Vegetable Oil Production: Industry Profile

Preliminary Final Report

Prepared for

Linda Chappell
U.S. Environmental Protection Agency
Air Quality Standards and Strategies Division
Office of Air Quality Planning and Standards
Innovative Strategies and Economics Group
MD-15
Research Triangle Park, NC 27711

Prepared by

Research Triangle Institute
Center for Economics Research
Research Triangle Park, NC 27709

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Prepared by

Mary K. Muth
Brooks M. Depro
Jean L. Domanico
Research Triangle Institute
Center for Economics Research
Research Triangle Park, NC 27709

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SECTION 1
INTRODUCTION

The U.S. Environmental Protection Agency's (EPA's) Office of Air Quality Planning and Standards (OAQPS) is compiling information on vegetable oil plants as part of its responsibility to develop National Emission Standards for Hazardous Air Pollutants (NESHAP) under Section 112 of the 1990 Clean Air Act. The NESHAP is scheduled to be proposed in 1999 and the Innovative Strategies and Economics Group is responsible for developing an economic impact analysis (EIA) in support of the evaluation of impacts associated with the regulatory options considered for this NESHAP.

This industry profile of the vegetable oil industry provides information to be used to support the EIA of the NESHAP. The vegetable oil industry includes the following SIC codes: SIC 2046—Wet Corn Milling, SIC 2075—Soybean Oil Mills, SIC 2074—Cottonseed Oil Mills, and SIC 2076—Vegetable Oil Mills, not elsewhere classified (N.E.C.). Of the facilities classified as wet corn mills (2046), only nine produce corn oil.[1] The facilities included in SIC 2076 process peanut, sunflower, canola (rapeseed), safflower, and other minor oilseeds.

Soybean oil processors comprise the largest share of the vegetable oil industry, producing about 75 percent of the domestic supply of vegetable oil. Vegetable oils are used almost entirely for human consumption, although small quantities are used for industrial purposes such as in paints, resins, and animal feeds.

According to the 1992 Census of Manufactures, the most recent year for which complete data are available, 221 establishments make up the industries in these four SIC codes.[2,3] In 1995, these industries employed 19,500 people and had a total value of industry shipments of $953 million.[4] About half of these establishments use a solvent extract process to produce vegetable oils. The others use a mechanical extraction process. However, data reported by the Bureau of the Census group both types of establishments together.

The establishments that use solvent extraction processes produce hexane emissions—one of two sources of air pollution for this industry. The other source, particulate emissions, is not the subject of the NESHAP. To produce crude vegetable oil, processors prepare the oilseeds for extraction and then extract the oil using the solvent hexane, which EPA lists as a hazardous air pollutant.[5]

This industry profile report is organized as follows. Section 2 includes a detailed description of the production process for vegetable oils, with discussions of individual oil products, oilseed inputs, and costs of production. Section 3 describes the characteristics, uses, and consumers of vegetable oils as well as substitution possibilities. Section 4 discusses the organization of the industry and provides facility-level and company-level data. In addition, small businesses are reported separately for use in evaluating the impact on small businesses to meet the requirements of the Small Business Regulatory Enforcement and Fairness Act (SBREFA). Section 5 contains market-level data on prices and quantities and discusses trends and projections for the industry. The information in this report will be used as background in developing the EIA methodologies.

SECTION 2
THE SUPPLY SIDE

In this section, the supply side of the vegetable oils industry is discussed. First, the production process is described, including inputs used in the production process and final outputs produced. Second, the types of products produced are described in more detail. Third, by-products and co-products of the production process are discussed as well as input substitution possibilities. Finally, data on costs of production and economies of scale are provided.

2.1 PRODUCTION PROCESS, INPUTS, AND OUTPUTS

The production process for vegetable oils is described, from receiving oilseeds to refining, in this section. Although the discussion concentrates on soybean oil, differences in the production process for the other major oilseeds are noted. In addition, this section describes oilseeds and hexane, two specialized inputs in the production of vegetable oil.

2.1.1 Production Process

Until the mid-1800s, vegetable oils were extracted from oil seeds through mechanical or hydraulic means.[6] Today, processors use solvent extraction as the primary method for producing vegetable oil.[7] The same basic process used for extracting soybean oil is used for extracting other types of vegetable oils. However, differences in the production processes for cottonseed, corn, and peanut oil are also noted.

Preparation of Soybeans for Solvent Extraction. Figure 2-1 illustrates the steps used to prepare soybeans for solvent extraction.[8] These steps include receiving and

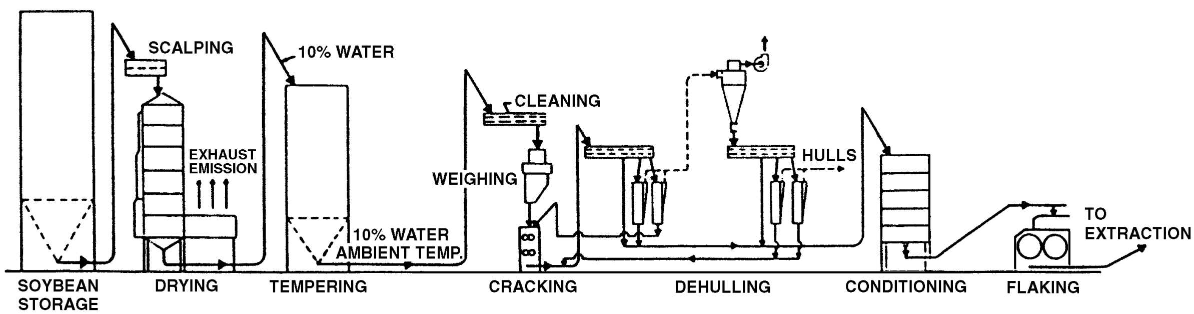

Figure 2-1. Conventional soybean preparation.

Source: Moore, N.M. Journal of American Oil Chemical Society. 60:190. 1983. Cited in Erickson, D.R. (ed.). Practical Handbook of Soybean Processing and Utilization. Chapter 6. 1983.

storing, cleaning, drying, tempering, cracking, dehulling, conditioning, flaking, and expanding. Each of these steps is described in more detail below.

Receiving and storing raw soybeans. Soybeans arrive at a facility by truck or rail and are sampled for moisture content, foreign matter, and damaged seeds. Then the beans are weighed and conveyed to concrete silos or metal tanks for storage until processing.

Cleaning or "scalping." At the time of processing, the beans are removed from storage and cleaned. Another term for cleaning is "scalping." Foreign materials are removed by screening, and loose hulls are removed by aspiration.[9]

Drying. When cleaning is complete, the beans are dried to reduce their moisture to 10 or 11 percent by weight.[10] Soybeans shipped in international trade or from storage elevators are typically 13 percent moisture. They are dried to this level to prevent heating in storage and shipment.[11]

Tempering. After drying, the beans are tempered for 2 to 3 days to allow the moisture to equilibrate and the hulls to loosen. Soybeans are generally cleaned again after drying using magnets, screens, and aspirators.[12]

Cracking. During the process of cracking, beans are passed through a series of corrugated rolls that are generally about 10 inches in diameter and 42 inches long. The purpose of cracking is to break the soybeans into pieces suitable to dehulling and flaking. Usually each bean is broken into four to six pieces. This is a very important step. Cracking should produce a minimum of fines, which can cause trouble with the extraction process, and no mashed beans, which adhere to hulls.[13]

Dehulling. The purpose of dehulling is to produce high protein meal for animal feed or flour for human consumption. Soybeans do not have to be dehulled for oil to be extracted. However, dehulling decreases the volume that passes through the extractor, thus increasing throughput. Beans are dehulled by screening and aspiration.[14] The removed hulls may be combined with hulls from the earlier cleaning steps and used in animal feed.[15]

Conditioning. Cracked soybeans, with or without hulls, are then transported to conditioners. These are vertical stack cookers or rotary horizontal cookers where the soybeans are heated and moistened to make them pliable enough to ensure proper flaking.[16]

Flaking. Conditioned soybeans are fed through large, smooth-surfaced rollers and emerge as flakes ranging in thickness from 0.2 mm (0.008 in) to 0.5 mm (0.02 in).[17]

Expanding. Although flaking has traditionally been the final step prior to extraction, expanders, which were introduced in the early 1980s, are now used by most domestic soybean and cottonseed processors.[18] Expanders mix flaked soybeans with water and steam and press them into pellets called "collets." Collets are denser and more porous than flakes. They allow more oil to be extracted from the soybeans and increase the throughput of the extractor. Collets also allow the solvent to drain more freely, decreasing the energy needed for desolventizing.[19]

Solvent Extraction Process for Soybeans. Figure 2-2 shows a flow diagram of the conventional solvent extraction process.[20] The process uses the solvent hexane to dissolve the oil present in the soybeans. The mixture of oil and hexane is

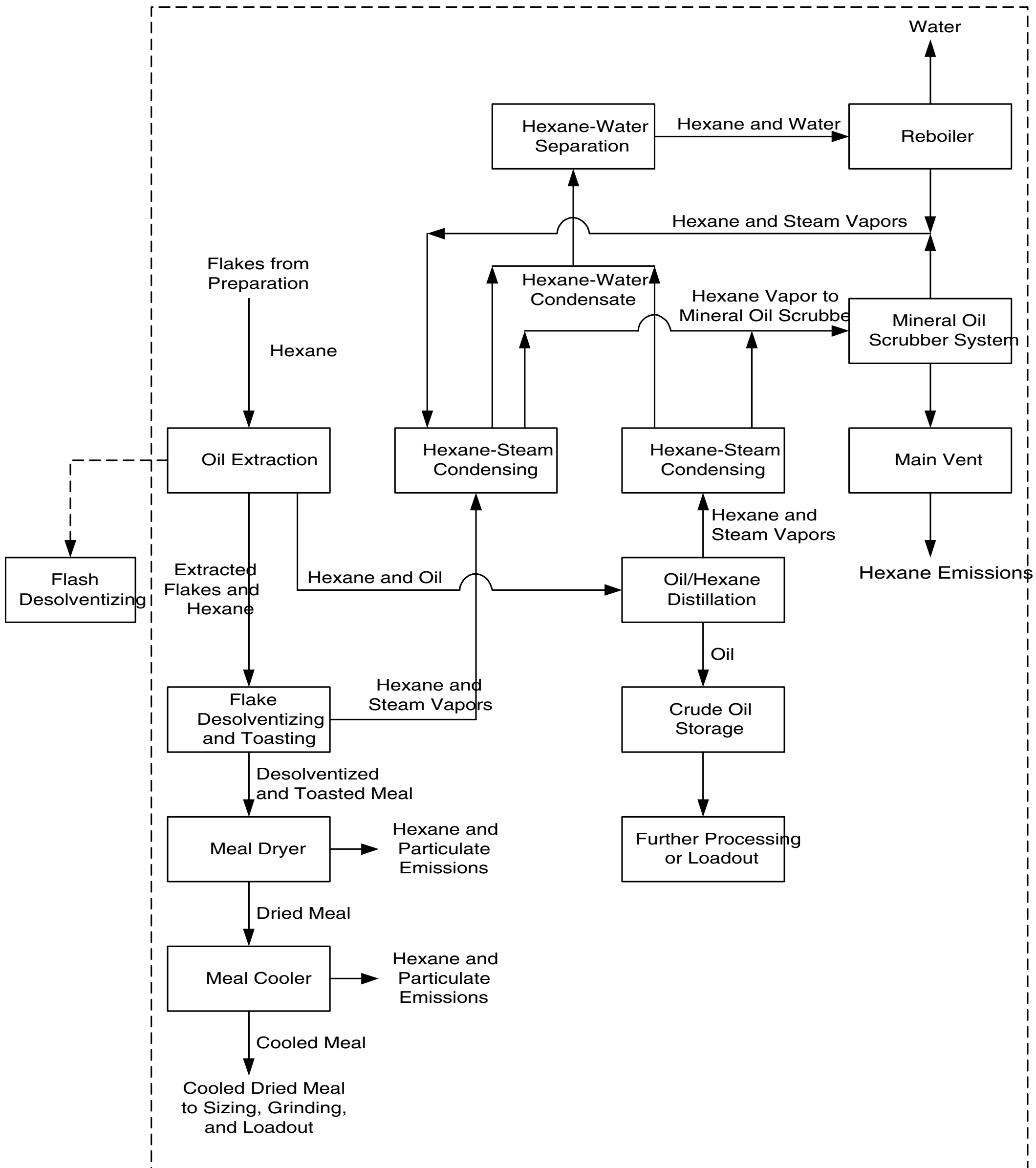

Figure 2-2. Flow diagram of the "conventional" solvent extraction process.

Source: Midwest Research Institute. Emission Factor Documentation for AP-42, Section 9.11.1. Vegetable Oil Processing. Prepared for the U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Emission Factor and Inventory Group. Cary, NC, Midwest Research Institute. November 1995.

called "miscella."[21] There are several different types of extractors, including rotary or deep-bed, horizontal belt, and continuous loop extractors. Some immerse the solids in the solvent, some percolate the solvent through the solids, and some use a combination of both immersion and percolation.[22] Rotary or deep-bed extractors have compartments or cells in which solids are washed with successively less concentrated miscella and finally with fresh solvent. At large facilities, these cells can be as deep as 5 meters, hence the name "deep-bed." Horizontal belt extractors convey solids through a series of solvent sprays. After percolating through the bed, the miscella is collected in a hopper below the conveyor. Continuous loop extractors are shallow-bed extractors that carry the solid material through an enclosed vertical loop. The solids go through both percolation and immersion, and are completely turned over, allowing the solvent to contact flakes from both sides.[23]

Solvent Recovery Process for Soybean Oil. The solvent recovery process is the separation of solvent from both oil and meal. Solvent leaves the extractor both in miscella and as residual on the defatted flakes. The process of removing solvent from each is described below as well as a discussion of solvent losses. Vapors from either of the desolventizing processes pass through the vapor recovery system previously described.

Removing solvent from miscella. Solvent is removed from the miscella by double-effect evaporation and steam stripping.

First, it passes through a long-tube vertical evaporator with a vapor dome. As the miscella passes through the tubes, it is heated, and 70 to 85 percent of the solvent evaporates. The second-stage evaporator, which further concentrates the miscella, is a rising film evaporator that operates under partial vacuum. Most remaining solvent is finally removed as the oil passes through an oil stripper where, under vacuum, it is exposed to steam and then an oil dryer. The crude oil then goes into storage to await refining.

Vapors pass through a condenser and a mineral oil absorption system, which removes solvent from the air before it is discharged. This system includes a packed absorption column, a packed steam-jacketed stripping column and heat exchangers.[24]

Removing solvent from spent soybean flakes. Defatted flakes generally contain 35 to 40 percent solvent that must be recovered before the flakes are used.[25] (Flakes that have been processed with expanders may contain as little as 25 percent residual hexane.[26]) If the flakes will be used for animal feed, they will undergo conventional desolventizing. If they will be used for human consumption, they will undergo flash desolventizing, which better preserves nutritional value.

Conventional desolventizing involves conveying the spent flakes through a desolventizer-toaster (DT), where they are toasted to about 100°C (212°F) and treated with both contact and noncontact steam to remove solvent.

Flash desolventized, which is used on less than 5 percent of soybeans processed, involves either processing flakes under vacuum with noncontact steam or passing them through a loop using superheated hexane. Flakes are then treated with small quantities of steam in a rotary or agitated vessel. The flakes produced by flash desolventizing are called "white flakes."

Solvent loss. Processing plants recover and reuse almost all solvent. Losses may occur, however, through leaks in equipment and process seals, and through retention by the meal and oil. Because of the nature of the processes, hexane losses from flash desolventizing tend to be higher than for conventional desolventizing.[27] Total solvent loss in a well-run plant can be as low as 0.5 kg of solvent per metric ton of beans processed (0.2 gal/short ton). About half of the loss usually comes from residual solvent that remains in the meal after desolventizing.[28] This loss occurs during meal drying and cooling, which are described below.

Further Processing of Meals and Oil. Following the desolventizing process, meals and oils are further processed for their respective end uses. These processes are described briefly below.

Meal drying and cooling. Meal that has undergone desolventizing-toasting is about 105°C (221°F) and contains 16 to 20 percent moisture. It must pass through drying and cooling units. In the drying unit, hot air is blown into the meal from below. Excessive heat and air velocity must be avoided to minimize the risk of fire and excessive dust. The same process is used for cooling, except the air used is at room temperature.[29]

During drying and cooling, the air removes some residual solvent from the meal in addition to dust. This air may be passed through a particulate control device before being released to the atmosphere. Once cooling and drying are complete, the meal is ground, sized, and shipped for further processing.

Further processing of crude oil. The oil produced by the extraction process is crude oil that contains proteinaceous material, free fatty acids, phosphatides, and other impurities that must be removed before the oil is used.[30] To remove these impurities, the oil must undergo degumming, refining, bleaching, and deodorizing. Each of these is described below.

Degumming. Sometimes processors “degum” crude oil to remove phosphatides, or vegetable gums. This process prepares the oil for long-term storage, transport, or further refining and also produces lecithin, a food additive. Processors degum crude oil by mixing it with water, then they put it through settling or centrifugation to separate the gum.[31]

Caustic refining. The most common process for refining vegetable oils is caustic refining. Oil may or may not be degummed prior to caustic refining. Caustic refining involves mixing the oil with an aqueous alkali solution. The alkali neutralizes the free fatty acids, creating "soapstock." The soapstock then adsorbs colors and precipitates gums and proteinaceous materials. Soapstock is removed by settling or centrifugation. The oil is then washed with water to remove residual soap.[32]

Physical refining. Physical refining, an alternative to caustic refining for some oils, is a steam-stripping process whereby steam is injected into the oil under low pressure and high temperature, thus vaporizing impurities. Although this process is feasible with palm oil, it is currently infeasible for processing soybeans because of problems with flavor stability. This method has received attention from researchers because it has the advantage of not producing soapstock, a waste product that may create water pollution problems.[33]

Bleaching. The purpose of bleaching is to reduce or remove the following: pigments, oxidation products, phosphatides, soaps, and trace metals. Bleaching also improves the flavor of the oil. The products used for soybean bleaching are neutral earth, acid-activated earths, activated carbon, and silicates. Diatomaceous earth or another inert material may also be used to aid filtering. The process involves mixing the oil with the earth, heating the mixture, then filtering.[34]

Deodorizing. Deodorizing is the final step in refining. Steam is injected through the oil under low pressure and high temperature, removing any off-flavors or odors.[35]

<u>Processing of Other Vegetable Oils</u>. As previously mentioned, the processes for producing other types of vegetable oils are similar to that for soybean oil. Differences are noted here.

