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Pesticide Industry: A Profile

Draft Report

Prepared for

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U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Cost and Economic Impact Section
Research Triangle Park, NC 27711

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TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

LIST OF TABLES

hydrochloric acid, trifluralin, and several metallic compounds.[3] Both the quantity and type of air emissions from pesticide manufacturing processes vary greatly depending on the type of active ingredient produced, the final form of the product, and the type of control techniques used.

1.1 REGULATED ENTITIES AND POLICY ALTERNATIVES

1.1.1 Regulated Entities

Regulated entities include the manufacturers of pesticide active ingredients (PAIs). The pesticide industry includes both PAI manufacturers and pesticide formulators. Manufacturers of PAIs perform a different role than formulators in this industry. PAI manufacturers perform chemical reactions of two or more raw materials (organic and/or inorganic compounds) in the presence of solvents, catalysts, and acidic or basic reagents to produce a PAI. Formulators then take the manufactured PAIs as inputs and combine them with solid, liquid, and/or gaseous diluents before use.

1.1.2 Issues of Data Reporting

Pesticides are classified in SIC 2879, agricultural chemicals, n.e.c., which include pesticide preparations or formulations, and in SIC 28694, pesticide and other organic agricultural chemicals, which are active ingredients that can be used to formulate pesticides.

It appears that the proposed EPA regulation addresses those facilities in SIC 28694 primarily engaged in the manufacture of PAIs.

However, data reported by EPA indicate that the majority of pesticide manufacturers in the industry are vertically integrated, with 56 percent of the pesticide manufacturing facilities also engaging in formulating and packaging.[4]

In addition, 90 facilities have been identified as manufacturers of PAIs[5] whereas SIC 28694 includes only 20

establishments. It is likely that while the 277 establishments in SIC 2879 primarily engage in the formulation of PAIs, some subset of those facilities also engage in the manufacture of PAIs. For this reason, census data reported in this profile are reported separately for both SIC 28694* and 2879.

1.1.3 Policy Alternatives

The following methods may have potential to reduce air emissions related to pesticide production: use of alternative solvents or active ingredients, reformulating organic solvent-containing pesticides, use of microencapsulation manufacturing techniques (coating the active ingredient to form very small capsules), and good housekeeping at facilities.[6] Organic solvent and active ingredient substitutions have the highest potential to reduce air emissions. Reformulation and microencapsulation are expected to yield much lower emission reductions due to the complexity and very high costs of implementing these techniques. Good housekeeping is also not anticipated to have a significant impact on air emissions.[7]

1.2 REGULATORY ENVIRONMENT

The following discussion addresses the environmental regulatory environment surrounding the pesticide industry including those regulations that do not affect air emissions from the manufacturing process. Although the industry is regulated by a variety of health and safety regulations, these regulations are not discussed here. The regulation of pesticides attempts to balance the benefits of pesticides use with the potential costs associated with adverse environmental and health effects. This regulatory system originated with

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*Where Census data are not available at the 5-digit level, data are reported for SIC 2869, at the 4-digit level. These data will include all industrial organic chemicals, n.e.c., and not just PAIs.

the enactment of FIFRA in 1947. It states that a pesticide when used for its intended purpose must not cause "unreasonable adverse effects on the environment." Under this legislation, pesticide use is controlled via a registration process administered by EPA. Although a particular pesticide may have several different uses, each use is required to have its own registration. For a pesticide to be registered, manufacturers must provide EPA with data needed to support the product's registration, including substantiation of its usefulness and disclosure of its chemical and toxic properties, its likely distribution in the environment, and its possible effects on wildlife and plants.

In addition, the Federal Food, Drug and Cosmetic Act (FFDCA), originally enacted in 1954 and later amended, requires that a pesticide residue tolerance be defined for any pesticide used on food crops. This tolerance concentration, as defined under FFDCA, is the maximum quantity of a pesticide residue allowable on a raw agricultural commodity and in processed food when the pesticide has concentrated during processing.

Recently, under authority of the Clean Water Act, EPA promulgated a final rule establishing pesticide chemicals manufacturing category effluent limitation guidelines, pretreatment standards, and new source performance standards.

Presently, no regulations directly apply to air emissions that result from the manufacture or use of pesticides. However, existing and proposed regulations may have air pollution impacts. For example, the Resource Conservation and Recovery Act (RCRA) of 1976 regulates the generation, treatment, storage, transportation, and disposal of pesticide wastes in the form of solids, liquids, and contained gases.

1.3 OVERVIEW OF PROFILE

This profile begins by characterizing the supply side of the pesticide industry, including the stages of the production process, the types of pesticides, and the costs of production. Section 3 addresses the demand for pesticides. The organization of the pesticide industry is discussed in Section 4, including a description of U.S. manufacturing plants and the firms that own these plants. Finally, in Section 5, historical statistics on U.S. production and consumption of pesticides are presented as well as data on the foreign trade of pesticides.

SECTION 2
SUPPLY SIDE OF THE PESTICIDE INDUSTRY

2.1 PRODUCTION PROCESS

Pesticides are produced in two stages: the manufacture of a PAI, and the formulation of the final product.

2.1.1 Pesticide Manufacturing

A PAI is manufactured by chemical reaction of two or more raw materials often in the presence of solvents, catalysts, and acidic or basic reagents. Figure 2-1 illustrates an example flow schematic for the manufacture of a pesticide.[8] The manufacturing process can be as simple as a one-step reaction between two components followed by packaging of the final product to as complicated as a multi-step reaction followed by fractionation, separation, drying, and packaging. The proposed effluent guidelines identified a total of 225 separate PAI production processes that produce 835 different PAIs.[9]

Raw materials used in the production of pesticides might include a large number of organic and/or inorganic compounds. PAIs may also be used as raw materials in manufacturing derivative PAIs (intermediates), typically through the formation of various salts and esters. The manufacturing processes used by pesticide facilities are highly specialized with respect to the type of active ingredient being manufactured. In 1986, over 80 percent of the pesticide manufacturing processes were batch processes; the remaining were continuous processes.[10]

