner
Delmer L. Helgeson**

Department of Agricultural Economics
Agricultural Experiment Station
North Dakota State University
Fargo, North Dakota 58105

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AN ECONOMIC ANALYSIS OF INTERMEDIATE-SIZED SUNFLOWER PROCESSING PLANTS

LeRoy W. Schaffner and Delmer L. Helgeson*

Research directed at alternative energy supply sources escalated, particularly in the last decade, during periods of energy supply disruption and increases in energy costs. Vegetable oils, including sunflower, are alternative energy sources being evaluated as possible substitutes or extenders for diesel fuel. Because vegetable oils are a renewable resource, they have potential both as an energy alternative and as a way to make farm communities more self-sufficient in supplying fuel to meet agricultural requirements.

This study adds to the previous economic analyses of processing sunflower by various sized economic units. Earlier studies investigated the economics of commercial sunflower processing plants (Helgeson et al. 1977) and on-farm sized processing units (Helgeson and Schaffner 1982). Plant volumes identified for this analysis were keyed to common sizes of manufactured equipment items and plant sizes that could be integrated with rural agribusiness operations. Output from plants of this size would have a primary use as an extender for diesel fuel supply. Although it is recognized the current domestic supply of diesel fuel is adequate, any number of factors could alter future supply conditions in a manner that would make vegetable oils a more economically attractive alternative. This analysis, then, presents an economic analysis of producing sunflower oil in intermediate-sized processing plants. Comparisons of costs and returns are made with other studies of smaller and larger plants to compare seven sizes of plants and two types of processing alternatives.

Plant sizes of 25, 100 and 150 ton/day were selected. These plants have the capacity to supply 1,420; 5,682; and 8,523 farms, respectively, with a fuel mix of 10 percent vegetable oil and 90 percent diesel fuel.¹ Two processing techniques, a straight screw press (full hot screw press as commonly referred to in the industry) and a prepress-solvent method, were employed in the analysis. Prices for 1983 were used to estimate investments required for land, buildings, equipment, and plant operating costs. Average prices for the years 1979-82 were used to determine product income for plants operating 24 hours/day for 300 days/year. Machinery costs were based on quotations received directly

*Schaffner is Professor Emeritus, and Helgeson is Professor, Department of Agricultural Economics, North Dakota State University, Fargo.

¹It was assumed an average farm in North Dakota would consume 4,800 gallons of diesel fuel annually (Helgeson and Schaffner 1982). Using a 10 percent vegetable oil and 90 percent diesel fuel mixture would require 480 gallons of vegetable oil/farm. A 25 ton/day plant would produce 681,818 gallons of sunflower oil annually, a 100 ton/day plant 2,727,273, and the 150 ton/day plant 4,090,909 gallons annually. Annual gallons divided by 480 equals the number of farms that these plants would support at a 10:90 ratio of sunflower oil to diesel fuel.

from manufacturers, and formulas for estimating operating costs were taken from a study by Helgeson et al. (1977). The per-ton investment and cost figures are computed on the annual volume for the three plant sizes; 7,500 tons for the 25 ton/day plant, 30,000 tons for the 100 ton/day plant and 45,000 tons for the 150 ton/day plant.

Straight Hot Screw Press Plants

The types of buildings required and the total estimated investment have been developed for three plant sizes employing the straight screw press method (Table 1). Bins large enough to hold a one-day supply of sunflower seed are located in the receiving facility, where the seed is also cleaned and dried. Investment in the seed storage facility includes the scale, dump, dryer, cleaner, and other equipment necessary to operate the elevator. Investment in facilities for receiving, cleaning, and drying ranges from \$96,700 for the 25 ton/day plant to \$564,000 for the 150 ton/day plant. All buildings referred to hereafter will be of steel frame type design.

The storage facility is the largest of the buildings required for the processing units with a capacity to store a 60-day supply of sunflower seeds. Storage building investments ranged from \$81,900 to \$468,000 for the smallest to the largest sized plants.

Building sizes were estimated in close consultation with equipment manufacturers. Seed enters the processing building from the receiving area, and the finished products, oil and meal, leave the building and move to storage facilities. Investments for processing building requirements ranged from \$64,245 to \$174,200 (Table 1).

A separate building for an office and laboratory houses the secretaries, manager, and other personnel connected with the sale of the final product. A laboratory is needed for calculating the theoretical yield of oil and meal, for determining moisture levels of seed for control of the processing operations, and for analyzing the oil before it is shipped. An estimated size for an office and laboratory was based on a study by Brewster et al. (1956).

A boilerhouse, shop, and locker for the workers were budgeted as a separate building (Table 1); an option would have been to include this building as part of the processing facility. The boilerhouse provides the steam and hot water for the rest of the factory, and the shop houses tools for maintenance and repair of equipment. A locker unit provides space for the workers to change clothes and to meet restroom and luncheon facility requirements.

Other items included as part of building investments were storage tanks for processed oil, sunflower meal, and fuel oil used for producing steam and heat for the buildings. Sunflower oil storage tanks are large enough to hold 18.5 days supply, and the meal tanks hold 11 days of sunflower meal. Fuel oil tanks were sized based on a refill of four times/year.