Cottonseed Oil:

- Differences in Preparation: Cottonseeds used for oil come from cotton gins where the seeds are separated from the fibers. They must undergo an additional cleaning step called "delinting" where they pass through a series of cylindrical saws to remove any remaining cotton fiber from the seeds.

- Differences in Extraction Process: Some cottonseed processing plants use prepressing for initial oil extraction. A mechanical screw-press, which exerts up to 2,000 pounds of pressure per square inch, removes some of the oil. The remaining oil is removed through solvent extraction.

- Difference in Plant Size: Soybean crushing plants are generally larger than cottonseed crushing plants.

Corn Oil:

- Differences in Preparation: Corn oil is concentrated in the germ, which can be separated from the hull by either wet milling (used to produce starch and corn oil) or dry milling (used to make grits, meal, and flour).[36] Wet milling involves soaking the kernels in warm water with a small amount of acid. Then the wet corn is ground into a slurry and passed through germ separators. Here the germ is separated, washed to remove starch, and dried.[37]

- Differences in Extraction Process: Corn oil processors remove about 80 percent of the oil from the germ by prepressing and use solvent extraction to remove the rest.

Peanut Oil:

- Differences in Extraction Process: Prepressing removes about 50 percent of the oil from peanuts. Solvent extraction removes the rest.

2.1.2 Inputs

The primary inputs to vegetable oil processing are the specialized inputs, oilseeds and hexane, and the nonspecialized inputs, labor, capital, and energy. In this section, each specialized input is described.

Oilseeds. Oilseeds are the primary input in the production of vegetable oils. Domestically produced oilseeds include soybean, corn, cottonseed, peanut, sunflower, safflower, and canola (rapeseed). Because oilseeds are agricultural products, their supply is determined by many factors, including weather, disease, costs of agricultural chemicals, prices of commodities, and government programs. In particular, corn, soybean, and cotton production have been affected by government programs. However, in the future, government programs will play a less significant role in determining the supply of agricultural products. The

1995-1996 growing season was the last to be regulated under the 1990 Food, Agriculture, Conservation and Trade Act. This Act contained numerous provisions intended to stabilize farm income and regulate supply through acreage restrictions and payments to farmers. The Federal Agricultural Improvement and Reform Act of 1996 (also called the 1996 Farm Bill) legislates major changes in federal agricultural programs. It provides for a 7-year transition period of declining government involvement in agriculture and payments to farmers that are decoupled from production volumes.[38] Thus, in the future, farm programs will no longer affect the price or production of any of the oilseeds.

Hexane. Hexane is the solvent used commercially to extract vegetable oils. It is not pure hexane but is a petroleum fraction that is a mixture of 6-carbon-atom saturated hydrocarbons. The components of extraction-grade hexane vary depending on suppliers. It will typically consist of from 50 percent to 90 percent *n*-hexane by volume. It may also contain isohexane and methylcyclopentane. The boiling point is critical and may range between 65 and 70°C (149 to 158°F). Impurities such as sulfur, benzene, and other aromatic compounds must be avoided in hexane used for extraction because they may cause odors or toxicity.

Scientists have explored the possibility of alternative solvents for vegetable oil extraction. A desirable solvent would have the following characteristics: plentiful supply, low toxicity, nonflammability, high solvency power, ease of separation from extracted material, desirable boiling point, low specific heat, low latent heat of vaporization, and high stability. The disadvantages of hexane are its flammability and dependence on the supply of petroleum. Because of hexane's flammability, processing plants must have very high safety standards. Researchers have considered aqueous or supercritical carbon dioxide extraction for vegetable oils. This method has not yet been shown to be feasible and would not be adaptable to existing plants without major capital expenditures.[39] At present, hexane is the best solvent available to vegetable oil processors.

2.2 TYPES OF PRODUCTS AND SERVICES

The major domestic oil crops include soy, corn, cottonseed, peanut, and sunflower. The minor oil crops include canola, flax seed, mustard, canola (rapeseed), and safflower.[40] The following section describes each of the three most significant oils: soybean, corn, and cottonseed.

2.2.1 Soybean Oil

Soybean oil makes up over 75 percent of the edible fats and oils consumed in the United States.[41] It also has an number of industrial uses. Several characteristics make soybean oil desirable. It has a high level of unsaturated fat, it remains liquid over a wide temperature range, it can be partially hydrogenated, it can be readily refined, and it contains naturally occurring antioxidants. It has two disadvantages:

- It has a relatively high content of phosphatides that must be removed in processing.
- Its high polyunsaturated fatty acid content makes it susceptible to oxidation and flavor changes.

Salad oil, cooking oils, and frying fats can be made from pure soybean oil. Semisolid shortenings can contain mostly partially hydrogenated soybean oil with small amounts of completely hydrogenated palm or cottonseed oil. Soybean oil is the primary oil used in the manufacture of margarine.

2.2.2 Corn Oil

Corn oil is a very high quality oil because of its high polyunsaturated fatty acid content and its low linolenic acid content. Production of corn oil has increased recently because of increased demand for other corn products that are produced jointly with corn oil. These include ethanol for the fuel market and high-fructose corn syrup.[42]

2.2.3 Cottonseed Oil

Cottonseed oil is higher in saturated fats than soybean oil but has a very low linolenic acid content. Cottonseed oil has become popular because of its functionality and flavor. Acreage of cotton has remained stable in the United States, while the demand for whole cotton seeds as a dairy feed and oil seed has increased. The increased domestic demand has caused a decrease in exports.[43]

2.3 MAJOR BY-PRODUCTS, CO-PRODUCTS, AND SUBSTITUTION POSSIBILITIES

A number of other commodities, such as cake or meal, hulls, and linters, are produced jointly with vegetable oil. In the case of corn oil, joint products also include corn starch; corn sweeteners, including high-fructose corn syrup; corn gluten feed; and corn gluten meal. By-products of the degumming and refining processes also include lecithin, soapstocks, deodorizing distillates, and spent bleaching earth.[44]

2.3.1 Cake and Meal

Cake or meal is the residue left after the oil is extracted from a seed, nut, or kernel. Most cake or meal is used in high-protein animal feeds. Small amounts of soybean meal (about 2 percent) are used for human consumption.[45]

2.3.2 Hulls

Hulls are the outer covering of soybeans and oilseeds. Hulls are removed from cottonseeds, sunflower seed, peanuts, and soybeans, but not from canola prior to extracting oil. They are used primarily in animal feeds.

2.3.3 Linters

Linters are the short fibers that adhere to cottonseeds and must be removed prior to processing. These fibers have commercial value.

2.3.4 Lecithin

Lecithin is a mixed phosphatide product that results from the degumming process. Food processors use it as a wetting and dispersing agent, an emulsifier, and an antioxidant. Lecithin also has many uses in pharmaceuticals, cosmetics, animal feeds, and other industries.[46] The supply of lecithin is two to three times greater than the demand. To dispose of excess lecithin, processors may add it to the meal or dispose of it in the soapstock.[47]

2.3.5 Soapstock

Soapstock, a by-product of the caustic refining process, has commercial value in animal feed and in the manufacture of soap and other chemicals. In 1992 the National Oilseed Processors Association changed the name from soapstock to refining by-product lipid to better reflect the product's use as an animal feed.[48]

2.3.6 Deodorizing Distillates

Deodorizing distillates contain tocopherols and sterols, both of which have commercial value. Tocopherols are used to manufacture vitamin E and other antioxidants. The pharmaceutical industry uses sterols in the production of many drugs including hormones and steroids.[49]

2.3.7 Spent Bleaching Earth

Spent bleaching earth, which is a mixture of clay and oil, must be handled with care because it is flammable. Processors can add it to animal feed, and the oil adds calories and the clay reduces caking. It can also be burned as a fuel, mixed with organic materials and composted, or disposed of in a landfill after treatment with water to reduce flammability.[50]

Table 2-1 contains the dollar values for vegetable oil and major co-products for corn, soybeans, cottonseed, and peanuts.[51,52] With the exception of peanut oil, the value of other products exceeds the value of the oil.

TABLE 2-1. VALUE AND PERCENTAGES OF PRODUCTS AND BY-PRODUCTS FOR SOYBEANS, CORN, COTTONSEED, AND PEANUTS: 1992

	Value ($$10^6$)	Percent
Soybeans		
Oil	$2,479.90	27.7%
Cake and meal	$5,024.00	56.1%
Lecithin	$41.60	0.5%
Hulls	$119.40	1.3%
Other	$1,286.80	14.4%
Total	$8,951.70	100.0%
Corn		
Oil	$801.60	12.5%
Sweeteners	$2,911.00	45.4%
Starch	$1,305.50	20.3%
Other, including gluten	$1,397.50	21.8%
Total	$6,415.50	100.0%
Cottonseed		
Oil	$286.00	38.8%
Linters	$56.30	7.6%
Cake, meal, hulls and other	$394.40	53.5%
Total	$736.70	100.0%
Peanuts		
Oil	$96.60	
Cake and meal	$28.20	
(Total and percents not available)		

Source: U.S. Department of Commerce, Bureau of the Census. 1992 Census of Manufactures, Industry Series—Fats and Oils. MC92-I-20G. Washington, DC, Government Printing Office. 1995.

U.S. Department of Commerce, Bureau of the Census. 1992 Census of Manufactures, Industry Series—Grain Mill Products. MC92-1-20D. Washington, DC, Government Printing Office. 1995.

2.4 COSTS OF PRODUCTION

Oilseed processing facilities are considered to be "commodity businesses." They are market-driven, low-margin, high-volume operations that produce a generic product from a widely available raw material.[53]

Table 2-2 contains aggregate information on costs for the vegetable oil industry by SIC code.[54,55] It includes costs for payroll, materials, and new capital expenditures, as well as value of shipments.

Material costs include five components:

- parts used in the manufacture of finished goods (materials, parts, containers, and supplies incorporated into products or directly consumed in the process);
- purchased items later resold without further manufacture;
- fuels;
- electricity;
- commissions or fees to outside parties for contract manufacturing.[56]

For comparison, costs are listed in both current and 1992 dollars.

Table 2-3 presents average hourly earnings, value added per production worker hour, and payroll and materials as a percentage of value of shipments.[57,58,59,60,61] In 1995, materials

TABLE 2-2. LABOR, MATERIAL, AND NEW CAPITAL EXPENDITURE COSTS BY SIC FOR VEGETABLE OILS: 1977, 1982, 1987, 1992-1995

		Payroll ($$10^6$)		Cost of Materials ($$10^6$)		New Capital Expenditures ($$10^6$)		Value of Shipments ($$10^6$)	
Industry	Year	Current $	1992$[a]	Current $	1992$[a]	Current $	1992$[a]	Current $	1992$[a]
SIC 2046—Wet Corn Milling	1977	191.10	$345.10	$1,338.00	$2,416.23	$232.20	$419.32	$2,014.80	$3,638.44
	1982	254.70	$298.51	$2,101.00	$2,462.37	$326.20	$382.31	$3,268.40	$3,830.56
	1987	298.90	$340.77	$2,694.40	$3,071.83	$281.90	$321.39	$4,788.90	$5,459.72
	1992	371.30	$371.30	$3,742.30	$3,742.30	$409.20	$409.20	$7,045.20	$7,045.20
	1993	364.40	$359.19	$3,644.30	$3,592.19	$441.90	$435.58	$6,886.20	$6,787.74
	1994	372.80	$362.89	$4,426.50	$4,308.85	$546.42	$531.90	$7,623.20	$7,420.59
	1995	393.10	$369.46	$4,507.10	$4,236.02	$774.50	$727.92	$8,532.50	$8,019.32
SIC 2074—Cottonseed Oil	1977	51.50	$93.00	$670.80	$1,211.37	$13.00	$23.48	$859.20	$1,551.59
	1982	76.20	$89.31	$715.00	$837.98	$59.60	$69.85	$933.30	$1,093.83
	1987	44.80	$51.08	$378.80	$431.86	$12.20	$13.91	$470.70	$536.63
	1992	49.60	$49.60	$510.80	$510.80	$12.00	$12.00	$737.80	$737.80
	1993	48.80	$48.10	$529.50	$521.93	$21.80	$21.49	$743.70	$733.07
	1994	52.50	$51.10	$614.30	$597.97	$69.80	$67.94	$803.80	$782.44
	1995	50.50	$47.46	$616.60	$579.51	$12.20	$11.47	$835.70	$785.44

(continued)

TABLE 2-2. LABOR, MATERIAL, AND NEW CAPITAL EXPENDITURE COSTS BY SIC FOR VEGETABLE OILS: 1977, 1982, 1987, 1992-1995 (CONTINUED)

		Payroll ($$10^6$)		Cost of Materials ($$10^6$)		New Capital Expenditures ($$10^6$)		Value of Shipments ($$10^6$)	
Industry	Year	Current $	1992$[a]	Current $	1992$[a]	Current $	1992$[a]	Current $	1992$[a]
SIC 2075—Soybean Oil	1977	130.70	$236.03	$7,012.80	$12,664.10	$72.30	$130.56	$7,580.00	$13,688.38
	1982	188.70	$221.16	$7,896.80	$9,255.05	$113.40	$132.90	$8,603.60	$10,083.42
	1987	172.50	$196.66	$8,103.30	$9,238.39	$90.70	$103.41	$9,074.10	$10,345.18
	1992	225.30	$225.30	$9,372.50	$9,372.50	$123.20	$123.20	$10,650.60	$10,650.60
	1993	230.70	$227.40	$10,153.00	$10,007.84	$146.70	$144.60	$11,705.00	$11,537.65
	1994	239.80	$233.43	$10,605.90	$10,324.02	$137.00	$133.36	$12,496.20	$12,164.08
	1995	242.80	$228.20	$11,272.30	$10,594.33	$161.70	$151.97	$13,275.50	$12,477.05
SIC 2076—Other Vegetable Oils	1977	17.60	$31.78	$304.70	$550.24	$7.40	$13.36	$360.80	$651.55
	1982	22.30	$26.14	$467.00	$547.32	$66.90	$78.41	$556.90	$652.69
	1987	19.90	$22.69	$353.30	$402.79	$4.90	$5.59	$431.50	$491.94
	1992	26.20	$26.20	$532.30	$532.30	$10.40	$10.40	$666.20	$666.20
	1993	27.50	$27.11	$603.80	$595.17	$8.10	$7.98	$721.10	$710.79
	1994	24.20	$23.56	$522.70	$508.81	$6.00	$5.84	$630.00	$613.26
	1995	24.70	$23.21	$591.90	$556.30	$4.60	$4.32	$721.70	$678.29

[a] Dollars adjusted to 1992 using producer price index for all commodities.

Sources: U.S. Department of Commerce, Bureau of the Census. 1992 Census of Manufactures, Industry Series—Fats and Oils. MC92-I-20G. Washington, DC, Government Printing Office. 1995.
U.S. Department of Commerce, Bureau of the Census. 1992 Census of Manufactures, Industry Series—Grain Mill Products. MC92-I-20D. Washington, DC, Government Printing Office. 1995.

TABLE 2-3. AVERAGE HOURLY EARNINGS, VALUE ADDED PER PRODUCTION WORKER HOUR AND LABOR AND MATERIAL COSTS RELATIVE TO VALUE OF SHIPMENTS BY SIC FOR VEGETABLE OILS: 1977, 1982, 1987, 1992-1995

		Production Workers' Average Hourly Earnings		Value Added Per Production Worker Hour			
Industry	Year	Current $	1992$[a]	Current $	1992$[a]	Payroll Costs as a Percent of Value of Shipments (%)	Materials Costs as a Percent of Value of Shipments (%)
SIC 2046—Wet Corn Milling	1977	$8.42	$15.21	$42.46	$76.68	9.5%	66.4%
	1982	$12.36	$14.49	$83.87	$98.30	7.8%	64.3%
	1987	$14.95	$17.04	$160.81	$183.34	6.2%	56.3%
	1992	$15.90	$15.90	$221.60	$221.60	5.3%	53.1%
	1993	$16.41	$16.18	$234.70	$231.34	5.3%	52.9%
	1994	$16.60	$16.16	$230.90	$224.76	4.9%	58.1%
	1995	$17.14	$16.11	$280.80	$263.91	4.6%	52.8%
SIC 2074—Cottonseed Oil	1977	$3.86	$6.97	$21.23	$38.34	6.0%	78.1%
	1982	$5.62	$6.59	$20.92	$24.52	8.2%	76.6%
	1987	$6.62	$7.55	$23.76	$27.09	9.5%	80.5%
	1992	$7.88	$7.88	$49.16	$49.16	6.7%	69.2%
	1993	$8.26	$8.14	$52.34	$51.59	6.6%	71.2%
	1994	$7.77	$7.56	$45.70	$44.49	6.5%	76.4%
	1995	$8.14	$7.65	$48.07	$45.18	6.0%	73.8%

(continued)

TABLE 2-3. AVERAGE HOURLY EARNINGS, VALUE ADDED PER PRODUCTION WORKER HOUR AND LABOR AND MATERIAL COSTS RELATIVE TO VALUE OF SHIPMENTS BY SIC FOR VEGETABLE OILS: 1977, 1982, 1987, 1992-1995 (CONTINUED)

		Production Workers' Average Hourly Earnings		Value Added Per Production Worker Hour		Payroll Costs as a Percent of Value of Shipments (%)	Materials Costs as a Percent of Value of Shipments (%)
Industry	Year	Current $	1992$[a]	Current $	1992$[a]		
SIC 2075—Soybean Oil	1977	$5.97	$10.78	$25.43	$45.92	1.7%	92.5%
	1982	$9.19	$10.77	$50.61	$59.31	2.2%	91.8%
	1987	$11.11	$12.67	$100.15	$114.18	1.9%	89.3%
	1992	$12.89	$12.89	$114.76	$114.76	2.1%	88.0%
	1993	$12.82	$12.64	$137.25	$135.29	2.0%	86.7%
	1994	$13.33	$12.98	$166.44	$162.02	1.9%	84.9%
	1995	$13.40	$12.59	$188.00	$176.69	1.8%	84.9%
SIC 2076—Other Vegetable Oils	1977	$4.88	$8.81	$23.36	$42.18	4.9%	84.5%
	1982	$8.22	$9.63	$44.44	$52.08	4.0%	83.9%
	1987	$10.36	$11.81	$75.18	$85.71	4.6%	81.9%
	1992	$12.67	$12.67	$111.50	$111.50	3.9%	79.9%
	1993	$11.79	$11.62	$99.86	$98.43	3.8%	83.7%
	1994	$12.36	$12.03	$73.36	$71.41	3.8%	83.0%
	1995	$12.45	$11.70	$112.27	$105.52	3.4%	82.0%

[a] Dollars adjusted to 1992 using producer price index for all commodities.