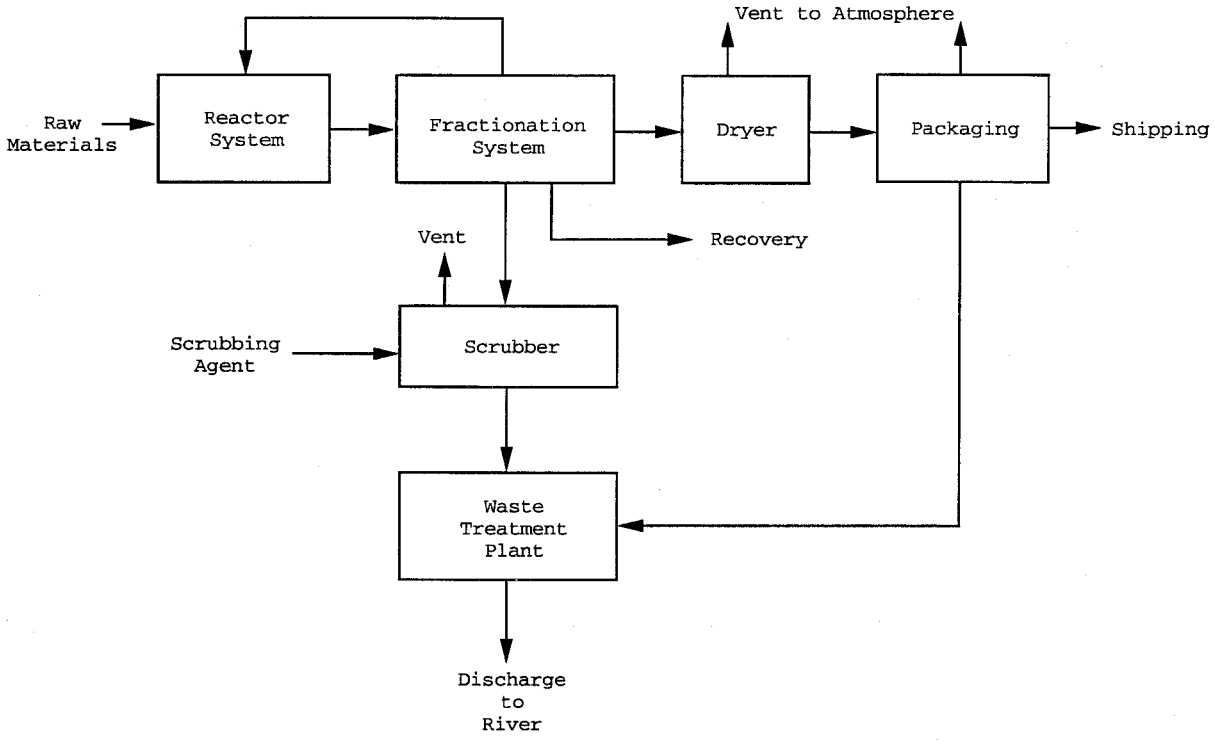


Figure 2-1. Example pesticide manufacturing flow schematic.[11]

2.1.2 Pesticide Formulation

The formulation process involves mixing, blending, and/or diluting one or more PAIs with solvents, inert materials, or dyes without an intended chemical reaction. PAIs are formulated into several different pesticide products for ease of application, effective application, and economy. An example of a formulation process schematic is presented in Figure 2-2. The formulated product is intended for direct application, which is usually in the form of dust, wettable powders, granules, emulsifiable concentrates, and aerosols. Pesticide formulation is done either by the manufacturer or by

independent formulators who purchase the basic PAIs from the manufacturers. As Figure 2-2 shows, formulation is typically a much less complicated process than the manufacture of the PAI.

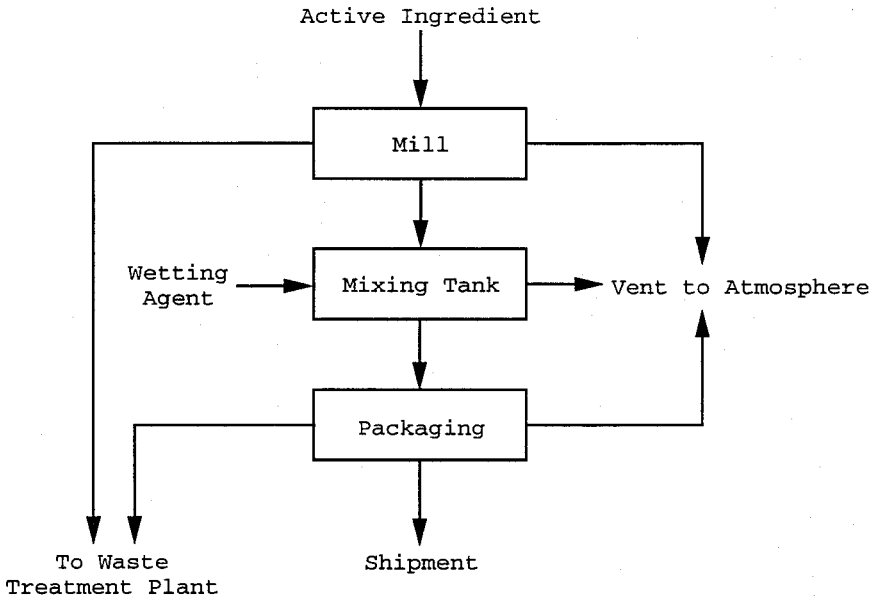


Figure 2-2. Example pesticide formulation flow schematic.[12]

2.2 TYPES OF PESTICIDES

Herbicides, insecticides, fungicides, and other chemicals make up the four classes of pesticides presented in this profile. This is the same categorization used by EPA's Office of Pesticide Programs (OPP) for its system of pesticide clusters.* These four types of pesticides are substances or mixtures of substances intended to prevent, destroy, repel, or mitigate any pest and any substance or mixture of substances intended for use as a plant regulator, defoliant, or

*In 1980, the OPP defined PAI markets to ensure that the EPA regulated competing PAIs fairly. Six hundred PAIs were classified into 48 clusters according to the major use of the chemicals.

desiccant. Pests targeted by pesticides include weeds, insects, fungi, and other forms of life. The four types of pesticides and their primary applications are described in Table 2-1.