The estimated total investment in buildings was \$326,135 for the 25 ton/day plant, \$1,042,240 for the 100 ton/day plant, and \$1,497,235 for the 150 ton/day plant (Table 1). Total investment in buildings was estimated at \$43.48/ton for the smallest plant, \$34.74/ton for the 100 ton/day size, and

TABLE 1. ESTIMATED BUILDING INVESTMENT AND TOTAL INVESTMENT IN STRAIGHT HOT SCREW PRESS SUNFLOWER PLANTS, OPERATING 300 DAYS/YEAR, 1983

Buildings & Total Investment Items	Plant Size in Tons/Day		
	25	100	150
Receiving, cleaning, and drying ^a	\$ 96,700	\$ 380,400	\$ 564,000
Seed storage	81,900	306,600	468,000
Processing building	64,245	150,760	174,240
Office and lab	27,470	59,520	75,540
Boiler room, maintenance shop, and lockers	30,150	43,600	58,565
Oil storage	12,040	48,150	73,775
Meal storage	9,815	38,610	61,215
Fuel oil storage	3,815	14,600	21,900
Total building investment	326,135	1,042,240	1,497,235
Railroad spur	12,500	16,665	16,665
Land	79,500	106,000	106,000
Equipment investment	812,010	1,986,220	2,581,900
Total investment	<u>\$1,230,145</u>	<u>\$3,151,125</u>	<u>\$4,201,800</u>

^aIncludes scale, dump, dryer, cleaners, and other equipment.

SOURCE: 1981 North Dakota Plant Cost Survey and Bulletin 503. 1977.
Department of Agricultural Economics, North Dakota State University, Fargo.

\$33.27/ton for the largest plant. Additional information for building sizes and unit costs is presented in Appendix Table 1.

Other investment items include the railroad spur to accommodate rail tank cars for shipping oil and meal to and from the plant, land for the plant site, and processing equipment. Equipment is the largest single item of investment (Table 1). Equipment investment ranges from \$812,915 for the small plant to \$2,581,900 for the large plant (Table 2). On per-ton basis of annual operating capacity, investment in equipment was \$108.27 for the 25 ton/day plant, \$66.21 for the 100 ton/day plant, and \$57.38 for the 150 ton/day plant.

Total estimated investment in the three plant sizes came to \$1,230,145 for the 25 ton/day size, \$3,151,125 for the 100 ton/day size, and \$4,201,800 for the 150 ton/day size. On a per-ton-processed basis, this amounts to \$164.02, \$105.04, and \$93.37, respectively, for the three plant sizes.

The estimated number of employees required for the three plant sizes was 13 persons for the 25 ton/day plant size, 17 for the 100 ton/day plant, and 18 for the 150 ton/day plant (Appendix Table 2). Total estimated wages

TABLE 2. ESTIMATED EQUIPMENT INVESTMENT FOR STRAIGHT HOT SCREW PRESS
SUNFLOWER PLANTS, OPERATING 300 DAYS/YEAR, 1983

	Plant Size in Tons/Day		
	25	100	150
Days run bin	\$ 14,095	\$ 20,995	\$ 23,100
Magnet	835	975	975
Cracking roll	30,705	34,020	36,945
Flacking roll	58,080	84,455	84,455
Cooker-dryer	69,645	197,795	241,310
Screw press	153,750	558,100	837,150
3-Way cake spout	1,100	2,965	2,965
Water cooling system	--	28,050	42,635
Meats run-around bin	23,030	24,840	24,840
Oil bucket elevator	--	9,130	9,130
Oil settling tank	25,520	32,990	32,990
Unfiltered oil tank with agitator	10,725	11,210	11,210
Oil pumps	4,810	6,490	6,490
Oil clarifying	--	116,020	116,020
Filtered oil tank	7,560	6,105	7,265
Oil meter	3,575	4,320	4,320
Cake cooler	--	38,830	48,540
Cake grinder	--	10,725	11,475
Conveyers and elevators	57,750	77,085	77,085
Sheet metal	3,575	5,570	5,570
Piping and valves	7,425	12,320	14,785
Electrical supplies	53,900	75,120	78,875
Boiler & water treatment system	50,600	83,050	156,965
Laboratory equipment	17,600	17,600	17,600
Air compressor	7,975	8,910	8,910
Miscellaneous equipment ^a	29,080	72,035	115,505
Total equipment investment	631,335	1,539,705	2,017,110
Equipment installation	180,675	446,515	564,790
Total equipment and installation investment	<u>\$812,010</u>	<u>\$1,986,220</u>	<u>\$2,581,900</u>

^aIncludes workshop equipment, electric substation, office equipment, trucks, and car.

SOURCE: 1981 North Dakota Sunflower Plant Cost Survey.

for the plants were \$241,280 for the 25 ton/day plant, \$299,520 for the 100 ton/day plant, and \$314,080 for the 150 ton/day plant (Table 3). Estimated wages for administering the plants (i.e., salaries for one manager and three assistant managers) were \$101,400 for each of the three plant sizes. On a per-ton basis, wages for the three plants were \$32.17, \$9.98, and \$6.98, respectively. The 25 ton/day plant does not make as efficient use of labor as the 100 and 150 ton/day plants, but the specified number of workers is essential for plant operations.

TABLE 3. ESTIMATED WAGES FOR STRAIGHT HOT SCREW PRESS SUNFLOWER PLANTS, OPERATING 300 DAYS/YEAR, 1983^a

	Plant Sizes in Tons/Day		
	25	100	150
Manager	\$ 31,200	\$ 31,200	\$ 31,200
Assistant manager	70,200	70,200	70,200
Receiving	14,560	29,120	29,120
Processing	72,800	87,360	101,920
Office	14,560	29,120	29,120
Miscellaneous	14,560	29,120	29,120
Laboratory technician	<u>23,400</u>	<u>23,400</u>	<u>23,400</u>
Total wages	<u>\$241,280</u>	<u>\$299,520</u>	<u>\$314,080</u>

^aHours worked were estimated by the job performed and number of shifts worked.