Sources: U.S. Department of Commerce, Bureau of the Census. 1992 Census of Manufactures, Industry Series—Fats and Oils. MC92-I-20G. Washington, DC, Government Printing Office. 1995.
U.S. Department of Commerce, Bureau of the Census. 1992 Census of Manufactures, Industry Series—Grain Mill Products. MC92-1-20D. Washington, DC, Government Printing Office. 1995.
U.S. Department of Commerce. Bureau of the Census. 1994 Annual Survey of Manufactures, Statistics for Industry Groups and Industries. M94(AS)-1. Washington, DC, Government Printing Office. 1996.
U.S. Department of Commerce. Bureau of the Census. 1995 Annual Survey of Manufactures, Statistics for Industry Groups and Industries. M95(AS)-1. Washington, DC, Government Printing Office. 1997.
U.S. Department of Labor, Bureau of Labor Statistics. BLS LABSTAT database. <http://www.bls.gov>. 1997.

costs as a percentage of value of shipments ranged from 52.8 percent for wet corn millers to 84.9 percent for soybean oil producers. (Not all wet corn milling facilities produce corn oil. As of 1996, it is estimated that nine corn mills were engaged in corn oil production using solvent extraction.[62] Payroll costs in the vegetable oil industry are fairly small relative to value of shipments. In 1995, cottonseed oil producers and wet corn millers had the highest payroll costs relative to value of shipments (6.0 percent and 4.6 percent) and soybean oil producers had the lowest (1.8 percent).

Soybean crushing plants with daily crushing capacities between 1,000 and 3,000 metric tons per day have capital installation costs ranging from $22,500 to $33,000 per metric ton[*] of daily capacity, with an average of $27,500. Differences can be attributed to site conditions, building design, extent of automation, amount of storage, type of shipping and receiving, and availability of utilities and waste treatment. Capital costs per ton are higher for smaller plants and lower for larger plants.[63]

As indicated in Figure 2-3, operating expenses for soybean-crushing plants average about $16.50 per metric ton, ranging from $14.75 for the largest plants to $22.10 for the

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[*]A metric ton is equal to 2.2046 short tons.

smallest.[64] Operating expenses vary across plants because of differences in capacity and process design.[65,*]

*The source of this information was published in 1995. The year for which the dollars are reported is not given. Dollar amounts most likely refer to the early 1990s.

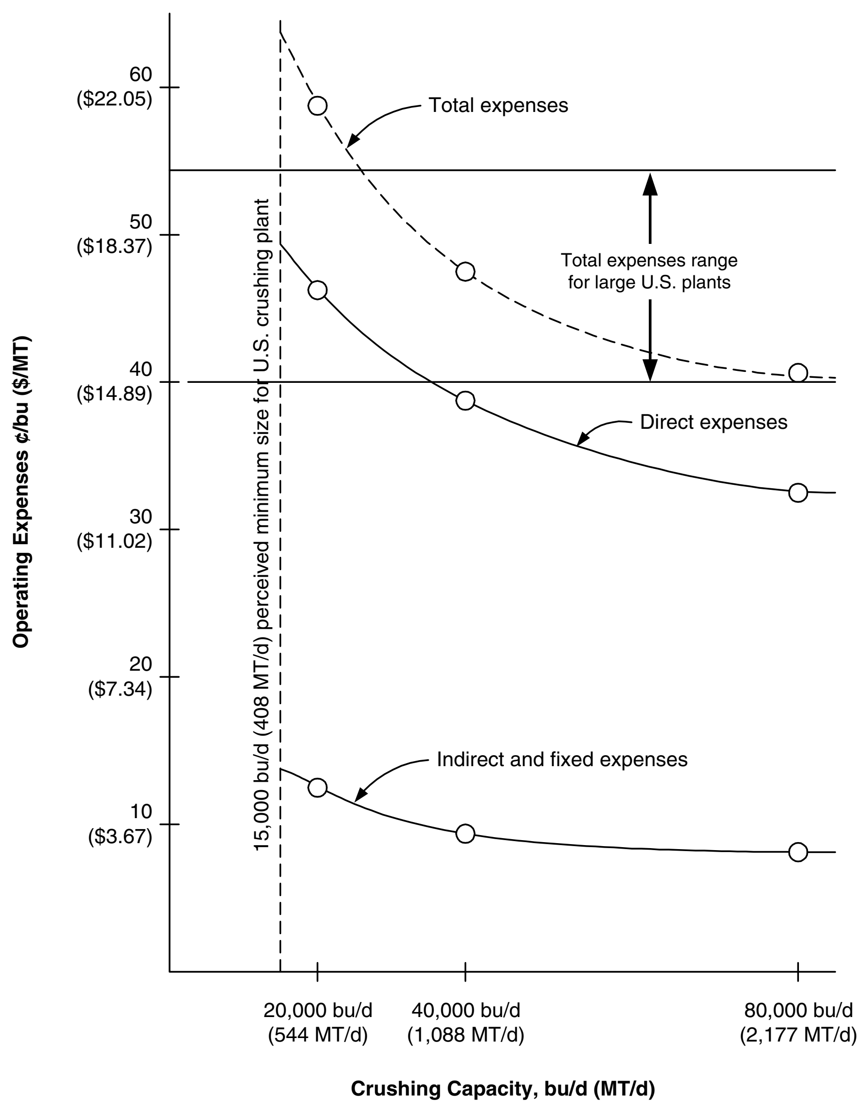

Figure 2-3. Soybean-crushing plant operating expenses vs. plant size.

Source: Erickson, David R., ed. Practical Handbook of Soybean Processing and Utilization. Champaign, IL, AOCS Press and St. Louis, MO, United Soybean Board. 1995.

SECTION 3

THE DEMAND SIDE

In this section, the demand side of the vegetable oil industry is described. First, the functional and nutritional characteristics of vegetable oils that consumers consider to be desirable are described. Next, the consumers are described as well as the uses of vegetable oils. Finally, the elasticities of demand for vegetable oils are provided, and substitution possibilities are described.

3.1 PRODUCT CHARACTERISTICS

Oil purchasing agents normally buy oils in accordance with the specifications adopted by the National Oilseed Processors Association or the American Oilseed Association. These specifications require the oil to have a bland flavor and no odor and to meet many other specific criteria for physical characteristics and chemical composition.[66] According to Monoj Gupta, principal scientist at Frito-Lay, Inc. "When selecting an oil, we first look for the flavor of the product, then aftertaste, aroma, consumer acceptance and shelf life stability."[67]

The factors that influence the food processor’s or consumer’s choice of vegetable oil can be grouped into two categories:

- Functional characteristics and
- Perceptions about health effects.

This section describes the functional characteristics of vegetable oils required by consumers and food processors and the current thinking on the health effects of various fats and oils.

3.1.1 Functional Characteristics

Functional characteristics determine how suitable a fat or oil is for a particular purpose. Important functional characteristics of fats and oils are melting behavior, crystal structure, resistance to oxidation, and flavor.

Melting Behavior. Melting behavior is the temperature at which and the speed with which a fat or oil becomes liquid. The desired melting behavior varies depending on the intended use for the fat or oil. For example, in the production of margarine, processors require a fat that is soft at room temperature and melts quickly at body temperature. Bakers prefer shortening that has a high melting point for good baking performance. Salad oils must be completely liquid at room temperature.[68]

Crystal Structure. The crystal structure of a fat or oil determines its texture. The appropriate crystal structure is especially important in margarine for creating a desirable "mouthfeel" and in shortening for providing texture and volume to baked goods. Crystal structure is not as important in frying shortenings and salad oils.[69]

Resistance to Oxidation. Oxidation causes rancidity and off-flavors and must be avoided in all uses of vegetable fats and oils. This factor is especially important in frying shortenings that must be stable at high temperatures and in salad oils where flavor is very important.[70] High levels of linolenic acid make vegetable oils more likely to oxidize. Hydrogenation increases resistance to oxidation. Oils with high levels of linolenic acid may require hydrogenation to improve stability. Scientists have bred new varieties of soybeans that yield oil with improved characteristics, such as lower levels of linolenic acid.[71]

Flavor. In general, it is desirable for vegetable oils to have little or no flavor, no odor, and no aftertaste. Flavors and odors are removed during the refining, bleaching, and deodorizing processes described in Section 2.[72]

3.1.2 Perceptions About Health Effects

Since the 1960s, dietary fat has been implicated as a cause of heart disease. As scientists continue to learn about the effects of various types of fats, specific dietary recommendations change. The following is a summary of current beliefs about the health affects of various fats and oils and how these beliefs affect consumption of vegetable oils.

Reduce Total Dietary Intake of All Fats and Oils. Scientists agree on this point, but consumers do not appear to be modifying their behavior significantly as a result. Table 3-1 presents the per-capita consumption of fats and oils in the United States from 1975 to 1995.[73] Per-capita

TABLE 3-1. PER-CAPITA CONSUMPTION OF OILS AND FATS IN THE U.S. (LBS.): 1975-1995

Year[a]	Butter	Lard	Edible Tallow	Margarine	Baking or Frying Fats	Salad or Cooking Oils	Other	Total
1975	4.7	3.2	NA	11.1	17.0	17.9	2.0	52.3
1976	4.3	2.9	NA	12.0	17.8	19.5	2.0	54.9
1977	4.3	2.5	NA	11.5	17.3	19.1	1.9	53.1
1978	4.4	2.4	NA	11.4	17.9	20.1	2.0	54.7
1979	4.5	2.5	0.4	11.3	18.5	20.8	1.7	56.5
1980	4.5	2.6	1.1	11.4	18.2	21.2	1.5	57.3
1981	4.2	2.5	1.0	11.3	18.5	21.8	1.4	57.5
1982	4.3	2.5	1.3	11.1	18.6	21.9	1.6	58.2
1983	4.9	2.1	2.1	10.4	18.5	23.6	1.5	60.3
1984	4.9	2.1	1.7	10.5	21.3	19.8	1.7	58.7
1985	4.9	1.8	1.9	10.9	23.0	23.5	1.6	64.1
1986	4.6	1.7	1.8	11.5	22.2	24.2	1.7	64.2
1987	4.7	1.8	1.9	10.2	21.5	25.4	1.3	62.2
1988	4.5	1.8	0.8	10.4	21.6	25.8	1.3	62.1
1989	4.4	1.8	0.9	10.6	21.5	24.0	1.3	61.1
1990	4.4	1.9	1.2	10.9	22.3	24.2	1.2	62.9
1991	4.4	1.7	1.4	10.7	22.4	25.2	1.3	64.0
1992	4.4	1.7	2.4	11.0	22.4	25.6	1.4	65.8
1993	4.7	1.7	2.2	11.2	25.2	25.1	1.8	68.6
1994	4.8	2.3	2.8	10.0	24.2	24.4	1.6	67.2
1995	4.5	2.2	2.7	9.3	23.0	24.7	1.6	65.3

[a] Calendar year data.

consumption increased nearly 25 percent during that time, from 52.3 pounds to 65.3 pounds. The increase can be attributed entirely to increased consumption of vegetable oils in the form of baking or frying fats and salad or cooking oils. However, Americans decreased their total consumption of fats and oils slightly (about 5 percent) between 1993 and 1995.[74]

Reduce Consumption of Saturated Fats. Researchers recommend that Americans should reduce the amount of saturated fat consumed. Research has shown that saturated fat, not dietary cholesterol, is the major contributor to elevated blood cholesterol levels.[75] Since domestically produced vegetable oils contain relatively less saturated fat, this information may explain why Americans have increased their consumption of vegetable oils relative to animal fats.

Substitute Monounsaturated Fats for Saturated Fats. While there is currently no consensus, many researchers believe that substituting monounsaturated fats for saturated fats is beneficial. Studies suggest that monounsaturated fats can lower blood cholesterol, especially the harmful or LDL type (low-density lipoproteins) while protecting the good or HDL type (high-density lipoproteins).

The relative amounts of monounsaturated, polyunsaturated, and saturated fats vary by the type of fat or oil. Coconut oil has the highest percentage of saturated fat (92 percent), followed by palm kernel oil (86 percent), and butter (66 percent). Of the domestically produced vegetable oils, cottonseed oil has the highest percentage of saturated fat (26 percent), followed by peanut oil (18 percent), soybean oil (15 percent), and corn oil (13 percent). Canola oil, at 6 percent, has the lowest percentage of saturated fat. Olive oil has the highest percentage of monounsaturated fat (77 percent), followed by canola (62 percent) and peanut oil (49 percent).[76,77] Consumers have responded to this information with extremely strong demand for "healthy" oils. Consumption of canola oil has been increasing steadily.[78] Demand for olive oil has remained strong in spite of very high prices, while consumption of palm oil has declined.[79]

Avoid Trans Fatty Acids. Trans fatty acids are created during the process of hydrogenation and are present in hydrogenated vegetable oils. Scientists believe that they may increase the risk of cardiovascular disease.[80] When listed on a food label, the term "hydrogenated" has a negative connotation for many consumers.

3.2 USES AND CONSUMERS

Most vegetable oils are consumed in edible products, including salad and cooking oil, baking and frying fats, and margarine. Some vegetable oil is used in animal feed, and small quantities are also used in the production of inedible products such as inks, diesel fuel, organic chemicals, paints, coatings and varnishes, plasticizers, lubricants, and soap. The following section describes these products and presents the percentages of soybean, corn, and cottonseed oils used in each category.

3.2.1 Edible Uses of Vegetable Oils

Table 3-2 contains data on the quantities of fats and oils used in edible products in the United States from 1987 through 1994.[81] Soybean oil comprises about three-quarters of all fats and oils used in edible products.

Figure 3-1 illustrates the total per capita consumption of fats and oils in the United States in 1995.[82] Vegetable oils in the form of salad and cooking oils, baking or frying fat, and margarine constituted more than 85 percent of the total. This section describes these edible uses for vegetable oils in more detail.

Salad or Cooking Oils. Salad or cooking oils are vegetable oils that are completely liquid at room temperature. They are alkali-refined, bleached, and deodorized. Salad or cooking oils are sold directly to consumers under brand names such as CPC International's Mazola, Procter & Gamble's Crisco and Puritan, and ConAgra's Wesson, as well as private label or store brands.[83] Soybean oil is sold in supermarkets with the general label "vegetable oil," while other vegetable oils such as corn oil or canola oil are labeled specifically. Salad and cooking oils are also used in the production of mayonnaise, salad dressings, and other prepared foods.

Baking and Frying Fats. Baking and frying fats, also called shortening, may be hydrogenated or partially hydrogenated. Hydrogenation is the process of treating fats

TABLE 3-2. QUANTITIES OF OILS AND FATS USED IN EDIBLE PRODUCTS IN THE U.S.: 1987-1994 (10^6 LBS.)

	Vegetable Oils					Tropical Oils		Animal Fats		
Year[a]	Soybean Oil	Corn Oil	Cotton-seed Oil	Peanut Oil	Sunflower Oil	Palm Oil	Coconut Oil	Edible Tallow	Lard	Total Fats and Oils
1987/88	10,429	946	[b]	181	[b]	198	233	864	280	14,175
1988/89	9,636	1,060	917	[b]	38	205	211	779	324	13,719
1989/90	10,537	1,129	801	167	61	94	161	706	304	14,383
1990/91	10,722	1,143	777	[b]	166	98	169	501	314	14,491
1991/92	11,112	1,085	685	[b]	145	99	164	440	337	14,765
1992/93	11,505	945	640	[b]	129	83	202	408	302	14,959
1993/94	11,832	649	558	[b]	[b]	87	234	[b]	288	14,975
1994/95	12,175	636	532	108	[b]	[b]	247	382	346	15,238

[a] The reporting year runs from October to September.
[b] USDA withholds figures to avoid disclosing data for individual companies.

Source: U.S. Department of Agriculture, Economic Research Service. Oil Crops Yearbook. OCS-1996. Washington, DC, U.S. Department of Agriculture. October 1996.

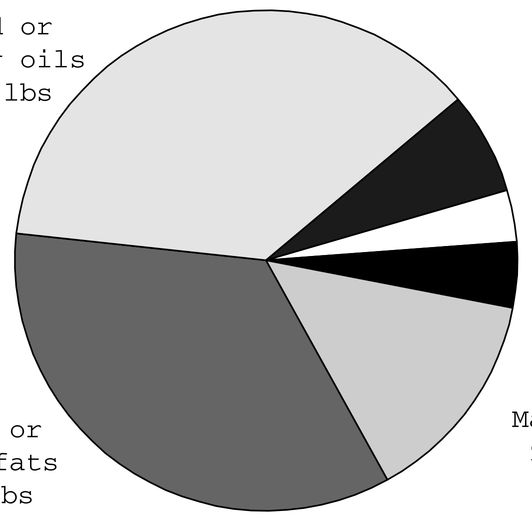

Figure 3-1. Per-capita consumption of oils and fats in the U.S.: 1995.

Source: U.S. Department of Commerce, Bureau of the Census. 1996 Current Industrial Reports—Fats and Oilseed Crushings, Production, Consumption, and Stocks (M20K). Washington, DC, Government Printing Office. 1997.

and oil with hydrogen gas in the presence of a catalyst. The process changes liquid oils into a solid form. Hydrogenation also improves the oil's resistence to thermal and atmospheric oxidation.[84] Baking and frying fats may be fluid, plastic (semi-solid), or solid at room temperature. Like salad and cooking oils, shortening is sold directly to consumers under brand names such as Crisco and Wesson, and under private labels, as well as to commercial users.

Margarine. Margarine is a combination of about 80 percent vegetable oil and 20 percent water or milk with other ingredients such as emulsifiers, vitamins, milk solids, and flavors.[85] Lower-fat margarine spreads contain less oil and more water. Margarine is also sold to food processors and directly to consumers under brand names such as Land O Lakes, Fleishman's, Mazola, and Promise as well as private labels.