Of these four types of pesticides, herbicides are the most used pesticide, accounting for 53 percent of the U.S. pesticide sales at the user level in 1991.[13] Figure 2-3 illustrates the share of sales for each pesticide in the U.S.

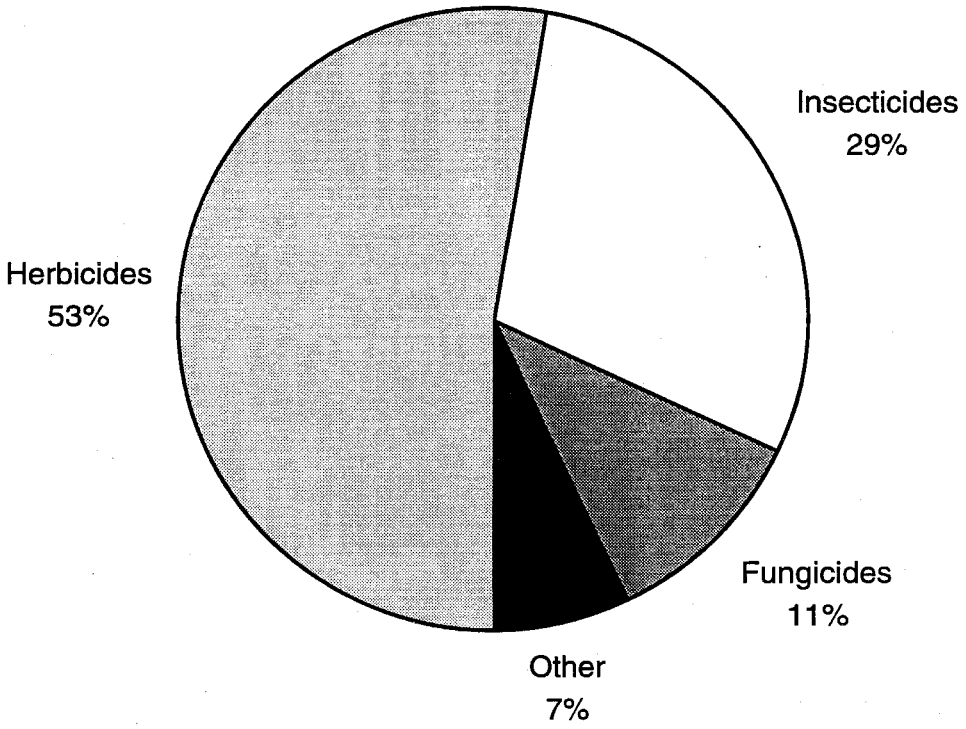


Figure 2-3. U.S. pesticide sales at user level, 1991 estimates.[14]

Herbicides, insecticides, fungicides, and other chemicals are considered conventional pesticides while wood preservatives, disinfectants, and sulfur are considered other types of pesticides. As Table 2-2 illustrates, the use of conventional pesticides has been greater than the use of other types of pesticides in both 1990 and 1991.[15]

2.3 COSTS OF PRODUCTION

The costs of production facing the pesticide industry include combinations of capital and labor. Table 2-3 reports new capital expenditures and costs of materials, labor and purchased fuels and electric energy. For SIC 2869, cost of materials in 1991 accounted for the largest share, 71 percent, of total production costs while costs of purchased fuels and electric energy accounted for the smallest share, 5 percent, of total production costs. New capital expenditures accounted for 11 percent of costs while cost of labor accounted for 13 percent.

For SIC 2879, the relative shares of labor and capital in 1991 were similar to those for SIC 2869. Cost of materials accounted for 71 percent of total production costs while cost of purchased fuels and electric energy only accounted for 3 percent. Labor costs accounted for 16 percent and new capital expenditures accounted for 10 percent of production costs. While only new capital expenditures are reported here, not capital stocks, it does appear that labor costs account for slightly more than new capital costs as a share of total costs for both SIC 2869 and 2879. The cost of materials accounts for the largest share of production costs in both SIC 2869 and 2879. Total pesticides R&D expenditures were $1,217 million in 1990 and $1,317 in 1991, a 7 percent increase.[16] As additional cost of production data become available for the pesticide industry, they will be added to this section.

TABLE 2-1. MAJOR TYPES OF PESTICIDES AND PRIMARY APPLICATIONS[17]

Pesticide:	Primary Application:
Herbicides used on:	
	Broad spectrum of uses
	Corn
	Soybeans, cotton, peanuts, alfalfa
	Sorghum, rice, and small grains
	Oranges
	Grapes
	Fruit trees
	Sugarbeets, beans, and peas
	Drainage ditches, rights of way, forestry, and ponds
	Turf
	Vegetables
	Tobacco
	Unclassified uses
Insecticides used on/for/as:	
	Cotton
	Soybeans, peanuts, wheat, and tobacco
	Corn and alfalfa
	Sorghum
	Fruit and nut trees, excluding oranges and grapes
	Oranges
	Grapes
	Vegetables
	Livestock and domestic animals
	Non-agricultural sites (as repellent)
	Domestic bug control and for food processing plants
	As fumigants and nematicides
	Termite control
	Lawns, ornamentals, and forest trees
	Mosquito larva
	Unclassified uses

(continued)

TABLE 2-1. MAJOR TYPES OF PESTICIDES AND PRIMARY APPLICATIONS (continued)

Pesticide:	Primary Application:
Fungicides used on:	
	Broad spectrum of uses
	Fruits and nuts
	Grapes
	Vegetables
	Oranges
	Seed treatments
	Post-harvest fruit and vegetables
	Grain storage
	Ornamentals
	Turf
	Unclassified uses
Other Pesticides:	
	Industrial preservatives
	Slimicides used in pulp and paper and cooling towers
	Industrial microbiocides
	Sanitizers used in dairies, food processing, and restaurants
	Synergists used as insecticide synergists, surfactants, chelating agents, and carriers
	Food preservatives
	Wood preservatives, used for industrial, commercial
	Disinfectants
	Water disinfectants
	Plant regulators, defoliants, and desiccants
	Preservatives, disinfectants, slimicides
	Molluscides and miscellaneous vertebrate control agents
	Bird chemosterilants, toxicants, and repellants
	Dog and/or cat repellants
	Rodent toxicants, anticoagulants, predator control
	Unclassified uses