Wages were 30 percent of the total variable costs for the 25 ton/day plant while the wages for the 100 and 150 ton/day plants made up 16 and 12 percent (Table 4). Interest on operating capital was the largest expense item for the 100 and 150 ton/day plants; interest amounted to 27 and 29 percent of total variable cost. For the 25 ton/day plant, this item made up 18 percent. Other expense items which made up over 10 percent of the total variable costs were electricity, fuel oil, and repairs and maintenance of equipment. Total variable costs on a per-ton-processed basis were \$61.53, \$41.81, and \$38.95, respectively, for the three plant sizes. Variable costs do not include sunflower seed cost.

Estimated total fixed costs for the three plant sizes were \$276,350; \$502,455; and \$626,175, respectively (Table 5). Fixed costs for depreciation, interest on investment, and salaries of the plant manager and three assistant managers made up 80 percent of the total fixed cost in all three plant sizes. Fixed cost per ton came to \$36.85, \$16.75, and \$13.92 for three plant sizes analyzed.

TABLE 4. ESTIMATED VARIABLE COSTS FOR STRAIGHT HOT SCREW PRESS SUNFLOWER PLANTS, OPERATING 300 DAYS/YEAR, 1983

	Plant Sizes in Tons/Day		
	25	100	150
Wages	\$139,880	\$ 198,120	\$ 212,680
Social insurance ^a	43,430	53,915	56,535
Electricity ^b	52,315	209,250	313,875
Water and sewage ^c	2,015	4,030	6,050
Fuel oil ^d	55,915	214,200	321,300
Repair and maintenance of equipment ^e	57,450	139,035	180,735
Interest on seasonal capital ^f	83,595	334,380	510,015
Product selling expense ^g	6,000	24,000	36,000
Inventory loss ^h	7,410	29,635	44,450
Laboratory expense ⁱ	1,725	6,900	10,350
Insurance on inventory, \$10.25/\$1,000	7,140	29,040	43,565
Miscellaneous expense ^j	4,570	12,425	17,355
Total variable cost	<u>\$461,445</u>	<u>\$1,254,930</u>	<u>\$1,752,910</u>

^aIncludes cost of workmen's compensation (1.6 percent), general liability (3.3 percent), Social Security (6.7 percent), and health insurance (6.4 percent) for a total of 18 percent of total wages.

^bIt was estimated from other studies that a screw press plant would require 155 kilowatt hours of electricity per ton of sunflower processed.

^cWater usage was estimated by industry engineers and increased 15 percent for other uses. The water rate used was \$0.0011685/gallon.

^dFuel oil usage was estimated at 7.1 gallons for the 25 ton/day plant and 6.8 gallons for the 100 and 150 ton/day plants for each ton of sunflower processed. Price/gallon was \$1.05.

^eRepair and maintenance was estimated to be 7 percent of installed equipment cost.

^fSeasonal capital was calculated using the value of 1.5 months of stored sunflower seed, 18.5 days of processed oil, 11 days of meal, and credit to customers of two months oil and meal. The total value was calculated at 12 percent interest.

^gCost of sales services mainly includes brokerage on oil and meal, taxes, and licenses. These were estimated at \$.80/ton processed.

^hInventory loss due to shrinkage in seed, meal, and oil, as well as moisture losses, plus waste and spoilage were estimated at 3 percent of the average investment in seed.

ⁱLaboratory expenses were estimated at \$.23/processed ton.

^jMiscellaneous expenses were estimated at 1 percent of the variable cost.

TABLE 5. ESTIMATED FIXED COSTS FOR STRAIGHT HOT SCREW PRESS SUNFLOWER PLANTS, OPERATING 300 DAYS/YEAR, 1983

Item	Plant Sizes in Tons/Day		
	25	100	150
Depreciation	\$ 46,980	\$118,740	\$158,925
Interest on investment ^a	73,870	189,070	252,110
Salaries ^b	101,400	101,400	101,400
Administrative ^c	38,605	47,925	50,250
Insurance on buildings and equipment ^d	2,760	7,000	9,245
Property taxes ^e	6,270	17,475	24,300
Building maintenance ^f	<u>6,525</u>	<u>20,845</u>	<u>29,945</u>
Total fixed cost	<u>\$276,350</u>	<u>\$502,455</u>	<u>\$626,175</u>

^aCalculated at a rate of 12 percent.

^bIncludes wages of manager and three assistant managers.

^cAdministrative costs include travel, advertising, auditing services, legal fees, telephone, office supplies, and postage. These costs were estimated at 16 percent of total labor cost.

^dInsurance was calculated at .3 of 1 percent of the equipment investment and .1 of 1 percent of the building investment.

^eThe assessed value is one-half of the initial cost of buildings, land, railroad spur, and storage tanks. The mill levy of 300 mills was applied to 10 percent of the assessed valuation.

^fEstimated at 2 percent of the initial building cost.

Depreciation cost for all plant facilities was calculated using the straight-line method with zero salvage value. Three depreciation rates were applied depending upon the estimated length of useful life of the buildings and equipment involved. Total annual depreciation cost/ton of sunflower processing capacity was \$6.26, \$3.96, and \$3.53 for processing units arrayed from the smallest to largest in size.