3.2.2 Inedible Uses of Vegetable Oils

Ink. Soybean oil-based ink has gained popularity because of its ecological advantages and superior printing quality. Soy ink biodegrades more quickly, is easier to remove from paper for recycling, and has a lower VOC content than petroleum-based inks. Because soy oil is clear, it produces brighter colored inks. It costs about 50 percent more than petroleum-based ink, however. Other types of vegetable oils can be used in inks as well, but soybean producers have aggressively marketed soybean oil to the ink industry.[86] In 1992 the ink industry consumed 27.5 million pounds of soybean oil. This amount was projected to increase to 89 million pounds by 1997.[87]

Although scientists have developed inks that are totally derived from vegetable oils, most of the soy ink currently used is actually a soybean oil-petroleum hybrid. The American Soybean Association licenses printers to use their soy ink logo, which indicates at least a 30 percent soybean oil content for colored ink and a 40 percent soybean oil content for black news ink.

Because of its high quality, soy ink has captured 70 percent of the color newsprint ink market. Because of its high cost, however, it only makes up about 2 percent of the black newsprint ink market. The major scientific and technical obstacles to using vegetable oils in inks have been overcome. Future environmental regulation related to printing may help the marketing of vegetable oil-based inks.[88]

Diesel Fuel. Diesel fuel, or "Biodiesel," can be made from vegetable oils. It can be used in pure form or more typically is mixed with petroleum diesel. Pure biodiesel is biodegradable, nontoxic, and essentially free of sulfur and aromatics. It is a renewable resource and is produced domestically. Biodiesel requires no engine modifications or changes to fuel handling and delivery systems. It delivers similar power and miles per gallon.

Although it is not feasible to replace all diesel fuel with biodiesel (the entire domestic supply of vegetable oil could replace no more than 10 percent of the domestic market for diesel fuel), biodiesel would be useful in specific markets. Biodiesel could be used to replace diesel fuel for mass transit in cities that must reduce pollution to meet federal clean air standards. The marine market is also promising for biodiesel. Because it is biodegradable and nontoxic, it is well suited for use in environmentally sensitive areas such as coasts and wetlands. It is currently being tested for these applications.[89]

Organic Chemicals. Vegetable oils can be converted into many different organic chemicals, including glycerol and fatty acids. These are used in the production of adhesive tape, shaving cream, textile water repellents, candles, crayons, cosmetics, polishes, and mold lubricants. Purified fatty acids and fractions thereof are used to make many chemicals such as dimer and trimer acids, alcohols, amines and amides, and esters.[90]

Paints, Coatings, and Varnishes. In 1940, over 80 percent of paints, coatings, and varnishes were composed of vegetable oils. The use of vegetable oils in these products peaked around 1950. Petroleum-based products began to replace those made from vegetable oil, and by 1987 the market share had dropped to about 30 percent. In the future, vegetable oils may recapture some of this market. Currently, concern about volatile organic compounds is increasing demand for water-based paints, varnishes, and coatings. Vegetable oil is used in the production of alkyd resins, a component of water-based latex paint. Also, soybean breeders are studying ways to create soybeans that produce more useful oils for the production of paints, varnishes, and coatings.[91]

Plasticizers. Plasticizers are incorporated into plastics, rubber, and rubberlike materials to increase flexibility and toughness. About 2 billion pounds of plasticizers are used annually, and 10 to 15 percent of this amount is derived from vegetable oils. Soybean oil products are used extensively to plasticize polyvinyl chloride resins.[92]

Lubricants. In the past, vegetable oils were widely used as industrial lubricants. Petroleum-based mineral oils have largely replaced vegetable oils, however. Vegetable oils are still used in some minor applications, such as the lubrication of irrigation well equipment, where the lubricant may be discharged into an aquifer. Soybean oil is sometimes used to spray truck beds before carrying asphalt or to coat forms used to mold concrete structures. It prevents sticking and makes handling easier.[93]

Soap. Bar soaps are made primarily from inedible tallow and coconut oil. Small quantities of vegetable oils are used in the production of liquid soaps.[94]

3.2.3 Percentages of Vegetable Oils Used in Various Products

Figure 3-2 illustrates the percentages of soybean, corn, and cottonseed oils used in various products in the United States in 1996.[95] Quantities and percentages of all fats and oils are broken out by major edible and inedible uses in Table 3-3.[96] In addition, quantities and percentages are provided for cottonseed, soybean, corn, and peanut oil where available. These data are described in more detail below.

- Uses of cottonseed oil: About half of all cottonseed oil was used for baking and frying, and the other half for salad and cooking oil, with a small portion (2.4 percent) being used in inedible products. Cottonseed oil was not used in margarine production.

- Uses of soybean oil: In 1996, 44.7 percent of all soybean oil was consumed as salad and cooking oil, 38.1 percent as baking and frying fat, and 13.7 percent as margarine. The remaining 1 percent of edible uses went into other edible products, and a total of 2.5 percent was used in inedible products.

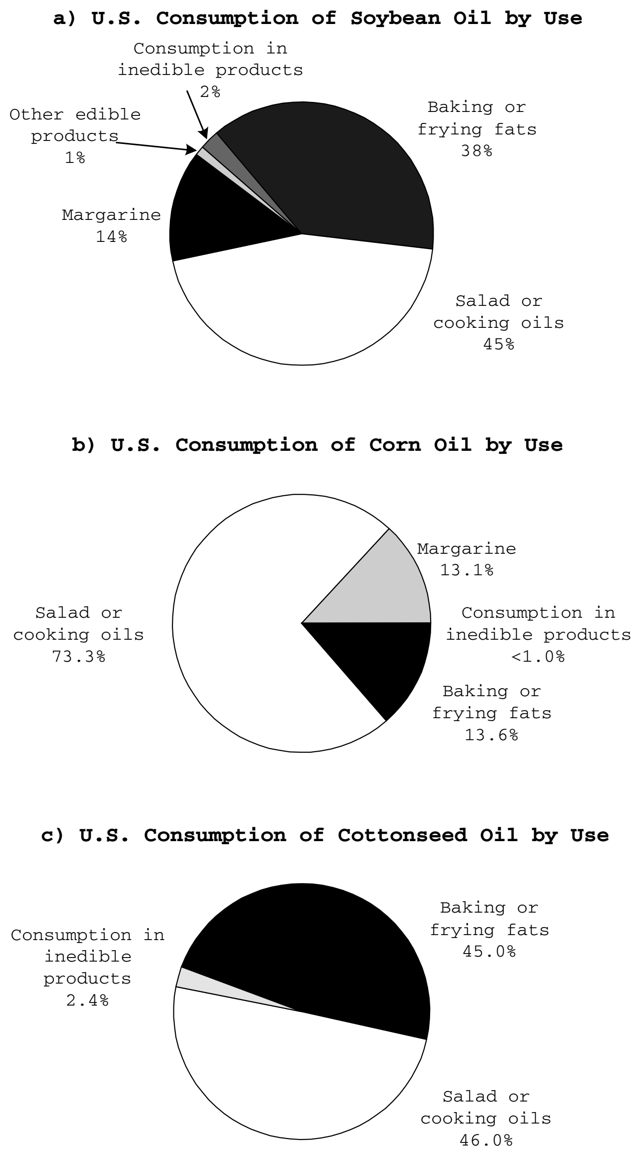

Figure 3-2. U.S. consumption of soybean, corn and cottonseed oil by use: 1996.

Source: U.S. Department of Commerce, Bureau of the Census. 1996 Current Industrial Reports—Fats and Oilseed Crushings, Production, Consumption, and Stocks (M20K). Washington, DC, Government Printing Office. 1997.

TABLE 3-3. VEGETABLE OILS BY EDIBLE AND INEDIBLE USES (10^6 LBS.): 1996

	All Fats & Oils		Cottonseed Oil		Soybean Oil		Corn Oil		Peanut Oil	
	Quantity	Percent	Quantity	Percent	Quantity	Percent	Quantity	Percent	Quantity	Percent
Total Consumption	20,847.13	100.0	525.60	100.0	12,322.30	100.0	590.00	100.0	137.40	100.0
Consumption in edible products	14,828.93	71.1	512.90	97.6	12,017.10	97.5	589.90	100.0	136.50	99.3
Baking and frying fats	5,934.60	28.5	236.60	45.0	4,690.00	38.1	80.10	13.6	--	
Salad or cooking oil	6,717.40	32.2	242.00	46.0	5,507.50	44.7	432.50	73.3	NA	
Margarine	1,816.23	8.7	NA		1,694.20	13.7	77.30	13.1	--	
Other edible products	360.70	1.7	NA		125.40	1.0	--		NA	
Consumption in inedible products	6,018.20	28.9	12.70	2.4	305.20	2.5	0.10	0.0	0.90	0.7
Soap	468.94	2.2	--		NA		--		--	
Paint and varnish	86.60	0.4	--		50.50	0.4	--		NA	
Feed	2,429.50	11.7	--		NA		--		--	
Resins and plastics	206.09	1.0	NA		121.10	1.0	--		NA	
Lubricants	124.54	0.6	NA		--		--		--	
Fatty acids	1,920.70	9.2	--		NA		--		--	
Other inedible products	781.93	3.8	NA		98.00	0.8	0.10	0.0	NA	

NA = Too few companies to report data.

Source: U.S. Department of Commerce, Bureau of the Census. Current Industrial Reports—Fats and Oils, Production, Consumption, and Stocks. Washington, DC, Government Printing Office. August 1997.

- Uses of corn oil: Almost three-quarters of all corn oil was consumed as salad and cooking oil; the balance was divided about equally between baking and frying fat and margarine. Less than 1 percent of corn oil was used for inedible products.

- Uses of peanut oil: Nearly all peanut oil (99.3 percent) was used for edible purposes with only 0.7 percent used for inedible purposes.

3.2.4 Elasticity of Demand

Table 3-4 shows the own-price elasticities for various fats and oils that were estimated by Chern et al.[97] All of these elasticities are less than -1.0, which means their demand is inelastic. (Inelastic demand means that a 1 percent increase in the price of the good causes less than a 1 percent decrease in the quantity of the good demanded.) Butter was the most price elastic at -0.816, and cottonseed oil followed at -0.646. Corn oil, lard, peanut oil, and soybean oil all had similar elasticities, ranging from -0.234 to -0.292. In other words, consumers alter their purchasing behavior in reaction to price changes more for butter and cottonseed oil than for corn, peanut, and soybean oils.

3.3 SUBSTITUTION POSSIBILITIES IN CONSUMPTION

Substitutes for domestically produced vegetable oils are imported tropical oils (coconut and palm oils), animal fats (butter, edible tallow, and lard) and imported olive oil. This section discusses each of these groups, plus the synthetic fat substitute "Olestra."

TABLE 3-4. ESTIMATED OWN PRICE ELASTICITIES FOR VEGETABLE OILS AND SUBSTITUTES

Product	Elasticity
Butter	-0.816
Corn oil	-0.235
Cottonseed oil	-0.646
Lard	-0.263
Peanut oil	-0.242
Soybean oil	-0.292

Source: Chern, Wen S., Edna T. Loehman, and Steven T. Yen. Information, Health Risk Beliefs, and the Demand for Fats and Oils. The Review of Economics and Statistics. 77(3):555-64. 1995.

3.3.1 Tropical Oils

Although palm and coconut oils have functional characteristics that make them useful to food processors, consumers perceive them to be "unhealthy" because of their high saturated fat content. Substituting hydrogenated vegetable oil for tropical oils may not be beneficial, however, because when oils are hydrogenated, they become saturated, and trans fatty acids are formed.[98]

3.3.2 Animal Fats

Butter, edible tallow (beef fat), and lard (pork fat) are also substitutes for vegetable oils. The public perceives these fats to be unhealthy also, because they are all high in saturated fat and contain cholesterol.

Margarine was invented in France 1869 as a substitute for butter. Until the 1940s, consumption of margarine was limited in the United States because of legislative restrictions put in place to protect the dairy industry. After these restrictions were removed, consumption greatly increased. By 1956, the per-capita consumption of margarine exceeded butter's and has remained higher.[99]

Margarine is cheaper than butter, and consumers generally believe it is "healthier." Provisions of the 1996 Farm Bill may cause the price of butter to fall in the future.[100] Lower butter prices and an increased understanding that consuming hydrogenated vegetable oils instead of animal fats may offer no health advantages might lead to increased consumption of butter relative to margarine.

3.3.3 Olive Oil

Olive oil, which is not produced domestically, is considered to be a "healthy" oil because of its high level of monounsaturated fats. The demand for olive oil has increased dramatically in recent years. Imports of olive oil increased from 48 million pounds in 1975 to 251 million pounds in 1995.[101]

3.3.4 Olestra

The Food and Drug Administration approved the use of

Olestra, a fat substitute, in January 1996. When Proctor & Gamble began to test market the product, they found that it caused severe digestive disturbances in many individuals. If Olestra had proved to be an acceptable fat substitute, it would have increased demand for vegetable oils, since vegetable oils are a major ingredient used in its manufacture.[102]

SECTION 4
INDUSTRY ORGANIZATION

This section describes the structure of the markets for vegetable oils, the characteristics of the facilities that manufacture vegetable oils, and the characteristics of the firms that own these manufacturing plants.

4.1 MARKET STRUCTURE

Market structure is of interest because it determines the behavior of producers and consumers in the industry. If an industry is perfectly competitive, then individual producers are not able to influence the price of the output they sell or the inputs they purchase. This condition is most likely to hold if the industry has a large number of firms, the products sold and the inputs purchased are undifferentiated, and entry and exit of firms is unrestricted. Product differentiation can occur both from differences in product attributes and quality and from brand name recognition of products. Entry and exit of firms are unrestricted for most industries except, for example, in cases where government regulates who is able to produce, where one firm holds a patent on a product, where one firm owns the entire stock of a critical input, or where a single firm is able to supply the entire market.

For a particular industry, we can evaluate each of the factors listed above to determine the potential for imperfectly competitive behavior. In the vegetable oil market, a fairly large number of firms produce each type of vegetable oil.* Crude vegetable oil products are undifferentiated and sold at an unbranded market level. In addition, entry of firms into the industry is unrestricted. Thus, all of the factors suggest that the vegetable oil industry is perfectly competitive. Indeed the National Oilseed Processors Association maintains that the industry is highly competitive.[103] However, due to large scale economies of size and scope, firms in the industry have an incentive to grow large. As they grow larger, market shares increase and the potential for imperfect competition increases.

In addition to evaluating the factors that affect competition in an industry, economists also evaluate four-firm concentration ratios (CR4s), eight-firm concentration ratios (CR8s), and Herfindahl-Hirschman indexes (HHIs). These values are reported at the 4-digit SIC level for 1992, the most recent year available, in Table 4-1.[104,105,106] The CR4, which measures the percentage of sales of the top 4 companies in the industry, range from 62 percent for cottonseed oil mills (SIC 2074) to 89 percent for all other vegetable oil mills (SIC 2076). Note that although mechanical extraction plants are included in these SICs, they are unlikely to be among the larger firms in the industry. The CR8, which measures the

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*More detail on the number of firms and facilities is provided in Sections 4.2 and 4.3.

percentage of sales of the top 8 companies in the industry, is 82 percent for cottonseed oil mills (SIC 2074) and above

TABLE 4-1. MEASURES OF MARKET CONCENTRATION BY SIC: 1992

SIC	Description	CR4	CR8	HHI	Number of Companies	Number of Establishments	Value of Shipments
2046	Wet Corn Milling	73	93	1,521	28	51	$7,045.2
2074	Cottonseed Oil Mills	62	81	1,430	22	45	$730.1
2075	Soybean Oil Mills	71	91	1,619	42	99	$10,650.6
2076	Vegetable Oil Mills, except corn soybean, and cottonseed	89	97	2,119	18	26	$666.2

Notes: CR4 denotes four-firm concentration ratio.
CR8 denotes eight-firm concentration ratio.
HHI denotes Herfindahl-Herschman index.

Sources: U.S. Department of Commerce. Concentration Ratios in Manufacturing. Washington, DC, Government Printing Office. 1992.

U.S. Department of Commerce. 1992 Census of Manufactures, Industry Series—Fats and Oils. MC92-I-20G. Washington, DC, Government Printing Office. 1995.

U.S. Department of Commerce. 1992 Census of Manufactures, Industry Series—Grain Mill Products. MC92-I-20D. Washington, DC, Government Printing Office. 1995.

90 percent for each of wet corn milling (SIC 2046), soybean oil mills (SIC 2075), and vegetable oil mills (SIC 2076).*

The criterion for evaluating the HHIs are based on the 1992 Department of Justice's Horizontal Merger Guidelines.[107] According to these criteria, industries with HHIs below 1,000 are considered unconcentrated (i.e., more competitive), those with HHIs between 1,000 and 1,800 are considered moderately

*Not all establishments in SIC 2046 produce corn oil; however, since all nine corn oil establishments are owned by six companies, the CR8 is 100 percent.

concentrated (i.e., moderately competitive), and those with HHIs above 1,800 are considered highly concentrated (i.e., less competitive). In general, firms in less-concentrated industries are more likely to be price takers, while firms in more-concentrated industries are more likely to be able to influence market prices. Based on these criteria, wet corn milling (SIC 2046), cottonseed oil mills (SIC 2074), and soybean oil mills (SIC 2075) are moderately concentrated and vegetable oil mills (SIC 2076) are highly concentrated.

While the CR4s, CR8s, and HHIs are suggestive of imperfect competition, they tell us nothing about the interactions of firms in the industry. Because of the homogeneity of the products produced, and because economies of size and scope provide firms with an incentive to grow large (resulting in high measures of concentration) the assumption of perfect competition is justifiable.

In addition to the measures of concentration, the numbers of companies and facilities as well as value of shipments are provided in Table 4-1. Because these values include mechanical extraction plants and are reported for 1992, they are larger than those reported in the following sections on solvent extraction plants.

4.2 FACILITY CHARACTERISTICS

Facilities comprise a site of land with a plant and equipment that combine inputs (raw materials, fuel, energy, and labor) to produce outputs (vegetable oils). The terms facility, establishment, and plant are synonymous in this report and refer to the physical location where products are manufactured. As of 1997, there were 109 operating vegetable oil production facilities that rely on hexane solvents to extract vegetable oil.[*,108] In addition, three facilities are planned for construction. Sales and employment estimates for these facilities were obtained from American Business Information Corporation.[109] Table 4-2 presents facility-level sales and employment data organized by the following Standard Industrial Classification (SIC) codes:[110,111]

- SIC 2046 Wet Corn Milling,
- SIC 2074 Cottonseed Oil Mills,
- SIC 2075 Soybean Oil Mills, and
- SIC 2076 Vegetable Oil Mills, except corn, cottonseed, and soybean.

Table 4-3 lists the distribution of these facilities by state.[112,113] As shown, Illinois (14 facilities), Iowa (13 facilities), Texas (9 facilities), and Arkansas (8 facilities) contain the highest number of vegetable oil production facilities using the solvent extraction method.