TABLE 2-2. U.S. USAGE OF CONVENTIONAL PESTICIDES AND OTHER TYPES, 1990 AND 1991 ESTIMATES[18]

Type	Billion Pounds A.I.	
	1990	1991
Conventional Pesticides	1.09	1.08
Wood Preservatives	0.77	0.80
Disinfectants[a]	0.29	0.30
Sulfur	0.04	0.04
TOTAL	2.19	2.22

[a]This estimate is for disinfectants but not other antimicrobials. It includes food industries, swimming pools/spas, cooling towers, and household and commercial/industrial uses. It does not include chlorine products registered with EPA for disinfectant or drinking water treatment uses.

TABLE 2-3. COSTS OF PRODUCTION FOR SIC CODES 2869 AND 2879 ($ millions)[19]

	New Capital Expenditures				
	Buildings and Other Structures	Machinery and Equipment	Cost of Materials	Total Employee Compensation	Cost of Purchased Fuels and Electric Energy
SIC Code 2869					
1989	328.7	3,155.4	29,433.1	4,865.5	2,461.5
1990	351.3	3,804.9	30,091.0	5,229.3	2,549.1
1991	366.0	4,171.6	30,671.3	5,503.6	2,358.8
SIC Code 2879					
1989	73.5	429.5	3,451.5	761.8	144.3
1990	93.5	464.1	3,414.9	823.2	149.7
1991	57.1	423.9	3,399.3	779.2	145.7

SECTION 3
DEMAND FOR PESTICIDES

This section characterizes the demand side of the market for pesticides. We describe the pesticides's characteristics, the uses and consumers of pesticides, and the substitution possibilities in consumption.

3.1 PRODUCT CHARACTERISTICS

Goods are valued by the consumer because of the properties or characteristics they possess. These characteristics are taken to be an objective, universal property of the good.[20] Therefore, the demand for a commodity is not simply for the physical good itself but instead for the utility derived by the "services" generated by the commodity's attributes.

Pesticides fall predominantly into four classes: insecticides, herbicides, fungicides, and other pesticides.

3.1.1 Insecticides

Insecticides control insects that damage crops through a variety of means. Some work as nerve poisons, muscle poisons, desiccants, sterilants, or pheromones; others exert their effects by physical means such as clogging air passages. The classes of insecticides most commonly used today are chlorinated hydrocarbons, organophosphates, and carbamates, and of these, the organophosphates are the most widely used.

3.1.2 Herbicides

Herbicides are used to control weeds, which compete with crop plants for water, nutrients, space, and sunlight. By

reducing the weed population, the need for farm labor is decreased and crop quality is enhanced. Herbicides work through a variety of modes of action. Some damage leaf cells and desiccate the plant; others alter nutrient uptake or photosynthesis. Some herbicides inhibit seed germination or seedling growth. Others are applied to foliage and kill on contact, thereby destroying leaf and stem tissues.

3.1.3 Fungicides

Fungicides control plant molds and other diseases. They include compounds of metals and sulfur as well as numerous synthetics. Some fungicides act by inhibiting the metabolic processes of fungal organisms and can be used on plants that have already been invaded and damaged by the organism. Other fungicides protect plants from fungal growth before damage to plants can occur. Fungicides frequently provide direct benefits to humans by retarding or eliminating fungal infections that can produce toxicants.

3.1.4 Other Pesticides

"Other" pesticides are often defined as rodenticides, fumigants, and molluscicides but typically do not include wood preservatives, disinfectants, or sulfur.

3.2 USES AND CONSUMERS OF PESTICIDES

Three major markets exist in the pesticide industry: agriculture, industrial/institutional/commercial, and home/lawn/garden. Pesticide use in the agricultural market accounts for approximately 76 percent of domestic pesticide use. The industrial/commercial/institutional market and the home/lawn/garden market account for approximately 18 and 6 percent of domestic pesticide use, respectively (see Figure 3-1).