Interest on invested capital was calculated at 12 percent of the average plant investment. This results in an average interest cost of 6 percent on the initial investment over the life of the total facilities. Interest charged on plant investment was 27 to 40 percent of the total per unit fixed costs. Interest cost/ton of processing capacity was \$9.84, \$6.30, and \$5.60.

Property taxes were estimated by taking one-half of the initial investment in buildings, land, and railroad spur. This result was the

assessment value. The assessment value was then multiplied by 10 percent, and the 10 percent value was multiplied by 300 mills to arrive at the property tax. A 300-mill levy is reasonable given that the average North Dakota mill levy was 228.12 mills for 1983, according to the North Dakota State Tax Department.

Total costs for operating the three sizes of straight screw press plants were \$737,795; \$1,757,385; and \$2,379,085. On the basis of operating capacity, per-ton basis costs were \$98.37 for the 25 ton/day plant, \$58.58 for the 100 ton/day plant, and \$52.87 for the 150 ton/day plant.

A four-year average price, 1979 to 1982, was used for sunflower seed, oil, and meal. This resulted in a sunflower seed price of \$200.00/ton or \$10.00/cwt. The four-year average price FOB Minneapolis was \$500/ton for oil. To arrive at a price for North Dakota, a transportation charge of \$22.60/ton was deducted, yielding \$477.40/ton as an oil price for the 25, 100, and 150 ton/day plants. On a per-pound basis the price used was 24 cents. A four-year average price FOB Minneapolis was also the basis for the sunflower meal price used. This resulted in an average price of \$100/ton. The transportation cost from eastern North Dakota to Minneapolis was \$13.40 in amounts of 80 tons or more. A meal price after allowing for transportation was \$86.60/ton.

The prices used for building and equipment investment and operating costs were 1983 prices. Building and equipment costs were derived from a 1981 sunflower plant cost survey adjusted to 1983 prices.

All plant sizes considered generated a negative return using 1983 prices for processing plant inputs and four-year average prices for final product (Table 6). Based on assumptions used in this analysis, these processing plants could only pay \$119.90, \$159.60, and \$165.32/ton for whole sunflower seed to generate a break-even position from operations. The oil price would need to be \$707/ton for the 25 ton/day plant, \$593 for the 100 ton/day plant, and \$577/ton for the 150 ton/day plant to break even with estimated costs used.

Prepress-Solvent Plants

A prepress-solvent type of sunflower plant is more efficient but not as economical as the full straight hot screw press plant in extracting oil from the seed. The full straight screw (hot) press plant extracts about 87.5 percent of the oil from the seed compared to 96.25 percent for a prepress-solvent plant. The 100 and 150 ton/day plants were analyzed for both full screw press and prepress-solvent methods of processing sunflower for oil. Plants smaller than 100 ton/day are regarded as too small to even consider for prepress-solvent operations; therefore, the 25 ton/day size was dropped from further analysis under the prepress-solvent alternative. Both methods were analyzed to determine the economic costs for these two distinct types of processing.

Solvent plants of this type require much the same type of buildings and equipment as the straight screw press plants (i.e., full hot screw press method) plus an additional building for the solvent processing and required solvent equipment. The additional equipment includes solvent extractor, evaporator for solvent recovery, desolventizer, toaster, mineral oil

TABLE 6. ESTIMATED OPERATING RESULTS SUMMARY FOR STRAIGHT HOT SCREW PRESS SUNFLOWER PLANTS, OPERATING 300 DAYS/YEAR, 1983

	Plant Sizes in Tons/Day		
	25	100	150
	-----\$/Ton-----		
Gross income			
Oil ^a	\$167.09	\$167.09	\$167.09
Meal ^b	51.09	51.09	51.09
Total gross income	218.18	218.18	218.18
Variable cost	61.53	41.83	38.95
Return over variable cost	156.65	176.35	179.23
Fixed cost	36.85	16.75	13.92
Return over variable and fixed costs	119.80	159.60	165.32
Sunflower seed cost ^c	200.00	200.00	200.00
Net return	\$(80.20)	\$(40.40)	\$(34.68)

^aThe plants were assumed to be 87.5 percent efficient. A ton of whole sunflower seed would yield .35 ton of oil. The 1979-82 average oil price adjusted to North Dakota was \$477.40/ton.

^bA ton of whole sunflower seed processed would yield .59 ton of 28 percent sunflower meal. The average 1979-82 price of sunflower meal was \$86.60/ton adjusted to North Dakota.

^cThe 1979-82 average price of sunflower seed was used. The average price/ton of seed was \$200.00 in North Dakota.

absorption, conveyors, and electrical and preparation equipment. This requires an additional total investment of \$1,050,325 for the 100 ton/day plant and \$1,231,380 for the 150 ton/day plant over the straight screw press plants.

A solvent tank for storing the hexane is also required. The increased building investment for the prepress-solvent plant over the full screw press plant is \$208,175 for the 100 ton/day plant and \$217,905 for the 150 ton/day plant. Estimated building requirements, total equipment investment, land, and railroad spur investment for each of the two sizes of plants are summarized in Table 7. The total building costs/ton of processing capacity were \$41.68 and \$38.11, respectively, for the two plants. This compares to \$34.74 and \$33.27 for the two plants using a straight screw press method of processing.

The total investment in equipment and installation was \$2.8 million for the 100 ton/day plant and \$3.5 million for the 150 ton/day plant (Table 8).