[*]According to the Census of Manufactures, the total number of vegetable oil production facilities is much greater than 109. However, it groups both mechanical and solvent extraction plants. The data reported here apply only to solvent extraction plants.

Data on manufacturing plants for each SIC code is described in more detail below followed by a discussion of current trends in manufacturing plants.

TABLE 4-2. FACILITY-LEVEL SALES AND EMPLOYMENT FOR SOLVENT EXTRACTION VEGETABLE OIL MANUFACTURING FACILITIES

Company Name	Facility Name	Facility Location		Sales Range ($\$10^6$)	Employment Range
Wet Corn Milling (SIC 2046)					
Archer Daniels Midland	Archer Daniels Midland	Clinton	IA	100-500	250-499
	Archer Daniels Midland	Decator	IL	100-500	250-499
	Archer Daniels Midland	Lubbock	TX	NA	NA
Bunge Corporation	Bunge Corp	Danville	IL	NA	NA
Cargill Incorporated	Cargill Inc	Eddyville	IA	100-500	250-499
	Cargill Inc	Memphis	TN	NA	NA
CPC International	CPC International	Bedford Park	IL	NA	NA
California Oils	California Oils[a]	Richmond	CA	1-2.5	50-99
Tate and Lyle PLC	A.E. Staley	Loudon	TN	100-500	100-249
Cottonseed Oil Mills (SIC 2074)					
Archer Daniels Midland	Southern Cotton Oil Co	Memphis	TN	20-50	100-249
	Southern Cotton Oil Co	Port Gibson	MS	10-20	20-49
	Southern Cotton Oil Co	Lubbock	TX	20-50	100-249
	Southern Cotton Oil Co	Levelland	TX	10-20	50-99
	Southern Cotton Oil Co	N Little Rock	AR	20-50	50-99
	Southern Cotton Oil Co[b]	Quanah	TX	20-50	50-99
	Southern Cotton Oil[b]	Sweetwater	TX	10-20	50-99
Chickasha Cotton Oil Mill	Chickasha Cotton Oil	Casa Grande	AZ	0.5-1	20-49
	Chickasha of Georgia	Tifton	GA	10-20	50-99
	Clinton Cotton Oil Mill	Clinton	OK	1-2.5	5-9

(continued)

TABLE 4-2. FACILITY-LEVEL SALES AND EMPLOYMENT FOR SOLVENT EXTRACTION VEGETABLE OIL MANUFACTURING FACILITIES (CONTINUED)

Company Name	Facility Name	Facility Location		Sales Range ($\$10^6$)	Employment Range
Cottonseed Oil Mills (SIC 2074) (continued)					
Chickasha Cotton Oil Mill (continued)	Lamesa Cotton Oil Mill	Lamesa	TX	10-20	50-99
	Rio Grande Oil Mill	Harlingen	TX	1-2.5	1-4
Delta Oil Mill	Delta Oil Mill	Jonestown	MS	20-50	50-99
Dunavant Enterprises	Anderson Clayton	Phoenix	AZ	N/A	N/A
	Anderson Clayton	Chowchilla	CA	20-50	100-249
Hartsville Oil Mill Incorporated	Hartsville Oil Mill	Darlington	SC	20-50	50-99
J.G. Boswell	J.G. Boswell[a,c]	Corcoran	CA	10-20	100-249
Oesceola Products	Osceola Products Co	Kennett	MO	10-20	50-99
	Osceola Products Co	Osceola	AR	20-50	50-99
Plains Cooperative Oil Mill Incorporated	Plains Co-op Oil Mill[d]	Lubbock	TX	1-2.5	5-9
Planter's Cotton Oil Mill	Planters Cotton Oil Mill Inc	Pine Bluff	AR	20-50	50-99
Producer's Cooperative Mill	Producers Cooperative Oil Mill	Oklahoma City	OK	20-50	50-99
Valley Cooperative Mills	Valley Co-op Oil Mill	Harlingen	TX	20-50	100-249
Yazoo Valley Oil Mill, Incorporated	Yazoo Valley Oil Mill	Helena	AR	20-50	50-99
	Yazoo Valley Oil Mill	Greenwood	MS	50-100	100-249
	Yazoo Valley Oil Mill[c]	West Monroe	LA	20-50	50-99

(continued)

TABLE 4-2. FACILITY-LEVEL SALES AND EMPLOYMENT FOR SOLVENT EXTRACTION VEGETABLE OIL MANUFACTURING FACILITIES (CONTINUED)

Company Name	Facility Name	Facility Location		Sales Range ($\$10^6$)	Employment Range
Soybean Oil Mills (SIC 2075)					
Ag Processing	A G Processing Inc	Eagle Grove	IA	100-500	50-99
	A G Processing Inc	Sergeant Bluff	IA	100-500	50-99
	A G Processing Inc	Mason City	IA	50-100	20-49
	A G Processing Inc	St Joseph	MO	50-100	100-249
	A G Processing Inc	Manning	IA	20-50	20-49
	A G Processing Inc	Dawson	MN	20-50	50-99
	Ag Processing Inc Assoc	Sheldon	IA	50-100	50-99
	Ag Processing	Hastings	NE	under construction	
Archer Daniels Midland	ADM Processing	Mankato	MN	100-500	50-99
	ADM Soybean Processing	Kansas City	MO	50-100	50-99
	Archer Daniels Midland Co	Des Moines	IA	100-500	100-249
	Archer Daniels Midland Co[e]	Decatur	IL	N/A	N/A
	Archer Daniels Midland Co	Lincoln	NE	100-500	100-249
	Archer Daniels Midland Co	Frankfort	IN	50-100	50-99
	Archer Daniels Midland Co	Mexico	MO	50-100	50-99
	Archer Daniels Midland Co	Fremont	NE	50-100	20-49
	Archer Daniels Midland Co	Kershaw	SC	20-50	20-49
	Archer Daniels Midland Co	Clarksdale	MS	20-50	20-49
	Archer Daniels Midland Co	Fostoria	OH	20-50	50-99
	Archer Daniels Midland Co	Galesburg	IL	20-50	20-49
	Archer Daniels Midland Co	Fredonia	KS	20-50	20-49
	Archer Daniels Midland Co	Little Rock	AR	20-50	20-49

(continued)

TABLE 4-2. FACILITY-LEVEL SALES AND EMPLOYMENT FOR SOLVENT EXTRACTION VEGETABLE OIL MANUFACTURING FACILITIES (CONTINUED)

Company Name	Facility Name	Facility Location		Sales Range ($\$10^6$)	Employment Range
Soybean Oil Mills (SIC 2075) (continued)					
Archer Daniels Midland (continued)	Archer Daniels Midland Co	Taylorville	IL	50-100	50-99
	Archer Daniels Midland Co	Valdosta	GA	20-50	50-99
Bunge Corporation	Bunge Corp	Decatur	AL	100-500	100-249
	Bunge Corp	Marks	MS	100-500	50-99
	Bunge Corp	Vicksburg	MS	100-500	50-99
	Bunge Corp	Cairo	IL	100-500	50-99
	Bunge Corp	Destrehan	LA	10-20	100-249
	Bunge Corp Soybean Processing	Emporia	KS	100-500	50-99
	Lauhoff Grain Co	Danville	IL	NA	250-499
Cargill Incorporated	Cargill Inc	Fayetteville	NC	100-500	50-99
	Cargill Inc	Sidney	OH	100-500	100-249
	Cargill Inc	Sioux City	IA	100-500	50-99
	Cargill Inc	Raleigh	NC	50-100	50-99
	Cargill Inc	Guntersville	AL	50-100	50-99
	Cargill Inc	Des Moines	IA	50-100	50-99
	Cargill Inc	Chesapeake	VA	20-50	100-249
	Cargill Inc	Iowa Falls	IA	NA	NA
	Cargill Inc	Bloomington	IL	50-100	50-99
	Cargill Inc	Kansas City	MO	50-100	20-49

(continued)

TABLE 4-2. FACILITY-LEVEL SALES AND EMPLOYMENT FOR SOLVENT EXTRACTION VEGETABLE OIL MANUFACTURING FACILITIES (CONTINUED)

Company Name	Facility Name	Facility Location		Sales Range ($\$10^6$)	Employment Range
Soybean Oil Mills (SIC 2075) (continued)					
Cargill Incorporated (continued)	Cargill Inc	Wichita	KS	50-100	100-249
	Cargill Inc	Gainesville	GA	20-50	100-249
	Cargill Inc	Cedar Rapids	IA	20-50	20-49
	Cargill Inc	Lafayette	IN	10-20	20-49
	Cargill Inc Protein Products	Cedar Rapids	IA	100-500	100-249
Central Soya Company	Central Soya Co	Decatur	IN	100-500	250-499
	Central Soya Co	Gibson City	IL	100-500	100-249
	Central Soya Co	Bellevue	OH	50-100	100-249
	Central Soya Co	Delphos	OH	20-50	50-99
	Central Soya Co	Marion	OH	20-50	50-99
	Central Soya Co	Morristown	IN	under construction	
Con Agra	Con Agra	Evansville	IN	under construction	
Harvest States Cooperative	Honeymead Processing/Refining	Mankato	MN	NA	100-249
Moorman Manufacturing	Moorman Manufacturing Co	Quincy	IL	NA	1000-4,999
	Quincy Soybean Co	Helena	AR	0.5-1	5-9
	Quincy Soybean Co	Quincy	IL	NA	250-499
Owensboro Grain Company	Owensboro Grain Co	Owensboro	KY	100-500	100-249
Perdue Farms	Perdue Farms Inc	Cofield	NC	100-500	100-249
	Perdue Farms Inc	Salisbury	MD	50-100	500-999
Riceland Foods Incorporated	Riceland Foods Inc	Stuttgart	AR	500-1,000	1000-4,999

(continued)

TABLE 4-2. FACILITY-LEVEL SALES AND EMPLOYMENT FOR SOLVENT EXTRACTION VEGETABLE OIL MANUFACTURING FACILITIES (CONTINUED)

Company Name	Facility Name	Facility Location		Sales Range ($\$10^6$)	Employment Range
Soybean Oil Mills (SIC 2075) (continued)					
Rose Acre Farm Incorporated	Rose Acre	Seymour	IN	50-100	500-999
Southern Soya Corporation	Southern Soya Corp	Estill	SC	5-10	50-99
Townsends	Townsends	Millsboro	DE	NA	NA
Vegetable Oil Mills (SIC 2076)					
Archer Daniels Midland	Archer Daniels Midland Co (produces canola oil)	Velva	ND	20-50	20-49
	Archer Daniels Midland Co (produces canola and peanut oil)	Augusta	GA	50-100	20-49
	Archer Daniels Midland Co (produces flax and sunflower oil)	Red Wing	MN	20-50	50-99
	Northern Sun (produces sunflower oil)	Enderlin	ND	50-100	50-99
	Northern Sun (produces sunflower oil)	Goodland	KS	20-50	20-49
Cargill Incorporated	Cargill Inc (produces canola, flax, sunflower oil)	West Fargo	ND	50-100	50-99
	Stevens Industries (produces canola and peanut oil)	Dawson	GA	100-500	100-249
Lubrizol Corporation	SVO Specialty Products (produces canola, safflower, and sunflower oil)	Culbertson	MT	10-20	20-49

(continued)

TABLE 4-2. FACILITY-LEVEL SALES AND EMPLOYMENT FOR SOLVENT EXTRACTION VEGETABLE OIL MANUFACTURING FACILITIES (CONTINUED)

Company Name	Facility Name	Facility Location		Sales Range ($\$10^6$)	Employment Range
Soybean Oil Mills (SIC 2075) (continued)					
Oilseeds International	Oilseeds International (produces safflower oil)	Grimes	CA	NA	NA
Rito Partnership	Rito Partnership (produces rice oil)	Stuttgart	AR	NA	NA
Sessions Company	Sessions Company (produces peanut oil)	Enterprise	AL	NA	NA

[a] Also produces safflower oil.
[b] Also produces peanut oil.
[c] Also produces cotton oil.
[d] Also produces corn oil.
[e] Three facilities are listed at this location. Two facilities produce soybean oil and one facility produces corn oil.

Sources: American Business Information (ABI). The American Business Disk [computer file]. Omaha, NE: American Business Information. 1997

Memorandum, from Zukor, Chuck, Alpha-Gamma Technologies, Inc., to vegetable oil NESHAP project files. January 20, 1998. List of facilities to consider in EPA’s industry profile and economic analyses for the vegetable oil production NESHAP.

TABLE 4-3. NUMBER OF SOLVENT EXTRACTION VEGETABLE OIL FACILITIES BY STATE AND SIC CODE

State	Wet Corn Milling (SIC 2046)	Cottonseed Oil Mills (SIC 2074)	Soybean Oil Mills (SIC 2075)	Except Corn, Cottonseed, and Soybean (SIC 2076)	Total
Alabama	0	0	2	1	3
Alaska	0	0	0	0	0
Arizona	0	2	0	0	2
Arkansas	0	4	3	1	8
California	1	2	0	1	4
Colorado	0	0	0	0	0
Connecticut	0	0	0	0	0
Delaware	0	0	1	0	1
Florida	0	0	0	0	0
Georgia	0	1	2	2	5
Hawaii	0	0	0	0	0
Idaho	0	0	0	0	0
Illinois	3	0	11	0	14
Indiana	0	0	6	0	6
Iowa	2	0	11	0	13
Kansas	0	0	3	1	4
Kentucky	0	0	1	0	1
Louisiana	0	1	1	0	2
Maine	0	0	0	0	0
Maryland	0	0	1	0	1
Massachusetts	0	0	0	0	0
Michigan	0	0	0	0	0
Minnesota	0	0	3	1	4
Mississippi	0	3	3	0	6
Missouri	0	1	4	0	5
Montana	0	0	0	1	1
Nebraska	0	0	3	0	3
Nevada	0	0	0	0	0

(continued)

TABLE 4-3. NUMBER OF SOLVENT EXTRACTION VEGETABLE OIL FACILITIES BY STATE AND SIC CODE (CONTINUED)

State	Wet Corn Milling (SIC 2046)	Cottonseed Oil Mills (SIC 2074)	Soybean Oil Mills (SIC 2075)	Except Corn, Cottonseed, and Soybean (SIC 2076)	Total
New Hampshire	0	0	0	0	0
New Jersey	0	0	0	0	0
New Mexico	0	0	0	0	0
New York	0	0	0	0	0
North Carolina	0	0	3	0	3
North Dakota	0	0	0	3	3
Ohio	0	0	5	0	5
Oklahoma	0	2	0	0	2
Oregon	0	0	0	0	0
Pennsylvania	0	0	0	0	0
Rhode Island	0	0	0	0	0
South Carolina	0	1	2	0	3
South Dakota	0	0	0	0	1
Tennessee	2	1	0	0	3
Texas	1	8	0	0	9
Utah	0	0	0	0	0
Vermont	0	0	0	0	0
Virginia	0	0	1	0	1
Washington	0	0	0	0	0
West Virginia	0	0	0	0	0
Wisconsin	0	0	0	0	0
Wyoming	0	0	0	0	0
Total	9	26	66	11	112

Sources: American Business Information, Inc. (ABI). The American Business Disk [computer file]. Omaha, NE, American Business Information. 1997.

Memorandum, from Zukor, Chuck, Alpha-Gamma Technologies, Inc., to vegetable oil NESHAP project files. January 20, 1998. List of facilities to consider in EPA’s industry profile and economic analyses for the vegetable oil production NESHAP.

4.2.1 Wet Corn Milling

Annual facility level sales and employment data were available for five of the nine facilities classified under wet corn milling manufacturers. Sales estimates ranged from $1 to $500 million. Figure 4-1 shows the distribution of sales across facilities. Four facilities' (80 percent) sales range between $100 and $500 million while the remaining facility's sales range is between $1 and $2.5 million. Figure 4-2 shows the distribution of employment for these facilities. Four facilities report employment between 100 and 999 and one facility reports fewer than 100 employees.

4.2.2 Cottonseed Oil Mills

Facility-level sales data were obtained for 25 of the 26 cottonseed oil manufacturing facilities. Annual sales reported for these facilities range from $0.5 million to $100 million. The distribution of sales across these facilities is shown in Figure 4-3. As indicated, the majority of these facilities (21 facilities or 84 percent) reported annual sales of between $10 and $100 million, while the remaining 4 facilities (16 percent) reported sales less than $10 million.

Figure 4-4 shows the distribution of employment across cottonseed oil facilities. Employment ranged from one to 249 employees. As shown in Figure 4-4, the majority of these cottonseed oil facilities (19 facilities or 76 percent) employ fewer than 100 employees. The remaining 6 facilities

(24 percent) reported employment between 100 and 999 employees.

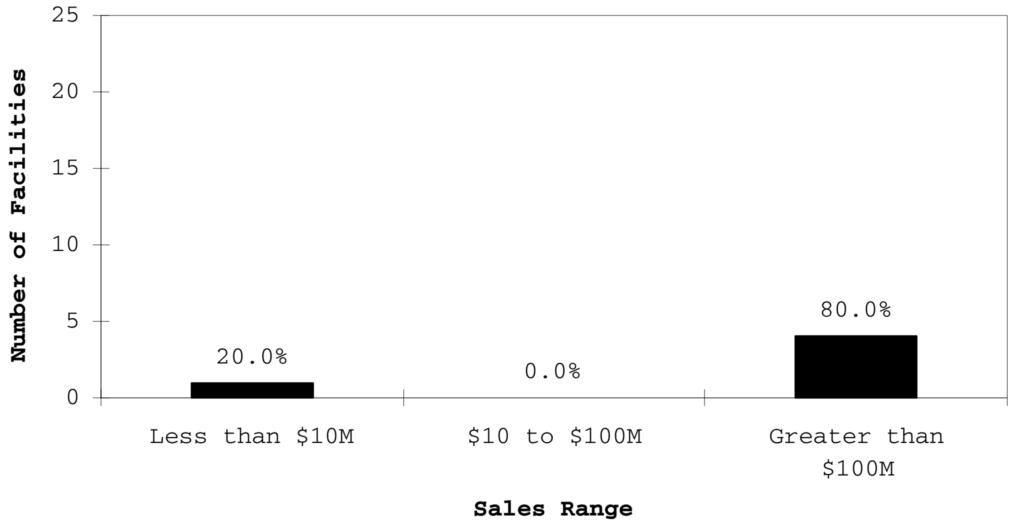

Figure 4-1. Distribution of wet corn milling facilities by sales range.