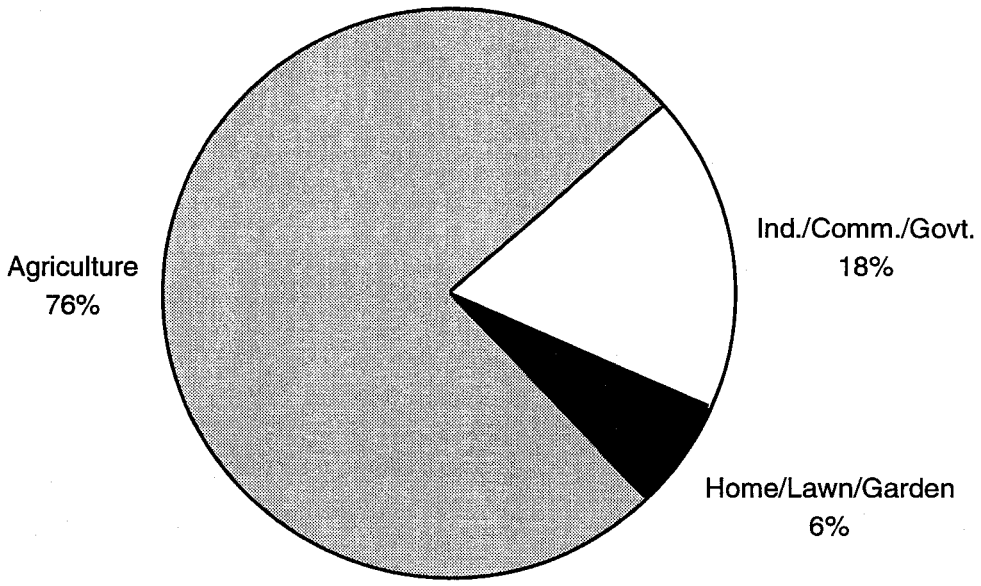
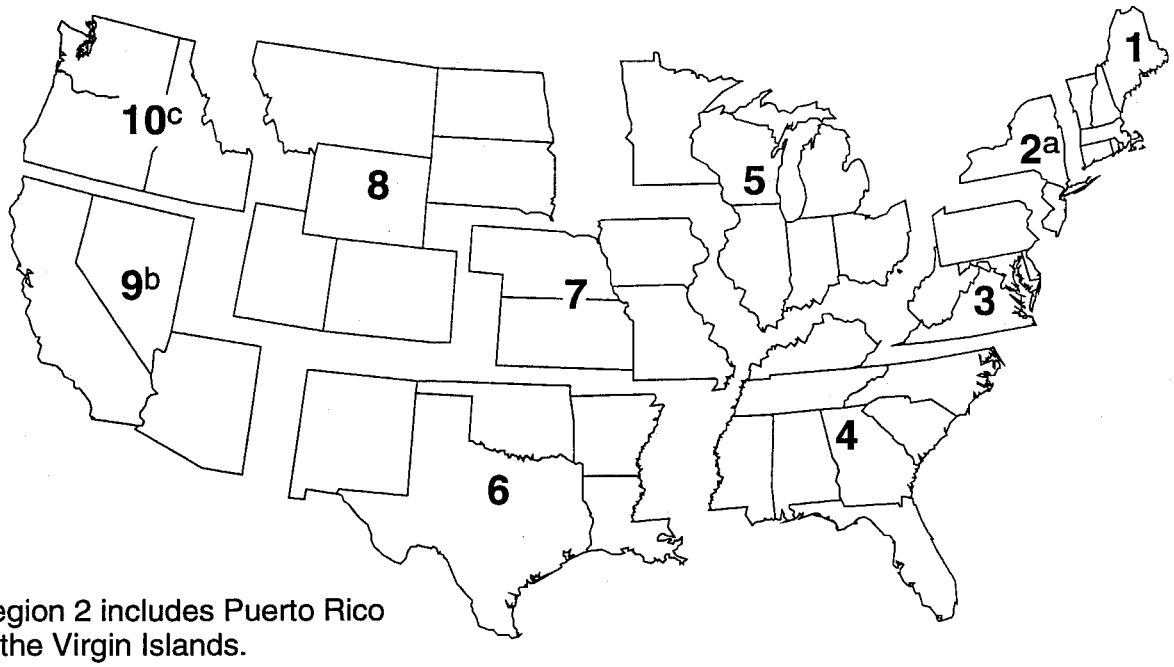


Figure 3-1. U.S. volume of pesticide usage by sector, 1991.[21]

Pesticides are applied by either private or commercial applicators. Private applicators are primarily individual farmers while commercial applicators are trained professionals skilled in applying pesticides in an efficient and environmentally safe manner. Figure 3-2 displays the ten different EPA regions, and Table 3-1 lists the number of private and commercial applicators within each EPA region. In total, the number of private applicators exceeds commercial applicators largely because of the large agricultural market. Most pesticide application in the industrial/commercial/ institutional and the home/lawn/garden markets and some in the agricultural market is performed by commercial applicators. Commercial applicators are typically contracted by the agricultural industry to apply pesticides to agricultural crops, as well as to food products during storage and transit. The industrial/commercial/institutional sector uses the services of commercial applicators to control pests in many



[a]Region 2 includes Puerto Rico & the Virgin Islands.
[b]Region 9 includes Hawaii.
[c]Region 10 includes Alaska.

Figure 3-2. U.S. EPA regional map.[22]

TABLE 3-1. NUMBER OF CERTIFIED APPLICATORS IN THE U.S., 1990 ESTIMATES[23]

EPA Region	Private	Commercial
1	7,869	9,025
2	28,735	49,071
3	47,690	22,581
4	225,370	46,925
5	156,925	41,997
6	225,831	34,585
7	140,870	27,418
8	70,510	46,774
9	21,389	20,888
10	39,284	26,092
U.S. TOTAL	975,473	325,336

settings including schools, health care facilities, prisons, food processing establishments, hotels, restaurants, factories, and warehouses. Household consumers use commercial applicators to manage pests that typically inhabit dwellings, such as termites, cockroaches, and mice, and to rid their lawn and garden of pests.

3.2.1 Agriculture Market

Agriculture accounts for over three-fourths of the quantity of pesticides used annually.[24] Approximately 62 percent of all planted agricultural acres are treated with at least one type of pesticide product.[25] The agricultural market consists primarily of field crops and fruits and nuts. Herbicides are the most commonly used form of pesticide for field crops; insecticides and fungicides are the more common pesticides for fruits and nuts. Table 3-2 presents various field crops and fruits and nuts and their respective percentage of acreage receiving the four major types of pesticides.

The agricultural sector has increasingly accounted for a higher percentage of total U.S. pesticide use since 1964. In 1964, this sector accounted for 59 percent (320 million pounds of active ingredient) of total domestic pesticide use, and this percentage increased to 76 percent (817 million pounds of active ingredient) in 1991. Figure 3-3 compares pesticide use for the agricultural sector to pesticide use for the entire United States.

3.2.2 Industrial/Commercial/Institutional

The industrial/commercial/institutional market differs from the agriculture market in many ways. First, the use of pesticide products in this sector is generally more uniform across the country. Second, pesticides used in this sector are generally used in smaller quantities per application than in the agriculture sector. Third, pesticides used in the industrial/ commercial/institutional sector are usually less