TABLE 7. ESTIMATED BUILDING AND TOTAL INVESTMENT FOR PREPRESS-SOLVENT SUNFLOWER PLANTS OPERATING 300 DAYS/YEAR, 1983

Type of Building	Plant Size in Tons/Day	
	100	150
Receiving, cleaning, and drying	\$ 380,400 ^a	\$ 564,000
Seed storage	306,600	468,000
Processing	150,760	174,240
Solvent processing	121,125	121,125
Office and laboratory	59,520	75,540
Boilerhouse, machine shop, and storeroom	43,600	58,565
Oil storage	52,965	79,500
Meal storage	36,645	54,970
Solvent storage	40,600	40,600
Fuel oil storage	29,200	43,800
Water cooling tower	29,000	34,800
Total building investment	1,250,415	1,715,140
Land	159,000	238,500
Railroad spur	16,665	18,750
Equipment and installation	2,775,370	3,460,790
Total investment	<u>\$4,201,450</u>	<u>\$5,433,180</u>

^aIncludes scale, dump, dryer, cleaner, motors, and other equipment.

SOURCE: 1981 North Dakota Sunflower Plant Cost Survey and Bulletin 503. 1977. Department of Agricultural Economics, North Dakota State University, Fargo.

Equipment and installation investment was \$92.51/ton for the 100 ton/day plant and \$76.91/ton for the 150 ton/day plant.

The investment in labor to operate the prepress-solvent plants is greater than for the full screw press method of processing sunflower oil. Prepress-solvent plants require another operation in a separate building and

TABLE 8. ESTIMATED EQUIPMENT INVESTMENT FOR PREPRESS-SOLVENT SUNFLOWER PLANTS OPERATING 300 DAYS/YEAR, 1983

Type of Equipment	Plant Size in Tons/Day	
	100	150
Days run bin	\$ 20,995	\$ 23,100
Magnet	975	975
Cracking roll	34,020	36,945
Flaking roll	84,455	84,455
Cooker-dryer	197,795	241,310
Screw press	558,100	837,150
3-Way cake spout	2,965	2,965
Water cooling system	28,050	42,635
Meats run around bin	24,840	24,840
Oil bucket elevator	9,130	9,130
Oil settling tank	32,990	32,990
Unfiltered oil tank with agitator	11,210	11,210
Oil pumps	6,490	6,490
Oil clarifying	116,020	116,020
Filtered oil tank	6,105	7,265
Oil meter	4,320	4,320
Cake cooler	143,000	181,500
Cake grinder	10,725	11,475
Conveyors and elevators	77,085	77,085
Sheet metal spouts	5,570	5,570
Piping and valves	12,320	14,785
Electrical supplies	75,120	78,875
Boiler and water treatment systems	83,050	156,965
Laboratory equipment	17,600	17,600
Air compressor	8,910	8,910
Solvent extractor	192,500	203,500
Evaporation and solvent recovery tank	79,200	93,500
Desolventizing section	126,500	143,000
Mineral oil absorption and accessories	115,500	121,000
Miscellaneous equipment ^a	73,830	127,675
Total investment in equipment	2,159,370	2,713,240
Equipment installation	616,000	737,550
Total investment in equipment	<u>\$2,775,370</u>	<u>\$3,460,790</u>

^aIncludes workshop equipment, electric substation, office equipment, trucks, and car.

SOURCE: 1981 North Dakota Sunflower Plant Cost Survey.

require a crew for each of the three shifts worked. The prepress-solvent method of processing would require about seven or more employees over the same size plants with full screw presses. Total number of workers was 24 and 25, respectively. Total salaries paid were \$401,440 and \$416,000 for the two solvent plants (Table 9).

TABLE 9. ESTIMATED WAGES FOR PREPRESS-SOLVENT SUNFLOWER PLANTS OPERATING 300 DAYS/YEAR, 1983^a

Type of Employee	Plant Size in Tons/Day	
	100	150
Manager	\$ 31,200	\$ 31,200
Assistant managers	70,200	70,200
Elevator	29,120	29,120
Processing	174,720	203,840
Office	29,120	29,120
Laboratory technician	23,400	23,400
Miscellaneous	43,680	29,120
Total wages	<u>\$401,440</u>	<u>\$416,000</u>

^aHours worked were estimated by the job performed and the number of shifts worked.

Total estimated variable costs were \$1.6 million and \$2.2 million, respectively, for these plants (Table 10). This amounts to \$54.20 and \$49.20/ton of operating capacity for the two plants, respectively. Fuel oil was the largest variable cost and interest on seasonal capital the second largest cost. Four items comprised 78 percent of the total variable cost: fuel oil, interest on seasonal capital, wages, and repair and maintenance on equipment.

Total fixed costs for prepress-solvent plants were estimated at \$629,675 for the 100 ton/day size and \$770,635 for the 150 ton/day plant (Table 11). On a per-ton basis of operating capacity, this amounts to \$20.99 and \$17.13. Depreciation and interest on investment make up about 65 to 68 percent of the total fixed cost. Administrative salaries were the third largest fixed cost item making up from 16 to 13 percent of the total fixed cost.

Total annual costs for operating a prepress-solvent plant were \$2.26 million for the 100 ton/day plant and \$2.98 million for the 150 ton/day plant. Converted to a per-ton basis, the total cost was \$75.19 and \$66.33 for these two plants. This compares to \$58.58 and \$52.87/ton for the full screw press method of processing sunflower oil.