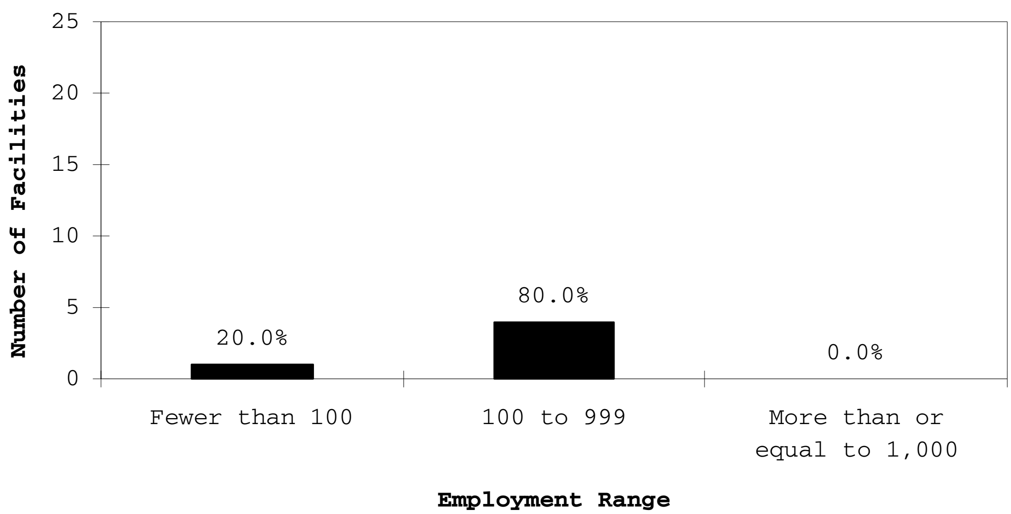

Figure 4-2. Distribution of wet corn milling facilities by employment range.

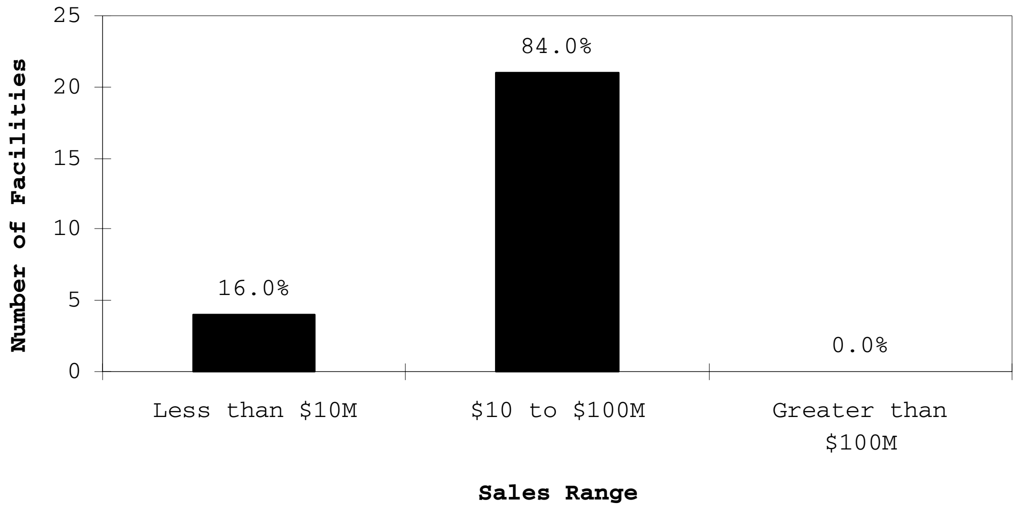

Figure 4-3. Distribution of cottonseed oil facilities by sales range.

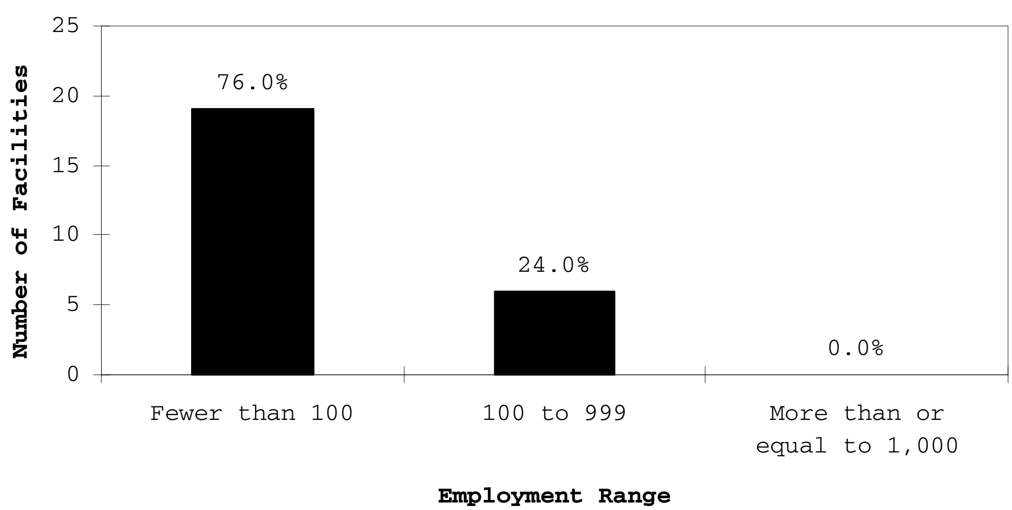

Figure 4-4. Distribution of cottonseed oil facilities by employment range.

4.2.3 Soybean Oil Mills

Annual sales estimates were obtained for 54 of the 66 soybean oil manufacturing facilities and ranged from $0.5 million to $1,000 million. Figure 4-5 shows the distribution of sales across these facilities. As shown, there are thirty-three facilities with sales between $10 and $100 million (61.1 percent). Nineteen facilities (35.2 percent) have sales over $100 million while two facilities (3.7 percent) have sales less than $10 million.

Figure 4-6 illustrates the distribution of soybean oil manufacturing facilities by employment. These estimates were obtained for 58 of 66 facilities and ranged from 5 to 5,000 employees. A majority of the facilities (36 facilities or 62.1 percent) reported employment below 100. Twenty facilities (34.5 percent) reported employment between 100 and 999 while 2 facilities (3.4 percent) employed more than 999 employees.

4.2.4 Vegetable Oil Mills, Except Corn, Cottonseed, and Soybean

Annual sales estimates were obtained for 8 of the 11 other vegetable oil manufacturing facilities and ranged from $20 million to $500 million. Figure 4-7 shows the distribution of sales across these facilities. Seven of the eight facilities (87.5 percent) reported sales between $10 and $100 million, and the remaining facility reported greater than $100 million in sales.

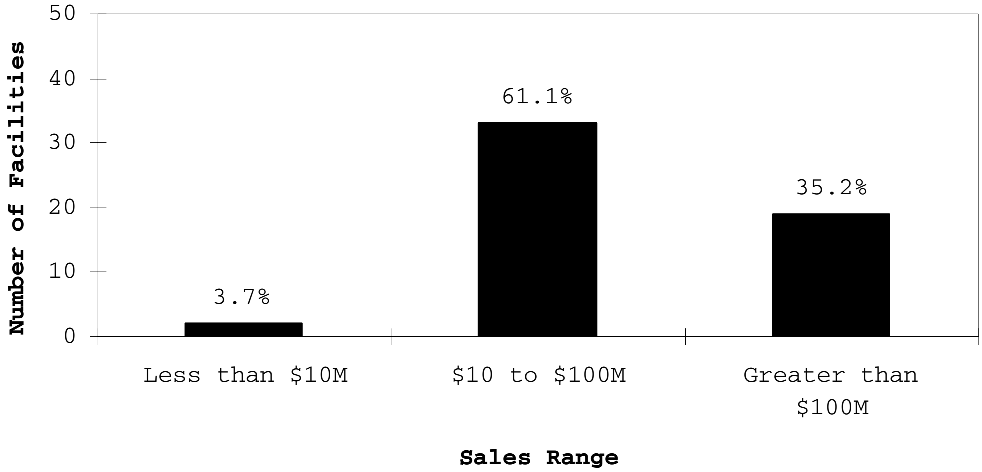

Figure 4-5. Distribution of soybean oil facilities by sales range.

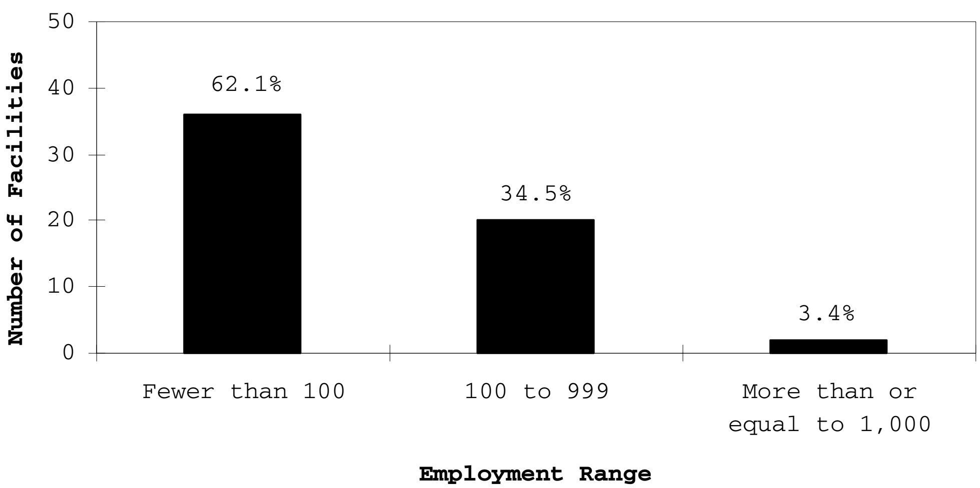

Figure 4-6. Distribution of soybean oil facilities by employment range.

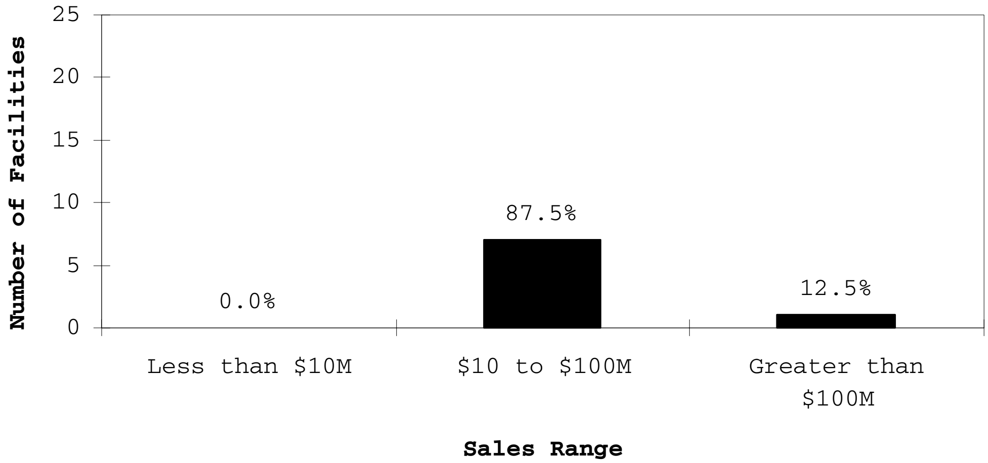

Figure 4-7. Distribution of vegetable oil mills, except corn, cottonseed, and soybean facilities by sales range.

Figure 4-8 shows the distribution of employment across these eight facilities. As shown in Figure 4-8, all eight facilities reported employment between 100 and 999.

4.2.5 Current Trends

Several vegetable oil companies have announced plans for new manufacturing plants and changes in crushing capacities at existing facilities. Archer Daniels Midland (ADM) plans to expand its cottonseed crushing capacity at its Valdosta, Georgia, facility.[114] ADM also reduced crushing rates at its Taylorville, Illinois, Little Rock, Arkansas, and Mexico, Missouri facilities.[115]

Ag Processing has announced it will build a new soybean processing facility in Hastings, Nebraska.[116] During 1996, Central Soya corporation opened a new soybean processing plant

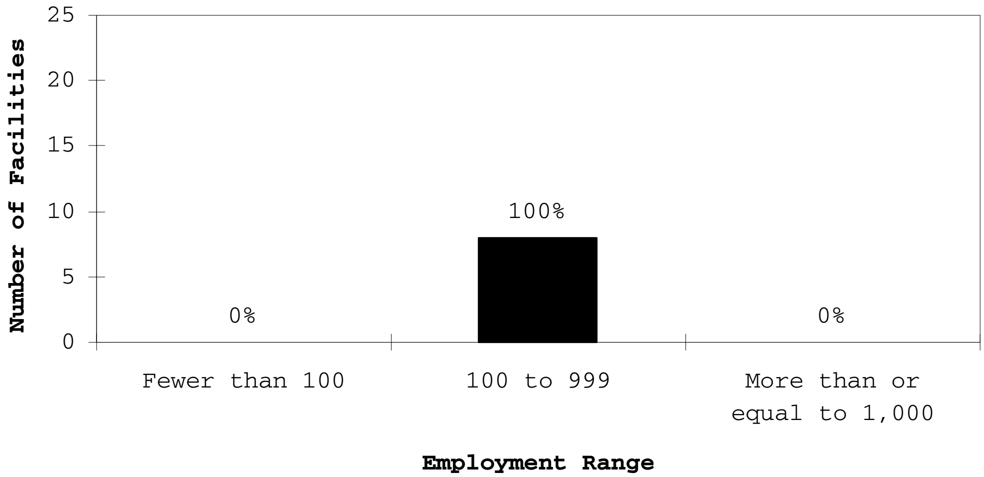

Figure 4-8. Distribution of vegetable oil mills, except corn, cottonseed, and soybean facilities by employment range.

in Morristown, Indiana. The second phase of this construction project will double the initial grinding capacity.[117]

4.3 COMPANY CHARACTERISTICS

Companies that own individual facilities are legal business entities that have the capacity to conduct business transactions and make business decisions that affect the facility. The terms company and firm are synonymous and refer to the legal business entity that owns one or more facilities. This section presents information on the parent companies that own vegetable oil manufacturing plants identified in the previous section.

4.3.1 Ownership

Based on facility data presented in Table 4-2, 32 companies have been identified as owners of vegetable oil manufacturing plants utilizing the solvent extraction method. Table 4-4 lists the most recently reported organization type, sales and employment data for 30 of the 32 companies.[118,119,120,121,122] In this table, we also identify the fiscal year for which these data are reported. Data were not available for Oilseeds International and Rito Partnership. Cargill Incorporated ($62,570.0 million), Con Agra (24,281.6 million), and Archer Daniels Midland Company ($13,314.0 million) are the largest companies with respect to total sales. Archer Daniels Midland owns the largest number of facilities (33 facilities) while Cargill Incorporated owns 17 facilities. Con Agra only owns one facility and it is currently under construction.

4.3.2 Size Distribution

Figure 4-9 shows the size distribution by sales range of the 30 companies with data available.* As shown, 11 companies (36.7 percent) reported sales greater than $1 billion. Seven companies (23.3 percent) reported sales between $100 and $999 million while ten companies (33.3 percent) reported sales of

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*The figures discussed in this section group together data reported for different fiscal years and therefore should be used with caution. However, the ranges reported are fairly broad so that it is unlikely that companies shifted between ranges over the time periods reported.

$10 to $99 million. The remaining two companies (6.7 percent) report sales less than $10 million.

TABLE 4-4. COMPANY-LEVEL DATA FOR SOLVENT EXTRACTION VEGETABLE OIL MANUFACTURERS

Company	Number of Facilities within SIC Code	Organization Type	Sales ($\$10^6$)	Employment	Fiscal Year Ending
Wet Corn Milling-SIC 2046					
Archer Daniels Midland Company	3	Public	13,314.0	14,811	June 30, 1996
Bunge Corporation	1	Private	2,570.0[a]	3,000	March 31, 1996
Cargill Incorporated	2	Private	62,570.0[a]	73,000	May 31, 996
CPC International	1	Public	9,844.0	55,300	Dec. 31, 1996
California Oils	1	NA	<2.5	<150	1996
Tate and Lyle PLC[b]	1	Foreign	7,315.4	17,743	1996
Cottonseed Oil Mills-SIC 2074					
Archer Daniels Midland Company	7	Public	13,314.0	14,811	June 30, 1996
Chickasha Cotton Oil Company	5	Private	93.0	600	March 31, 1995
Delta Oil Mill	1	Private	22.5	90	July 31, 1996
Dunavant Enterprises[b]	2	Private	720.0	2,000	June 30, 1995
Hartsville Oil Mill Incorporated	1	Private	>20.0	100	1996
J.G. Boswell	1	Private	80.0[a]	1,000	June 30, 1993
Osceola Products	2	Private	50.0	170	July 31, 1996
Plains Cooperative Oil Mill, Inc.	1	Private	128.0	108	Sept. 30, 1995
Planter's Cotton Oil Mill	1	Private	35.0[a]	100	July 31, 1996
Producers Cooperative Mill	1	Private	35.0	100	June 30, 1996

(continued)

TABLE 4-4. COMPANY-LEVEL DATA FOR SOLVENT EXTRACTION VEGETABLE OIL MANUFACTURERS (CONTINUED)

Company	Number of Facilities within SIC Code	Organization Type	Sales ($\$10^6$)	Employment	Fiscal Year Ending
Cottonseed Oil Mills-SIC 2074 (continued)					
Valley Cooperative Mills	1	Private	32.0[a]	100	1992
Yazoo Valley Oil Mill, Inc.	3	Private	113.7	300	July 31, 1996
Soybean Oil Mills-SIC 2075					
Ag Processing	8	Private	1,370.0	3,000	Aug. 31, 1995
Archer Daniels Midland Company	18	Public	13,314.0	14,811	June 30, 1996
Bunge Corporation	7	Private	2,570.0	3,000	March 31, 996
Cargill Incorporated	15	Private	62,570.0	73,000	May 31, 1996
Central Soya Company	6	Private	1,000.0	1,200	Dec. 31, 1994
ConAgra	1	Public	24,821.6	83,123	May 26, 1996
Harvest States Cooperative[c]	1	Private	1,000.0[a]	2,400	May 31, 1996
Moorman Manufacturing[d]	3	Private	800.0[a]	3,500	March 31, 1996
Owensboro Grain Company	1	Private	39.0[a]	120	Nov. 30, 1989
Perdue Farms	2	Private	2,000.0	19,000	March 31, 1996
Riceland Foods Incorporated	1	Private	807.6	2,000	July 31, 1996
Rose Acre Farms Incorporated	1	Private	152.0	900	1996
Southern Soya Corporation	1	Private	8.0	89	May 31, 1996
Townsends	1	Private	270.0[a]	3,000	May 30, 1993

(continued)

TABLE 4-4. COMPANY-LEVEL DATA FOR SOLVENT EXTRACTION VEGETABLE OIL MANUFACTURERS (CONTINUED)

Company	Number of Facilities within SIC Code	Organization Type	Sales ($\$10^6$)	Employment	Fiscal Year Ending
Vegetable Oil Mills, Except Corn and Cottonseed-SIC 2076					
Archer Daniels Midland Company	5	Public	13,314.0	14,811	June 30, 1996
Cargill Incorporated	2	Private	62,570.0	73,000	May 31, 1996
Lubrizol Corporation[e]	1	Public	1,600.0	4,358	Dec. 31, 1996
Oilseeds International	1	NA	NA	NA	NA
Rito Partnership	1	NA	NA	NA	NA
Sessions Company	1	Private	30.0	100	Dec. 31, 1994

[a] Estimated by source.
[b] Owns A.E. Staley.
[c] Owns Anderson Clayton.
[d] Owns Honeymead Processing.
[e] Owns Quincy Soybeans.
[f] Owns SVO Specialty Products.