TABLE 3-2. PESTICIDE USE IN AGRICULTURE BY TYPE OF CROP AND PESTICIDE

Crop	Bearing Acreage	Percentage of Acreage Receiving Pesticide			
		Herbicide	Insecticide	Fungicide	Other Pesticides
Field Crops[26]	(1,000 acres)				
Corn	71,375	96	29	*	*
Upland Cotton	10,115	88	65	7	48
Fall Potatoes	1,068	81	90	72	43
Rice	2,030	97	11	21	1
Soybeans	53,050	97	1	*	*
Winter Wheat	36,390	33	5	2	*
Durum Wheat	2,150	93	*	1	*
Other Spring Wheat	17,350	87	1	4	*
Fruits and Nuts[27]	Acres				
Oranges	430,800	84	93	75	2
Grapefruit	110,400	75	96	89	7
Lemons	15,400	34	99	57	1
Limes	6,200	99	99	99	12
Tangelos	10,350	75	95	65	9
Tangerines	10,050	72	88	64	4
Temples	7,700	76	100	95	3
Apples	349,600	42	99	83	57
Avocados	9,000	91	79	98	*
Sweet Cherries	36,500	42	95	84	38
Tart Cherries	39,400	27	83	96	43
Grapes	94,050	73	64	75	3
Peaches	88,900	51	98	96	1
Pears	45,100	52	99	89	43
Prunes and Plumes	9,000	37	85	62	2
Hazelnuts	28,300	91	93	34	*
Pecans	NA	39	74	71	*
Blackberries	4,000	89	76	84	*
Blueberries	22,450	63	85	77	3
Raspberries	10,700	78	87	83	*

*Applied on less than one percent of acres.

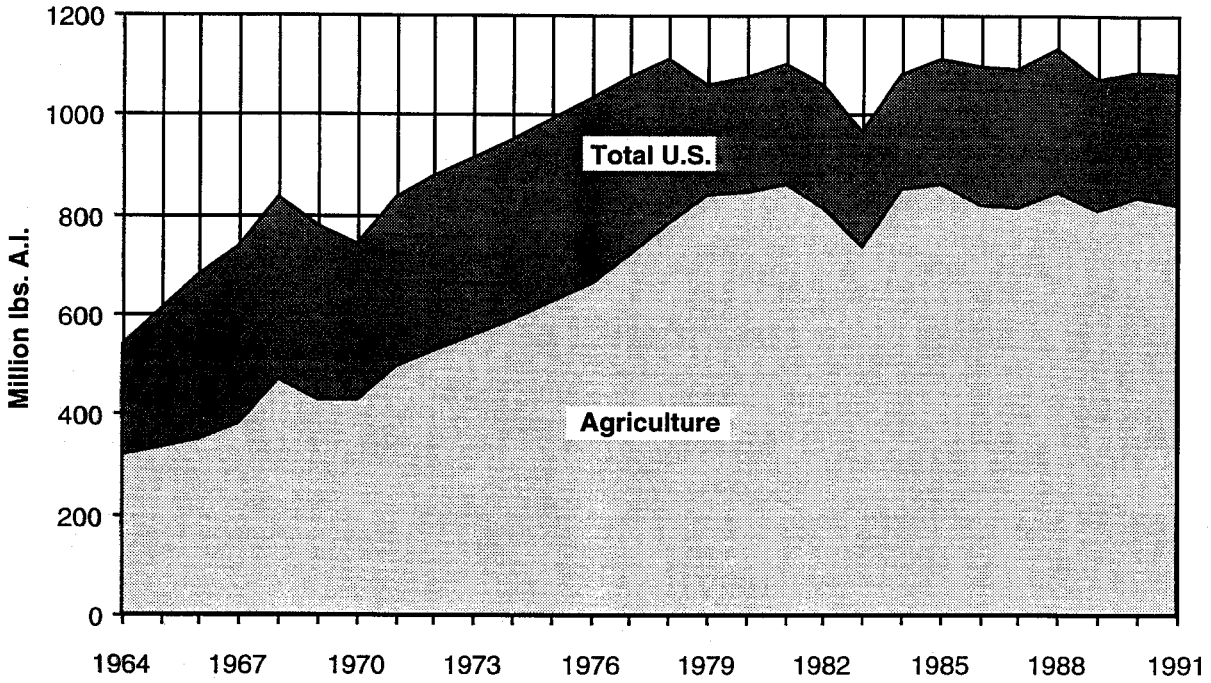


Figure 3-3. U.S. conventional pesticide usage and agricultural sector share, 1964-1991.[28]

expensive than in the agriculture sector per unit volume of pesticide because they are less concentrated.

The distinction between the industrial, commercial, and institutional uses of pesticides is based on the type of facilities and end users of the pesticides. Typical industrial end users include food-processing facilities and breweries. Industrial pesticides, such as preservatives, slimicides, or biocides, are used in cooling towers, paper and textile mills, and oil wells, for example.[29] Commercial establishments use pesticides to protect landscaping and to maintain cleanliness and health standards. Institutional end users may include hospitals, nursing homes, schools, restaurants, hotels, and contract cleaning businesses that serve stores, apartments, and office buildings.[30]

The industrial/commercial/institutional sector has increased its share of total U.S. pesticide use from 13 percent (140 million pounds of active ingredient) in 1979 to 18 percent (191 million pounds of active ingredient) in 1991.

Table 3-3 presents the U.S. annual volume of pesticides use for the industrial/ commercial/institutional sector from 1979 to 1991.

TABLE 3-3. U.S. ANNUAL VOLUME OF PESTICIDE USAGE, INDUSTRIAL/COMMERCIAL/INSTITUTIONAL, 1979-1991[31]
(millions of pounds active ingredient)

Pesticide Type	Year												
	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Herbicides	84	82	86	86	105	105	115	125	115	120	110	103	108
Insecticides	38	47	48	48	40	40	40	45	45	45	45	42	44
Fungicides and Other	18	18	19	19	20	20	21	25	40	40	40	38	39
TOTAL	140	147	153	153	165	165	176	195	200	205	195	183	191

3.2.3 Home/Lawn/Garden

Pesticides used in the home/lawn/garden sector are typically used to control pests in and around the home. Such products include rodenticides, insect repellents, lawn and garden pesticides, disinfectants and other pesticidal cleaners, insecticides to protect pets and eliminate household pests, herbicides, fertilizers with herbicides/insecticides, and insect baits and traps.[32] Some household pesticides such as those used for lawn and garden purposes are more seasonal than those used indoors, which remain more constant throughout the year.