An operating cost summary for the 100 and 150 ton/day prepress-solvent plants is provided in Table 12. Prices for sunflower seed, oil, and meal were the same as those used in analyzing the straight hot screw press method. A

TABLE 10. ESTIMATED VARIABLE COSTS FOR PREPRESS-SOLVENT SUNFLOWER PLANTS
OPERATING 300 DAYS/YEAR, 1983

Item	Plant Size in Tons/Day	
	100	150
Wages	\$ 300,040	\$ 314,600
Social insurance ^a	72,260	74,880
Electricity ^b	140,400	210,600
Water and sewage ^c	4,030	6,050
Fuel oil ^d	428,400	642,600
Repair and maintenance of equipment, including parts ^e	194,275	242,255
Interest on seasonal capital ^f	351,640	527,445
Product selling expense ^g	24,000	36,000
Inventory loss ^h	29,635	44,450
Laboratory expense ⁱ	6,900	10,350
Insurance on inventory, \$10.25/\$1,000	30,035	45,050
Hexane solvent ^j	28,350	37,800
Miscellaneous expense ^k	16,100	21,920
Total variable cost	<u>\$1,626,065</u>	<u>\$2,214,000</u>

^aIncludes cost of workmen's compensation (1.6 percent), general liability (1.6 percent), social security (6.7 percent), and health insurance (6.4 percent) for a total of 18 percent of total wages.

^bIt was estimated from other studies that a screw press-solvent plant would require 104 kilowatt hours of electricity/ton of sunflower processed. Cost of electricity was 4.5 cents/kilowatt hour.

^cWater loss was estimated by the French Company to be 100 gallons/ton of sunflower processed. This was increased 15 percent for other uses. The water cost/gallon was \$0.0011685.

^dIt was estimated it would take 13.6 gallons of fuel oil/ton of sunflower processed. The price used was \$1.05/gallon.

^eRepairs and maintenance were estimated to be 7 percent of installed equipment cost. This includes cost of parts.

^fSeasonal capital was calculated using the value of 60 days stored sunflower seed, 18.5 days of stored processed oil, 11 days of stored meal, and credit to customers of two months value of oil and meal. The total value was calculated at 12 percent interest.

^gCost of sales services mainly includes brokerage on oil and meal, taxes, and licenses. These were estimated at \$0.80/ton.

^hInventory loss due to shrinkage in seed, oil, and meal, as well as moisture losses, plus waste and spoilage were estimated at 3 percent of 16 percent of the total investment in sunflower seed.

ⁱLaboratory expenses were estimated to be \$0.23/ton of sunflower seed processed.

^jSolvent loss/ton was estimated to be 1.35 gallons for the 100 ton/day plant and 1.20 for the 150 tons plant. The price/gallon of hexane was estimated at \$0.70/gallon.

^kMiscellaneous expenses were estimated at 1 percent of the variable cost.

TABLE 11. ESTIMATED FIXED COSTS FOR PREPRESS-SOLVENT SUNFLOWER PLANTS
OPERATING 300 DAYS/YEAR, 1983

Item	Plant Size in Tons/Day	
	100	150
Depreciation:		
Buildings, 40 years, 2.5%	\$ 29,850	\$ 40,990
Equipment, 25 years, 4.0%	107,360	132,620
Other, 8.3 years, 12.0%	18,725	27,090
Total Depreciation	155,935	200,700
Interest on Investment ^a	252,090	325,990
Salaries ^b	101,400	101,400
Administrative ^c	64,230	66,560
Insurance on Buildings and Equipment ^d	9,575	12,100
Property Taxes ^e	21,435	29,585
Building Maintenance ^f	25,010	34,300
Total Fixed Cost	<u>\$629,675</u>	<u>\$770,635</u>

^aInterest on average investment at 12 percent.

^bIncludes wages of manager and the three assistant managers.

^cAdministrative costs include travel, advertising, auditing services, legal fees, telephone, office supplies, postage, etc. These costs were estimated at 16 percent of the total labor cost.

^dInsurance was calculated at .3 of 1 percent of the equipment investment and .1 of 1 percent of the building investment.

^eAssessed value is one-half of the initial cost of buildings, land, railroad spur, and storage tanks. The mill levy of 300 mills was applied to 10 percent of the assessed value.

^fEstimated at 2 percent of the initial building cost.

gross return of \$232.50/ton was used for both plants. When the \$200/ton seed cost was added to the total operating cost of processing, the cost/ton was \$275.19 and \$266.33/ton for the two solvent plants. If the gross income was \$232.30/ton, the net returns will be negative by \$42.90 and \$34.03/ton. In other words, these plants could only afford to pay \$157.10 and \$165.97/ton instead of the \$200.00 that was charged for whole sunflower seed to break even.

Summary of Plant Cost Analyses

A comparison, on a per-ton basis, for seven sizes of plants and two types of sunflower seed crushing plants is provided in Table 13. Some data in Table 13 were obtained from other studies. Income was adjusted so all studies would be comparable. The cost structure was based on 1981 data for the three

TABLE 12. OPERATING COST SUMMARY FOR PREPRESS-SOLVENT SUNFLOWER PLANTS
OPERATING 300 DAYS/YEAR, 1983

Item	Annual Income and/or Expense	Per Ton
100-ton plant:		
Gross income:		
Oil ^a	\$ 5,513,970	\$183.80
Meal ^b	1,454,880	48.50
Total gross income	6,968,850	232.30
Operating costs:		
Variable cost	1,626,065	54.20
Return over variable cost	5,342,785	178.09
Fixed cost	629,675	20.99
Return over variable and fixed cost	4,713,110	157.10
Sunflower seed ^c	6,000,000	200.00
Return over all costs	(1,286,890)	(42.90)
150-ton plant:		
Gross income:		
Oil ^a	8,270,955	183.80
Meal ^b	2,182,320	48.50
Total gross income	10,453,275	232.30
Operating costs:		
Variable cost	2,214,000	49.20
Return over variable cost	8,239,275	183.10
Fixed cost	770,635	17.13
Return over variable and fixed cost	7,468,640	165.97
Sunflower seed ^c	9,000,000	200.00
Return over all costs	\$(1,531,360)	\$(34.03)

^aThe plants were assumed to be 96.25 percent efficient. A ton of whole sunflower seed would yield .385 ton of oil. The average 1979-82 oil price was used. The average price was \$477.40/ton in eastern North Dakota.