Sources: Information Access Corporation. Business Index [computer file]. Foster City, CA: Information Access Corporation. 1997.
Dun & Bradstreet. D & B Million Dollar Directory: America's Leading Public & Private Companies. Bethlehem, PA, Dun & Bradstreet Corporation. 1997.
1997 Directory of Corporation Affiliations. Vol. 5: International Public and Private Companies. New Providence, RI, National Register Publishing. 1997.
Standard and Poor's Corporation. [CD-ROM]. Palo Alto, CA: Dialog Information Services. 1997.
American Business Information (ABI). The American Business Disk [computer file]. Omaha, NE: American Business Information. 1997.

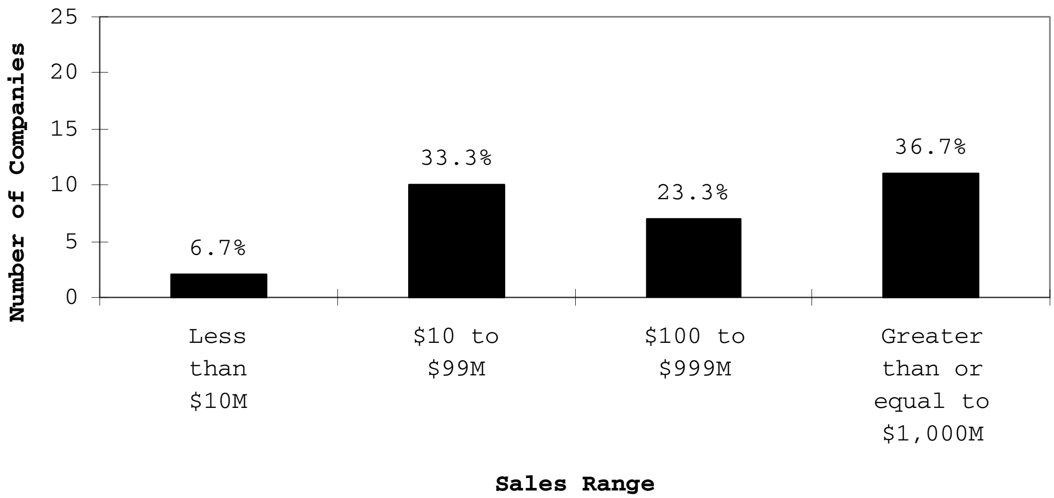

Figure 4-9. Distribution of companies that own vegetable oil manufacturing facilities by sales range.

Figure 4-10 shows the size distribution by employment for the 30 companies with data available. A total of 16 companies (53.3 percent) employed more than 1,000 employees and two companies (6.7 percent) reported employment between 500 and 999. The remaining 12 companies (40.0 percent) reported fewer than 500 employees.

4.3.3 Horizontal and Vertical Integration

Companies within the vegetable oil industry may be horizontally and/or vertically integrated. Horizontally integrated firms own several plants, each of which performs the same for similar functions. For example, a company may own several plants that produce soybean oil. As shown in Table 4-2, vegetable oil companies often own more than one

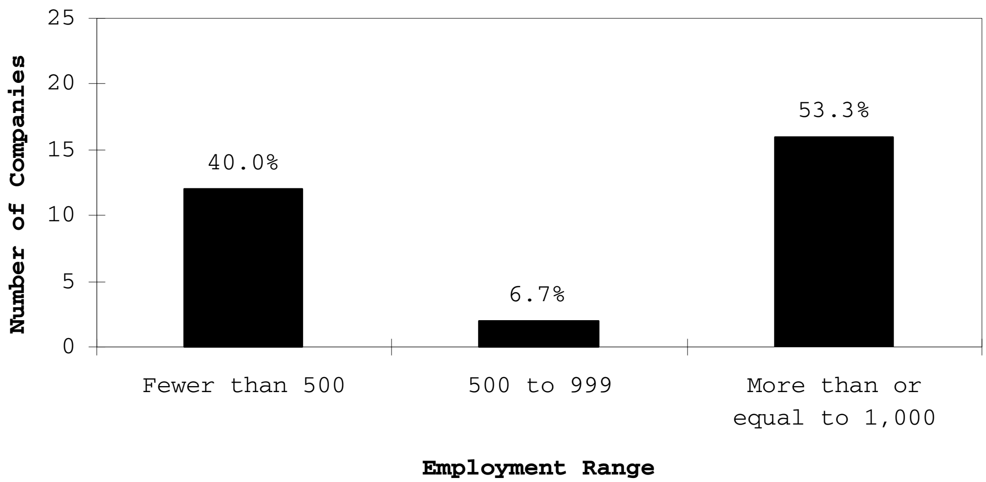

Figure 4-10. Distribution of companies that own vegetable oil manufacturing facilities by employment range.

manufacturing plant, which suggests several firms are horizontally integrated. A total of ten companies (31 percent) own more than one facility.

Vertically integrated firms may produce the inputs used in their production process or use the product as an input into other production processes. These firms may own several plants, each of which handles these different stages of production. For example, a company that crushes soybeans may also refine the oil and produce the final edible or industrial product. Data obtained from the Soya Bluebook Plus and company 10-K reports, suggest that larger vegetable oil manufacturers are vertically integrated. For example, ConAgra has announced plans to build a soybean crushing, refining and packaging facility to be completed in 1999 in order to "complete ConAgra's vertical integration in the soybean industry."[123] Other companies such as Archer Daniels Midland and Cargill Incorporated engage in the processing and refinement of raw materials as well as the production of the final vegetable oil products.

4.4 SMALL BUSINESSES IMPACTS

Vegetable oil firms can be grouped into small and large categories using the Small Business Administration's (SBA) general size standard definitions. These standards are organized by SIC code and are based on either the number of employees or by annual receipt levels of the firm. According to SBA size standards, firms falling under SIC codes 2074 Cottonseed Oil Mills and 2075 Soybean Oil Mills are categorized as small if the total number of employees falls below 500. Firms under SIC code 2046 Wet Corn Milling are categorized small if the number of employees is less than 750. Firm classified under SIC 2076 Vegetable Oils, except corn, soybean, and cottonseed are considered small if they employ less than 1,000 employees.

Table 4-5 lists the employment and sales data for small companies that are owners of vegetable oil manufacturing facilities using the solvent extraction method.[124,125,126] Based on the SBA definitions outlined above, a total of 14 firms can be classified as small. Two of these firms, Oilseeds International and Rito Partnership, do not have employment data available and are included as potential small businesses.

TABLE 4-5. CHARACTERISTICS OF SMALL BUSINESSES IN THE SOLVENT EXTRACTION VEGETABLE OIL INDUSTRY

Company	Number of Facilities within SIC Code	Organization Type	Sales ($\$10^6$)	Employment	Fiscal Year Ending
Wet Corn Milling-SIC 2046					
California Oils	1	NA	<2.5	<150	1996
Cottonseed Oil Mills-SIC 2074					
Delta Oil Mill	1	Private	22.5	90	July 31, 1996
Hartsville Oil Mill Incorporated	1	Private	>20.0	100	1996
Osceola Products	2	Private	50.0	170	July 31, 1996
Plains Cooperative Oil Mill, Inc.	1	Private	128.0	108	Sept. 30, 1995
Planter's Cotton Oil Mill	1	Private	35.0[a]	100	July 31, 1996
Producers Cooperative Mill	1	Private	35.0	100	June 30, 1996
Valley Cooperative Mills	1	Private	32.0[a]	100	1992
Yazoo Valley Oil Mill, Inc.	3	Private	113.7	300	July 31, 1996
Soybean Oil Mills-SIC 2075					
Owensboro Grain Company	1	Private	39.0[a]	120	Nov. 30, 1989
Southern Soya Corporation	1	Private	8.0	89	May 31, 1996

(continued)

TABLE 4-5. CHARACTERISTICS OF SMALL BUSINESSES IN THE SOLVENT EXTRACTION VEGETABLE OIL INDUSTRY (CONTINUED)

Company	Number of Facilities within SIC Code	Organization Type	Sales ($\$10^6$)	Employment	Fiscal Year Ending
Vegetable Oil Mills, Except Corn and Cottonseed-SIC 2076					
Oilseeds International	1	NA	NA	NA	NA
Rito Partnership	1	NA	NA	NA	NA
Sessions Company	1	Private	30.0	100	Dec. 31, 1994

Note: Small Business Administration size definitions:
2046 - <750 employees
2074 - <500 employees
2075 - <500 employees
2076 - <1,000 employees

Sales and employment data represent the most recent figures reported in the sources identified below. Companies without published sales and employment data are assumed to be small.

[a] Estimated by source.
[b] Owns A.E. Staley.
[c] Owns Anderson Clayton.
[d] Owns Honeymead Processing.
[e] Owns Quincy Soybeans.
[f] Owns SVO Specialty Products.

Sources: Information Access Corporation. Business Index [computer file]. Foster City, CA: Information Access Corporation. 1997.
Standard and Poor's Corporation. [CD-ROM]. Palo Alto, CA: Dialog Information Services. 1997.
American Business Information (ABI). The American Business Disk [computer file]. Omaha, NE: American Business Information. 1997.

SECTION 5
MARKETS

The following section includes historical information on domestic production and consumption of vegetable oil as well as a discussion of prices. It also includes information on imports and exports, and finally, this section presents information on trends and projections for the vegetable oil industry.

5.1 HISTORICAL MARKET DATA

The quantities of vegetable oils produced and consumed annually in the United States, prices of vegetable oils, and foreign trade are discussed below.

5.1.1 Domestic Production

Table 5-1 presents the U.S. production of various vegetable oils from 1984 through 1996.[127] Production of corn, cottonseed, soybean, and all other vegetable oils grouped together, is graphed in Figure 5-1 for these years as well.[128] The volume of soybean oil produced dwarfs that of all other types of vegetable oils.

The 5-year average annual growth rates (1992-1996) for domestically produced vegetable oils are presented in

TABLE 5-1. U.S. PRODUCTION OF EDIBLE VEGETABLE OILS: 1984-1996

	Production (10^3 lbs)							
Year[a]	Canola	Corn	Cottonseed	Peanut	Safflower	Soybean	Sunflower	Total Production
1984	0	1,194	1,175	187	64	11,468	483	14,571
1985	0	1,253	1,070	257	73	11,627	584	14,864
1986	0	1,400	781	152	98	12,783	587	15,801
1987	14	1,436	1,204	168	93	12,974	831	16,720
1988	54	1,415	1,243	250	96	11,737	518	15,313
1989	130	1,470	1,039	193	103	13,004	475	16,414
1990	18	1,656	1,154	213	78	13,408	536	17,063
1991	32	1,821	1,279	356	69	14,345	911	18,813
1992	49	1,878	1,137	286	87	13,778	730	17,945
1993	406	1,906	1,119	212	111	13,951	580	18,285
1994	299	2,217	1,312	314	115	15,613	1,165	21,035
1995	355	2,096	1,213	321	123	15,263	815	20,186
1996	307	2,160	1,250	211	109	15,400	728	20,165

[a] The reporting year runs from October to September.

Source: U.S. Department of Agriculture, Economic Research Service. Oil Crops Yearbook. OCS-1996. Washington, DC, U.S. Department of Agriculture. October 1996.

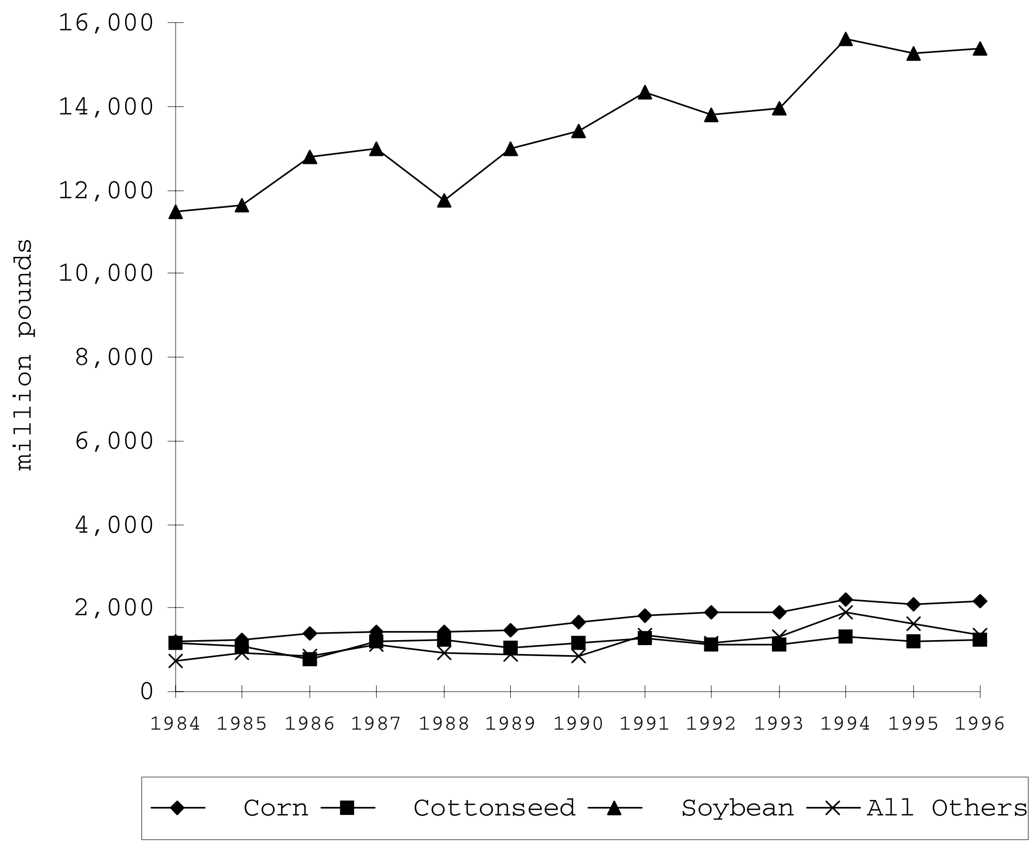

Figure 5-1. Production of corn, cottonseed, soybean, and all other vegetable oils: 1984-1996.[a]

[a] The reporting year runs from October to September.

Source: U.S. Department of Agriculture. Economic Research Service. Oil Crops Yearbook. OCS-1996. Washington, DC, U.S. Department of Agriculture. October 1996.

Table 5-2.[129] During this period, the growth rate for the production of canola oil was an extraordinary 152.1 percent per year, and its production now exceeds that of both peanut oil and safflower oil. Safflower oil production also showed a

TABLE 5-2. 5-YEAR AVERAGE ANNUAL GROWTH RATES IN PRODUCTION OF VEGETABLE OILS: 1992-1996[a]

Type of Oil	Annual Growth Rate
Canola	152.1%
Corn	3.7%
Cottonseed	0.0%
Peanut	-5.9%
Safflower	10.6%
Soybean	1.6%
Sunflower	3.9%
Total	1.6%

[a] The reporting year runs from October to September.

Source: U.S. Department of Agriculture, Economic Research Service. Oil Crops Yearbook. OCS-1996. Washington, DC, U.S. Department of Agriculture. October 1996.

strong annual growth rate of 10.6 percent. Corn and sunflower oil production grew at modest rates of 3.7 percent and 3.9 percent respectively. Soybean oil production grew 1.6 percent, while cottonseed oil production showed no change. During this time, peanut oil production declined at an annual rate of 5.9 percent. On the average, production of all vegetable oils increased 1.6 percent during that period.

5.1.2 Domestic Consumption

Table 5-3 presents U.S. consumption of vegetable oils, including imported tropical oils, from 1984 through 1996.[130]

TABLE 5-3. U.S. CONSUMPTION OF EDIBLE VEGETABLE OILS[a]: 1984-1996

	Consumption (10^3 lbs)										
Year[b]	Canola	Coconut	Corn	Cotton-seed	Palm	Palm kernel	Peanut	Safflower	Soybean	Sunflower	Total Consumption
1984	NA	851	930	684	370	284	174	25	9,917	144	13,379
1985	NA	1,019	863	650	591	333	121	51	10,553	144	14,325
1986	181	1,076	1,143	573	507	381	161	57	10,833	186	15,098
1987	261	935	1,066	750	342	467	219	24	10,930	88	15,082
1988	488	904	1,073	850	315	375	227	44	10,591	126	14,993
1989	510	866	1,028	765	256	344	193	110	12,083	174	16,329
1990	577	897	1,149	851	256	362	197	58	12,164	200	16,711
1991	801	906	1,202	1,075	223	344	179	18	12,245	396	17,389
1992	898	1,082	1,219	995	271	254	236	47	13,054	188	18,244
1993	1,162	1,067	1,228	873	359	315	187	40	12,941	129	18,301
1994	1,165	1,082	1,238	1,006	225	295	206	57	12,916	171	18,361
1995	1,257	999	1,334	990	240	293	192	35	13,450	125	18,915
1996	1,279	992	1,285	1,015	254	304	185	46	13,550	150	19,060

[a] Consumption is calculated as (Beginning Stocks + Production + Imports) - (Ending Stocks + Exports).
[b] The reporting year runs from October to September.

Source: U.S. Department of Agriculture, Economic Research Service. Oil Crops Yearbook. OCS-1996. Washington, DC, U.S. Department of Agriculture. October 1996.