As part of the EPA's National Home and Garden Pesticide Use Survey, EPA estimated that approximately 76 percent of all households treated their homes themselves for insects and related pests, while about 20 percent of all households hired a commercial applicator to treat for pests such as fleas, roaches, or ants.[33] In addition, about 15 percent of the households with lawns had pesticides applied by someone outside of the household, usually a commercial lawn care company.

The home/lawn/garden sector has slightly decreased their share of total U.S. pesticide use from 7 percent (77 million pounds active ingredient) in 1979 to 6 percent in 1991 (69 million pounds active ingredient). Table 3-4 displays the U.S. volume of pesticide use for the home/lawn/garden sector from 1979 to 1991.

TABLE 3-4. U.S. ANNUAL VOLUME OF PESTICIDE USAGE, HOME/LAWN/GARDEN, 1979-1991[34]
(millions of pounds active ingredient)

Pesticide Type	Year												
	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Herbicides	28	28	28	28	25	25	30	30	25	30	25	25	25
Insecticides	38	42	48	48	30	30	35	40	36	38	30	30	30
Fungicides and Other	12	12	12	12	10	10	10	11	12	12	14	14	14
TOTAL	77	82	85	88	65	65	75	81	73	80	78	69	69

3.3 SUBSTITUTION POSSIBILITIES IN CONSUMPTION

Because the four major types of pesticides--herbicides, insecticides, fungicides, and other pesticides--perform very specific functions (i.e., herbicides target plants while insecticides target insects and rodents), one is not directly substitutable for another in its end use. However, many active ingredients within each type of pesticide may be substituted. Substitutes for a PAI include alternative active ingredients as well as nonchemical substitutes. In constructing the 48 pesticide clusters, U.S. EPA's Office of Pesticide Programs (OPP) grouped all active ingredients that are substitutes for each other in a distinct cluster. For example, pesticide cluster F-6 includes fungicides whose primary application is on post-harvest fruits and vegetables. Conceptually, all active ingredients included in cluster F-6 should be substitutes; however, fungicide active ingredients

included in cluster F-5 or any other cluster F are not substitutes for one another.

In the long run, substitution possibilities include nonchemical pest control methods. Alternatives to chemical pest control methods include currently available biological, cultural, and environmental pest control methods.[35] In addition, farmers can change the types of crops they product based on pesticide use in different crop groups.

SECTION 4
ORGANIZATION OF THE PESTICIDE INDUSTRY

In this section, we describe the structure of the pesticide industry, the manufacturing plants' characteristics, and firm characteristics.

4.1 MARKET STRUCTURE

Market structure pertains to the number of firms in a market, the market shares of those firms, and the extent to which those firms perceive a threat of potential competition from new entrants. Market structure is of interest because of the effect it has on the behavior of producers and consumers. A market is generally considered to be the locus where producers and consumers interact to trade goods and services.

The shares of shipments accounted for by the 4, 8, 20, and 50 largest companies for SIC codes 2869 and 2879 are reported in Table 4-1. These concentration ratios are often used as a measure of the competitive structure of an industry. When a few firms produce a large portion of industry output, the market is often interpreted as oligopolistic, rather than purely competitive. The interpretation should be modified to consider the concentration of producers in the individual product markets, rather than in the aggregated multi-product industries. For example, one company may produce a small portion of industry output, but a large portion of the output in one product market. It would be mistaken to conclude a perfectly competitive market structure based on industry-level concentration measures, which are usually reported at the multi-product industry level (e.g., 4-digit SIC), rather than

TABLE 4-1. SHARE OF VALUE OF SHIPMENTS BY NUMBER OF COMPANIES: SIC CODES 2869 AND 2879[36]

	Companies (number)	Total ($10^6$$)	Percent accounted for by: 4 largest companies	8 largest companies	20 largest companies	50 largest companies	Herfindahl Index for 50 largest companies
SIC 2869							
1987	491	41,812	31	48	68	86	376
1982	488	30,394	36	52	73	90	475
1977	384	24,232	38	55	73	90	NA
1972	351	9,223	43	57	74	92	NA
SIC 2879							
1987	233	6,299	49	69	88	94	789
1982	286	5,436	44	66	85	94	703
1977	338	2,780	44	64	78	89	NA
1972	297	1,150	39	57	76	89	NA

the individual product level. However, the existence of high concentration measures at the industry level may be a good indication of some oligopolistic market power. The 1987 Census of Manufactures reports that in 1987, the four largest firms collectively held 31 percent of the market in SIC 2869 and 49 percent of the market in SIC 2879.[37] Walter Adams suggests that an industry might be considered highly concentrated only when the four-firm concentration ratio exceeds 50 percent.[38] However, because the pesticide industry is highly differentiated with respect to its products, there may be higher levels of concentration within a specific pesticide market.

The four firm concentration ratio data in Table 4-1 indicate a trend toward lower concentration for SIC 2869 but a trend toward higher concentration for SIC 2879. In the 1980s, establishments classified in SIC 2879 engaged in high levels of restructuring and consolidation. This was partly in response to the imposition of new environmental regulations and the increasing cost of research and development for pesticide manufacturers and formulators classified in SIC 2879.[39] Specific reasons for the trend towards lower concentrations in SIC 2869 are unknown at this time. However, in many cases an increase in competitive forces can lower the firm concentration ratio in an industry. For both SIC 2869 and 2879 it is important to remember that the 90 facilities EPA identified as manufacturers of PAIs[40] are distributed between SIC 28694 (20 facilities) and 2879 (the remaining 70). It is unclear whether the trends observed for 2869 and 2879 are in fact representative of PAI manufacturers because these facilities represent only a subset of the establishments included in the two 4-digit SIC classifications.

The Herfindahl Index has the merit of combining information about the market shares of all firms in the market, not just the largest four or the largest eight firms. The higher the index, the fewer the number of firms supplying the industry and the more concentrated the industry group or

industry is at the top. Census of Manufactures data report that the Herfindahl Index for SIC 2879 increased from 703 in 1982 to 789 in 1987 while decreasing from 475 in 1982 to 376 in 1987 for SIC 2869.[41] This trend does not appear to suggest increasing concentration in the industry as a whole. However, the four-firm concentration ratio for SIC 2869 did increase 10 percent between 1972 and 1987.