^bA ton of whole sunflower seed processed was assumed to yield .56 ton of 28 percent meal. The average 1979-82 price/ton was estimated to be \$86.60 in North Dakota.

^cThe 1979-82 average price of sunflower seed was used. The average price/ton of seed was \$200.00.

smallest on-farm type plants and for the largest, 1,000 ton/day plant. All costs were adjusted to 1983. The three smallest plants--0.35, 1.67, and 5.0 ton/day--are of the sizes to be used directly on the farm. These small plants would only process nine hours/day for 300 days/year while the larger plants would process 24 hours/day for 300 days/year.

TABLE 13. COMPARISON OF PER TON COSTS AND RETURNS FOR SEVEN SIZES AND TWO TYPES OF SUNFLOWER SEED CRUSHING PLANTS IN NORTH DAKOTA, 1983

	Screw Press Plants						Prepress Solvent, Tons/Day		
	On-Farm Screw Press, Tons/Day .35 ^a	1.67 ^a	5.00 ^a	Full Hot Screw Press, Tons/Day 25 ^b	100 ^b	150 ^b	100 ^c	150 ^c	1,000 ^c
Tons of sunflower seed processed/year	105	501	1,500	7,500	30,000	45,000	30,000	45,000	300,000
Total investment	\$ 275.57	\$ 63.17	\$ 27.67	\$164.02	\$105.04	\$ 93.37	\$140.05	\$121.59	\$ 88.57
Number employed	1	1	1	13	17	18	24	25	46
Gross income									
Oil	\$ 128.97 ^d	\$130.81 ^d	\$136.34 ^d	\$167.09 ^e	\$167.09 ^e	\$167.09 ^e	\$183.80 ^e	\$183.80 ^e	\$183.80 ^e
Meal	45.37 ^f	45.09 ^f	44.25 ^f	51.09 ^g	51.09 ^g	51.09 ^g	48.50 ^g	48.50 ^g	48.50 ^g
Total gross income	\$ 174.34	\$175.90	\$180.59	\$218.18	\$218.18	\$218.18	\$232.30	\$232.30	\$232.30
Variable cost	\$ 92.19	\$ 33.43	\$ 14.16	\$ 61.53	\$ 41.83	\$ 38.95	\$ 54.20	\$ 49.20	\$ 17.95
Fixed cost	\$ 103.73	\$ 10.86	\$ 3.88	\$ 36.85	\$ 16.75	\$ 13.92	\$ 20.99	\$ 17.13	\$ 13.30
Total cost, not including seed	\$ 195.92	\$ 44.29	\$ 18.05	\$ 98.37	\$ 58.58	\$ 52.87	\$ 75.19	\$ 66.33	\$ 31.25
Seed cost	\$ 200.00	\$200.00	\$200.00	\$200.00	\$200.00	\$200.00	\$200.00	\$200.00	\$200.00
Total cost	\$ 395.92	\$244.29	\$218.05	\$298.37	\$258.58	\$252.87	\$275.19	\$266.33	\$231.25
Net return	\$(221.58)	\$(68.39)	\$(37.46)	\$(80.19)	\$(40.40)	\$(34.68)	\$(42.90)	\$(34.03)	\$ 1.05
Break-even price that can be paid for seed	--	\$131.61	\$162.55	\$119.80	\$159.60	\$165.31	\$157.10	\$165.97	\$201.05
Processing margin	\$(25.66)	\$(24.10)	\$(19.41)	\$ 18.18	\$ 18.18	\$ 18.18	\$ 32.30	\$ 32.30	\$ 32.30
Processing efficiency	70%	71%	74%	87.5%	87.5%	87.5%	96.25%	96.25%	96.25%

^aScrew press plant operating nine hours/day for 300 days/year.^bScrew press plant operating 24 hours/day for 300 days/year.^cScrew press-solvent plant operating 24 hours/day for 300 days/year.^dOil price of \$460.60/ton was used.^eOil price of \$477.40/ton was used.^fSunflower meal price of \$69.80/ton was used.^gSunflower meal price of \$86.60/ton was used.

Prices for oil and meal for the three smallest plants were discounted because the oil will not be filtered as thoroughly. Meal produced from these small units would contain up to 15 percent oil making it less desirable as a livestock supplement. Feeders would have to limit the quantities fed/animal unit.

Total tonnage of whole sunflower seed processed ranged from 105 tons to 300,000 tons in a 300-day processing year. Total investments ranged from \$27.67 to \$275.87/ton of crushing capacity.

Gross income varied from \$174.34/ton for the smallest plant to \$232.30 for the larger plants with net returns closely related to the operating efficiency of the plant. Plant efficiency varied from 70 to 96.25 percent. Oil made up from 74 to 79 percent of the total gross income, and sunflower meal comprised the remainder.