Total domestic consumption of vegetable oils increased by 42 percent during that time. Consumption increased for all types of vegetable oils, except for palm oil. Consumption of canola oil increased dramatically and currently exceeds domestic production.[131]

The 5-year average annual growth rates for vegetable oil consumption are presented in Table 5-4.[132] All of the vegetable oils listed experienced positive annual rates of growth except for cottonseed oil, which showed an average annual rate of decline of 0.7 percent, and palm oil, which declined an average of 1.1 percent per year during that time. The overall annual average increase in consumption was 1.9 percent.

Per-capita consumption values were previously discussed in Section 3. Table 3-1 shows the increasing trend in per-capita consumption of fats and oils in the United States from 1975 to 1995. This upward trend in per capita consumption continued until reaching a peak in 1993, then declined slightly in 1995 and 1996.

5.1.3 Vegetable Oil Prices

Table 5-5 presents U.S. prices in current dollars for domestic crude vegetable oils from 1970 through 1996.[133,134] Soybean oil prices are generally lower than prices for other vegetable oils. For the year beginning October 1, 1995, corn oil and sunflower sold for 3 percent more than soybean oil.

Cottonseed oil sold for 7 percent more, and peanut oil sold for 63 percent more than soybean oil.

TABLE 5-4. 5-YEAR AVERAGE ANNUAL GROWTH RATES IN CONSUMPTION OF VEGETABLE OILS: 1992-1996[a]

Type of Oil	Annual Growth Rate
Canola	10.3%
Coconut	2.2%
Corn	1.4%
Cottonseed	-0.7%
Palm	5.8%
Palm kernel	-1.1%
Peanut	2.2%
Safflower	36.3%
Soybean	2.1%
Sunflower	-11.7%
Total	1.9%

[a] The reporting year runs from October to September.

Source: U.S. Department of Agriculture, Economic Research Service. Oil Crops Yearbook. OCS-1996. Washington, DC, U.S. Department of Agriculture. October 1996.

Table 5-6 contains 1995-1996 prices for other fats and oils.[135] For comparison, the price of coconut oil averaged 39.07 cents per pound during that period, which was 58 percent higher than the price of soybean oil. Palm oil cost 27.61 cents per pound, or 12 percent more than the price of soybean oil. Olive oil commanded the very high price of $1.77 per pound during this period, which was more than seven times the price of soybean oil.

TABLE 5-5. AVERAGE CURRENT DOLLAR PRICES OF CRUDE VEGETABLE OILS (CENTS/LB): 1970-1996

Year Beginning Oct. 1	Corn Oil	Cottonseed Oil	Peanut Oil	Soybean Oil	Sunflower Seed Oil
	Chicago	Valley Points[b]	Southeast Mills	Decatur	Minneapolis
1970		15.21		12.84	
1971		12.27		11.27	
1972		16.52		16.46	
1973		33.32		31.53	
1974		31.71		30.69	
1975		23.46		18.30	
1976	29.65	24.81		23.87	
1977	35.43	25.43		24.51	
1978	32.76	31.63		27.15	33.02
1979	27.38	25.34		24.32	26.08
1980	25.22	25.86		22.73	26.94
1981	23.42	20.10		18.95	24.95
1982	23.82	21.80		20.62	22.45
1983	28.62	32.80		30.55	33.61
1984	29.14	29.20		29.51	29.98
1985	18.46	16.91		18.00	19.10
1986	21.43	17.67		15.40	16.01
1987	23.27	21.67		22.67	23.59
1988	21.01	19.71		21.10	22.68
1989	24.82	23.30		22.30	24.40
1990	27.50	22.30		21.00	23.59
1991	25.82	20.10	27.30	19.10	21.63
1992	20.90	30.07	27.40	21.40	25.37
1993	26.38	30.30	43.20	27.10	31.08
1994	26.47	29.23	44.30	27.60	28.10
1995	25.55	26.53	40.30	24.75	25.40
1996[a]	24.00	25.25	40.60	22.60	22.60

[a] Data for 1996 are preliminary.
[b] Cottonseed oil prices starting in 1992 are Greenwood basis rather than Minneapolis.

Sources: U.S. Department of Agriculture, Economic Research Service. Oil Crops Yearbook. OCS-1996. Washington, DC, U.S. Department of Agriculture. October 1996.

U.S. Department of Agriculture, Economic Research Service. Oil Crops Outlook. OCS-0897. Washington, DC, U.S. Department of Agriculture. August 13, 1997.

TABLE 5-6. PRICES FOR OTHER FATS AND OILS: 1995-1996

	Price (cents/lb.)
Crude coconut oil[a]	39.07
Refined palm oil[a]	27.61
Olive oil[a]	177.00
Butter[b]	76.00
Edible tallow[b]	21.35
Lard[b]	30.30

[a] Reported for the year beginning October 1, 1995.
[b] Reported for the calendar year, 1995.

Source: For coconut and palm oils: U.S. Department of Agriculture, Economic Research Service. Oil Crops Yearbook. OCS-1996. Washington, DC, U.S. Department of Agriculture. October 1996. Tables 40f and g. Average from October 1995 to September 1996.

For olive oil: U.S. Department of Agriculture, Economic Research Service. Oil Crops Yearbook. OCS-1996. Washington, DC, U.S. Department of Agriculture. October 1996. Page 14.

For butter, tallow and lard: U.S. Department of Agriculture, Economic Research Service. Oil Crops Yearbook. OCS-1996. Washington, DC, U.S. Department of Agriculture. October 1996. Tables 49, 50, 51.

The prices for butter, edible tallow, and lard are reported for the calendar year, rather than the crop year, so they cannot be compared directly. The numbers indicate, however, that tallow and lard may sell for slightly less than soybean oil, and butter for as much as three times the price.

At present, soybean oil prices are increasing. As of September 1, 1997, soybean oil stocks have declined, and prices have increased to above 23 cents per pound. For

1997-1998, soybean oil prices are expected to average between 23 cents and 26 cents per pound.[136]

5.1.4 Imports and Exports

Table 5-7 contains data on the quantities of major vegetable oils imported to and exported from the United States from 1985 through 1996.[137] Trade volumes for each type of oil are described in more detail below.

Canola Oil. Since 1985, when the Food and Drug Administration first approved of canola oil as a food, the United States has been a net importer of canola oil. Imports of canola oil come almost entirely from Canada.[138] The quantity of canola oil imported into the United States increased from 185 million pounds in 1986 to 1071 million pounds in 1996. The United States also exports small quantities of canola oil as well (132 million pounds in 1996).

Coconut Oil. The United States is a net importer of coconut oil, since no coconut oil is produced domestically. A total of 1,047 million pounds were imported in 1996, and small quantities of coconut oil are re-exported. The Philippines is the leading supplier of coconut oil to the United States, followed by Indonesia.[139,140,141]

Corn Oil. The United States mostly exports corn oil, but a small quantity is imported as well. The quantity of corn oil exported has risen steadily since 1988, with 900 million pounds being exported in 1996. The largest share of exported corn oil goes to Asia, with Turkey being the largest single importer of U.S. corn oil, followed by Western Europe and Central America.[142,143,144]

TABLE 5-7. IMPORTS AND EXPORTS OF EDIBLE VEGETABLE OILS: 1984-1996 (10^6 LBS)

	Canola Oil			Coconut Oil			Corn Oil	Cottonseed Oil		
Year[a]	Imports	Exports	Net Exports	Imports	Exports	Net Exports	Net Exports[b]	Imports	Exports	Net Exports
1984	--	--	--	891	20	-871	260	0	433	433
1985	--	--	--	1217	22	-1195	344	0	442	442
1986	185	0	-185	1087	49	-1038	268	11	214	203
1987	273	0	-273	1074	77	-997	367	25	409	384
1988	430	8	-422	778	55	-723	356	0	406	406
1989	391	6	-385	1038	44	-994	414	13	354	341
1990	583	7	-576	946	51	-895	498	3	249	246
1991	815	15	-800	838	22	-816	566	18	281	263
1992	861	16	-845	1162	15	-1147	712	38	177	139
1993	902	76	-826	999	20	-979	716	26	248	222
1994	938	153	-785	1100	18	-1082	875	0	329	329
1995	1026	143	-883	948	18	-930	900	0	207	207
1996	1071	132	-939	1047	18	-1029	900	0	225	225

(continued)

TABLE 5-7. IMPORTS AND EXPORTS OF EDIBLE VEGETABLE OILS (10^6 LBS): 1984-1996 (CONTINUED)

	Peanut Oil			Safflower Oil			Soybean Oil			Sunflower Oil		
Year[a]	Imports	Exports	Net Exports	Imports	Exports	Net Exports	Imports	Exports	Net Exports	Imports	Exports	Net Exports
1984	2	29	27	0	32	32	20	1660	1640	0	287	287
1985	1	93	92	0	33	33	8	1257	1249	0	452	452
1986	2	6	4	0	29	29	15	1187	1172	0	343	343
1987	33	7	-26	0	55	55	196	1873	1677	4	703	699
1988	2	11	9	21	61	40	138	1661	1523	0	468	468
1989	5	19	14	31	43	12	22	1353	1331	5	350	345
1990	10	25	15	22	56	34	17	780	763	33	359	326
1991	1	151	150	22	73	51	1	1648	1647	9	471	462
1992	0	52	52	15	65	50	10	1419	1409	0	586	586
1993	11	61	50	16	75	59	68	1529	1461	7	450	443
1994	4	97	93	26	93	67	17	2680	2663	1	978	977
1995	5	108	103	28	95	67	100	1040	940	2	628	626
1996	5	60	55	25	95	70	75	1700	1625	5	617	612

[a] The reporting year runs from October to September.
[b] Imports and exports are not reported separately for corn oil.

Source: U.S. Department of Agriculture, Economic Research Service. Oil Crops Yearbook. OCS-1996. Washington, DC, U.S. Department of Agriculture. October 1996.

pounds being exported in 1996. The largest share of exported corn oil goes to Asia, with Turkey being the largest single importer of U.S. corn oil, followed by Western Europe and Central America.[145,146,147]

Cottonseed Oil. Exports of cottonseed oil from the United States have declined since 1984 because domestic production has remained steady, while consumption has increased (See Tables 5-1 and 5-2). In recent years, the U.S. has not imported any cottonseed oil but in 1996, the United States exported 225 million pounds.[148] Latin America, Asia and Canada are the three largest importers of American cottonseed oil.[149,150,151]

Peanut Oil. The U.S. imports small quantities of peanut oil, but is a net exporter. Quantities exported have varied widely since 1984. In 1996, net exports of peanut oil from the U.S. were 55 million pounds[152] Western Europe and Asia receive most of the American peanut oil that is exported.[153,154,155]

Safflower Oil. Net exports of safflower oil have been increasing over time. In 1996, the United States imported 25 million pounds of safflower oil, and exported 95 million pounds.[156] Japan is the United States' biggest customer for safflower oil.[157,158,159]

Soybean Oil. The United States imports small quantities of soybean oil, relative to production, primarily from Canada, but is a net exporter. The volume of net exports varies considerably from year to year. Since 1984, the largest volume of exports occurred in 1994, when exports exceeded imports by 2,663 pounds. However, net exports fell to 1,625 million pounds in 1996.[160] China is the largest single importer of American soybean oil.[161,162,163]

Sunflower Oil. In 1996, net exports of sunflower oil from the United States were 612 million pounds.[164] Latin America and Africa are the two largest consumers of exported American sunflower oil.[165,166,167]

Palm Oils. Malaysia and Indonesia produce most of the palm and palm kernel oil imported to the United States. In 1996, the United States imported about 603 million pounds of palm oils.[168,169,170]

Olive Oil. Olive oil is imported to the United States mainly from Italy and Spain. In 1996, the quantity imported was about 248 million pound.[171,172,173]

Dollar Values of Exports and Imports. Table 5-8 presents the current dollar values of vegetable oils imported to and exported from the U.S., to and from all other countries, in 1995 and 1996.[174] In 1995, the value of vegetable oil exported from the U.S. was over $1.8 billion. The value of exports exceeded the value of imports during that year by about 26 percent. In 1996, however, the reverse was true. The dollar value of imports (about $1.7 billion) was about 21 percent greater than the value of exports.[175,176,177]

TABLE 5-8. CURRENT DOLLAR VALUE AT U.S. CRUDE AND REFINED VEGETABLE OIL IMPORTS AND EXPORTS, 1995-1996

Type of Vegetable Oil	Value of Imports ($$10^3$)		Value of Exports ($$10^3$)	
	1995	1996	1995	1996
Canola oil	$286,795	$332,940	$38,627	$51,949
Castor oil	$30,972	$30,044		
Coconut oil	$307,458	$304,343		
Corn oil			$257,113	$268,831
Cottonseed oil	$103	$86	$92,252	$63,933
Olive oil	$348,428	$470,014		
Palm oil	$55,584	$59,259		
Palm oil kernel oil	$88,880	$114,319		
Peanut oil	$3,123	$2,532	$44,671	$33,001
Safflower oil	$51,052	$53,227		
Sesame oil	$21,852	$21,735		
Soybean oil	$9,403	$29,254	$694,080	$325,919
Sunflower oil			$299,489	$164,432
Other vegetable oils	$290,783	$297,989	$342,751	$413,611
Total	$1,443,381	$1,662,515	$1,820,035	$1,374,903

Source: U.S. Department of Agriculture, Economic Research Service. Foreign Agricultural Trade of the United States. January/February/March 1997. Final Issue. Washington, DC, USDA.

These values are further broken out for 1996 by top three importing and exporting countries for soybean, cottonseed, corn, and combined sunflower and safflower oil in Table 5-9.[178,179,*]

[*]The total values reported in Tables 5-8 and 5-9 differ slightly because they are from different sources. The Foreign Agricultural Trade of the United States(FATUS) data used in Table 5-8 include all forms of crude and refined vegetable oils. The U.S. Department of Commerce data presented in Table 5-9 exclude the small category “wholly hydrogenated oils”. In addition, Department of Commerce data may include revisions

TABLE 5-9. VALUE OF SELECTED CRUDE AND REFINED VEGETABLE OIL IMPORTS AND EXPORTS BY COUNTRY ($\$10^3$): 1996

	Import[a]		Export[b]	
	Value	Share	Value	Share
Soybean oil				
Canada	28,206	58.3%	28,003	8.7%
Mexico	16,974	35.1%	31,364	9.7%
China			104,467	32.3%
All others	3,221	6.7%	159,447	49.3%
Total	48,401		323,281	
Cottonseed oil				
Canada	63	100.0%	14,950	25.9%
Japan			10,873	18.9%
El Salvador			12,363	21.4%
All others			19,467	33.8%
Total	63		57,653	
Corn Oil				
Canada	5,069	94.0%	4,138	1.5%
Italy			26,202	9.6%
Saudi Arabia			37,337	13.7%
Turkey			56,598	20.8%
All others	322	6.0%	147,403	54.3%
Total	5,391		271,678	
Sunflower & Safflower Oil				
Argentina	39,781	62.7%	52	0.0%
Egypt			27,263	12.5%
Japan			51,087	23.5%
Mexico	21,912	34.6%	65,718	30.2%
All others	1,718	2.7%	73,538	33.8%
Total	63,411		217,658	

[a] Customs value basis.
[b] F.A.S. value basis.

not included in FATUS data.

Source: U.S. Department of Commerce, Bureau of the Census. U.S. Exports and Imports by Harmonized Commodity, 1996 Annual. FT947/96A. Washington, DC, Government Printing Office. July 1997.

5.2 TRENDS AND PROJECTIONS

This section presents information on futures prices for vegetable oils, and how recent trends in consumption and production may be useful in predicting future supply and demand for vegetable oil.

5.2.1 Futures Prices

Soybean oil and some oilseeds are traded on the futures market. In the futures market, "futures contracts" are bought and sold. A futures contract is an agreement to deliver a specified quantity of a commodity on a specific date in the future and trading usually begins about a year before the delivery date for the commodity. Futures prices reflect trader's expectations about where prices will be at the time of delivery.[180] The futures prices reported in the Wall Street Journal on November 3, 1997, indicate that prices for soybean oil and oilseeds should remain strong through the upcoming year. Futures prices for soybean oil through December 1998, range between 25.5 and 26.2 cents per pound. Canola oilseed futures prices increase through July 1998, and corn grain prices are expected to increase through 1999.

5.2.2 Trends in Consumption

One analyst predicts that the domestic market for vegetable oils will decline by 4.4 percent between 1995 and the year 2000, because of increased consumer awareness about the dangers of a high-fat diet.[181] The data do not support this prediction, however. Despite growing knowledge about the importance of a low-fat diet, total consumption of vegetable oils in the United States continues to increase.

As was previously mentioned, Table 5-4 shows that the average annual rate of growth in consumption was 1.9 percent from 1992 through 1996. For certain types of vegetable oils, consumption increased at much greater rates. Consumption of canola and safflower oils have increased at the rates of 10.3 percent and 36.3 percent respectively. Some of the growth in total consumption can be explained by population growth. Table 3-2 shows that per-capita consumption declined slightly in 1994 and 1995, after decades of increases, but it is too soon to determine whether this may have been an adjustment after a year of unusually high consumption in 1993, or an indication of a downward trend.

In addition to an upward trend in domestic consumption, foreign demand for vegetable oil is expected to grow. For the 1997/98 crop year, exports of soybean oil are expected to increase to 2,400 million pounds (a 41 percent increase from last year), largely because of increasing demand from China.[182]

Even if domestic per-capita consumption of vegetable oils for edible uses remains flat or declines slightly, demand for vegetable oils should remain strong for three reasons: 1) The U.S. population is expected to continue growing;[183] 2) Foreign demand is increasing;[184] 3) Demand for vegetable oil for inedible uses such as vegetable-oil based inks, and biodiesel will continue to grow (see Section 3.2).

5.2.3 Trends in Production

As Table 5-2 shows, all of the major vegetable oils except for peanut oil, experienced positive rates of growth in production between 1992 and 1996. The overall average rate of growth was 1.6 percent. The annual average rates for safflower and canola in particular were 10.6 percent and 152.1 percent respectively. There is no evidence that these trends will not continue. For the 1996-1997 crop year (October-September), production of soybean oil is estimated to be 15.7 billion pounds, an increase of about 2 percent over the 1995-1996 year.[185]

Expected prices for various crops influence a farmer's planting decisions from year to year. Future levels of production of any agricultural commodity in a particular year can be difficult to predict, because of fluctuations in growing conditions. Based on recent trends, however, it would be reasonable to expect slow, steady growth in the production of major vegetable oils (primarily soybean oil), and rapid growth in the production of the minor specialty oils, canola and safflower.

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