Total cost of processing, not including the seed cost, ranged from \$195.92 to \$18.05/ton of processing capacity. There was a wide variation among the plants as to the proportion of each cost to total costs. Variable costs ranged from 6 to 23 percent of the total costs, excluding seed. When the seed cost was included, the proportion of variable costs ranged from 73 to 98 percent of the total cost. The seed cost of \$200.00/ton ranged from 51 to 92 percent of the total cost.

All plants had a negative net return except the 1,000 ton/day plant, which had a return of \$1.05/ton. Costs included a return for all resources used in the processing of sunflower seed. The 1,000 ton/day unit had a processing margin (gross income minus sunflower seed cost) of \$32.30/ton. Plants smaller than 1,000 tons had a processing margin less than the cost of processing, which resulted in a negative net return. The negative returns ranged from \$221.58 to \$34.17/ton.

Summary

Primary objectives of this study were to develop investment and operating cost estimates for intermediate-sized sunflower processing plants. Two processing techniques were incorporated in the analyses for the intermediate-sized processing plants with all investment and operating costs estimated as influenced by the differential in processing techniques.

The variation in processing method resulted in developing five model intermediate-sized plants ranging from 25 to 150 tons/day. Detailed plant budgets were developed based on physical plant and equipment estimates secured from industry sources. Investment and operating costs for the intermediate-sized processing plants were compared to three units sized for on-farm processing and a commercial-sized processing plant of 1,000 tons/day.

Cost and revenue estimates clearly indicate intermediate-sized sunflower processing plants would not be economically feasible. Sunflower seed costs would need to range from 40 to 17 percent lower in price for these plants to realize a break-even level in operations. The small on-farm sized units were more pronounced in the level of negative net return realized in comparison to the various types of intermediate-sized processing plants. Net

return for the 1,000-ton, commercial-sized plant was positive; but very low at just slightly over a 1 percent rate of return on investment. Clearly, the estimated cost and return relationships were such that no new facilities would be planned given the low and/or negative rates of return.

APPENDIX

APPENDIX TABLE 1. BUILDING AND UNIT COSTS BY PLANT SIZE

	Straight Screw Press Tons/Day			Prepress-Solvent Tons/Day	
	25	100	150	100	150
Receiving elevator capacity in bushels	10,000	40,000	60,000	40,000	60,000
cost/bu.	\$ 9.67	\$ 9.51	\$ 9.40	\$ 9.51	\$ 9.40
Seed storage capacity in bushels	105,000	420,000	600,000	420,000	600,000
cost/bu.	\$ 0.78	\$ 0.78	\$ 0.78	\$ 0.78	\$ 0.78
Screw press processing square feet ^a	1,500	3,520	5,280	3,520	5,280
cost/sq. ft.	\$42.83	\$42.83	\$33.00	\$42.83	\$33.00
Boilerhouse, machine shop and storeroom square feet	1,390	2,010	2,700	2,010	2,700
cost/sq. ft.	\$21.69	\$21.69	\$21.69	\$21.69	\$21.69
Solvent processing sq. ft. ^b				74x31	74x31
				\$52.80	\$52.80
Office and lab. square feet	600	1,300	1,650	1,300	1,650
cost/sq. ft.	\$45.78	\$45.78	\$45.78	\$45.78	\$45.78
Oil storage gallons	42,045	168,180	257,678	185,000	277,500
cost/gallon	\$ 0.2863	\$ 0.2863	\$ 0.2863	\$ 0.2863	\$ 0.2863
Meal storage tons	165	649	1,029	616	924
cost/ton	\$59.49	\$59.49	\$59.49	\$59.49	\$59.49
Solvent storage gallons				40,500	40,500
cost/gallon				\$ 1.00	\$ 1.00
Fuel oil tank gallons	13,315	51,000	76,500	102,000	153,000
cost/gallon	\$ 0.2863	\$ 0.2863	\$ 0.2863	\$ 0.2863	\$ 0.2863
Land acres	3	4	4	6	9
cost/acre ^c	\$26,500	\$26,500	\$26,500	\$26,500	\$26,500
Railroad spur feet	250	333.3	333.3	333.3	375
cost/ft.	\$50.00	\$50.00	\$50.00	\$50.00	\$50.00

^aThe processing building is 30 feet high.

^bThe solvent processing building is 40 feet high.

^cThe per-acre cost also includes development costs of parking lots and drainage.

APPENDIX TABLE 2. ESTIMATED NUMBER OF WORKERS/PLANT BY TYPE OF WORK

Item	Straight Screw Press Tons/Day			Prepress-Solvent Tons/Day	
	25	100	150	100	150
Number of workers					
Manager	1	1	1	1	1
Assistant manager	3	3	3	3	3
Receiving elevator	1	2	2	2	2
Processing	5	6	7	12	14
Office	1	2	2	2	2
Lab. technician	1	1	1	1	1
Miscellaneous	1	2	2	3	2
Total	13	17	18	24	25
Annual wage/worker					
Manager	31,200	31,200	31,200	31,200	31,200
Assistant manager	23,400	23,400	23,400	23,400	23,400
Receiving elevator	14,560	14,560	14,560	14,560	14,560
Processing	14,560	14,560	14,560	14,560	14,560
Office	14,560	14,560	14,560	14,560	14,560
Lab. technician	14,560	14,560	14,560	14,560	14,560
Miscellaneous	23,400	23,400	23,400	23,400	23,400

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