TABLE 4-2. HERBICIDE AND INSECTICIDE AVERAGE PRICES, 1991-1993[42]

	1991	1992	1993	Change 1991-1993
Pesticide		$/pound		%
Herbicide	5.04	5.16	5.26	4.3
Insecticide	12.33	12.92	13.91	12.8

Herbicide and insecticide prices have generally risen over the past 3 years (see Table 4-2). Pesticide manufacturers increased expenditures to research and develop new products and to develop additional data to reregister older products.[43] Other factors contributing to increased pesticide prices are expensive biotechnology research and dealer liability insurance costs.

4.2 MANUFACTURING FACILITIES

Based on the Farm Chemical Handbook and TRI data, 131 companies have been identified as "Basic Producers."[44] This category of basic producers includes producers, distributors, and importers but does not include formulators. These sources also indicate that 18 companies both manufacture and formulate pesticides. Based on EPA's Economic Impact Analysis of Proposed Effluent Limitations Guidelines and Standards for the Pesticide Manufacturing Industry (hereafter referred to as

EPA's EIA), 90 pesticide manufacturing facilities were identified.[45] The background document also indicated that the number of pesticide plants decreased from 90 facilities in 1986 to 75 facilities in 1990 because of plant closures.

Table 4-3 reports the number of pesticide producers and formulators as reported by the Office of Pesticides and Toxic Substances.

TABLE 4-3. PESTICIDE PRODUCTION AND FORMULATION[46,47,48]

Year	Major Basic Producers	Other Producers	Major National Formulators	Other Formulators
1991, 1990	20	100	150-200	2,000
1989	20	100	150-200	2,500-2,800
1988	30	100	NA	3,300

4.2.1 Physical Characteristics

We describe the physical characteristics of the manufacturing plant, including their location and age.

4.2.1.1 Location. Approximately 48 percent of pesticide producers are located in the eastern part of the country; 37 percent are in the central U.S. Figure 4-1 displays the geographic distribution of the 131 pesticide producers.* About half of the pesticide formulators are located in the eastern U.S. The remaining are scattered throughout the central and the western U.S.[49]

4.2.1.2 Facility Age. The 1960s was the most active decade for facility construction; almost a quarter of the facilities were constructed prior to 1970. After 1980, only about 7 percent of existing facilities were constructed.[50]

*The "producers" identified in the PES memo include producers, distributors, and importers. Formulators are listed separately and not included in the "producers" category.

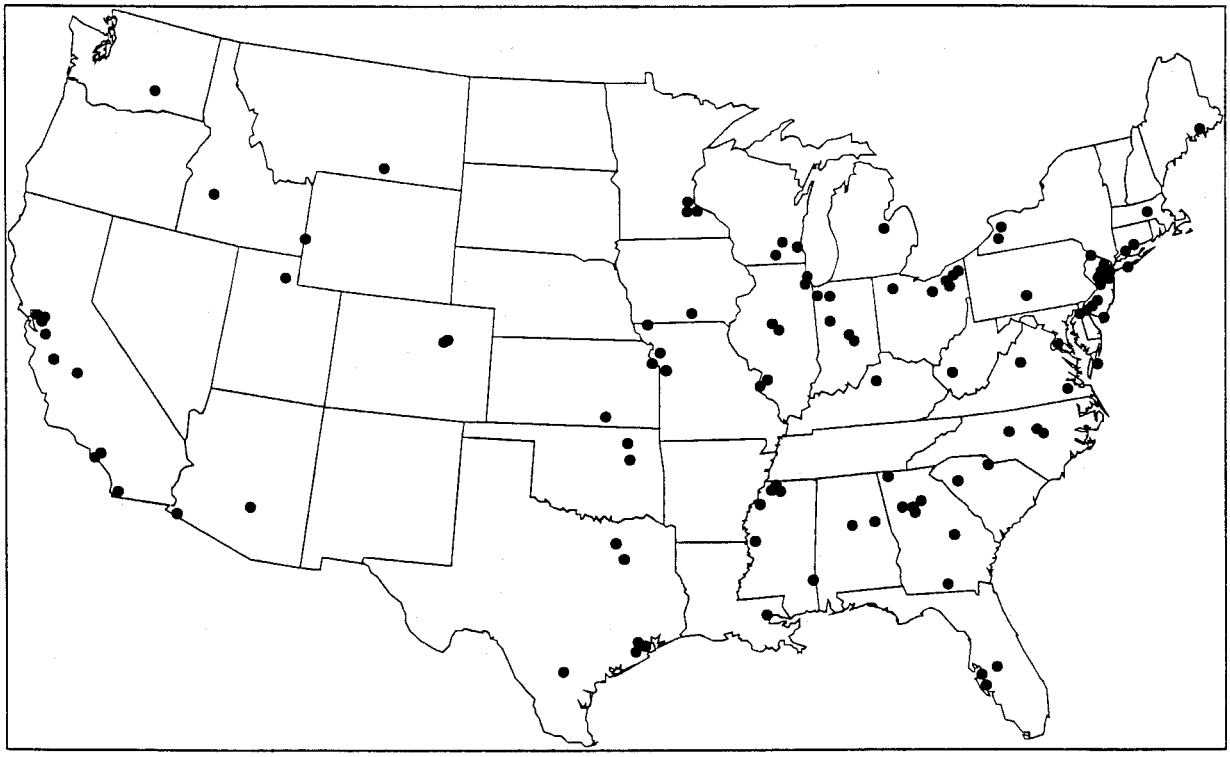


Figure 4-1. Geographic distribution of pesticide producers.[51]

Table 4-4 presents the distribution of facilities by the number of years in which they have produced pesticides. Approximately 38 percent of the facilities have produced pesticides for more than 30 years, while fewer than 13 percent of the facilities have produced pesticides for less than 10 years.

4.2.2 Production Capacity

Table 4-5 reports production capacity utilization for pesticide manufacturers from 1980 to 1989. The data indicate that production capacity utilization for all pesticides varied significantly during the 1980s, averaging approximately 65 percent for all pesticides.

The post-1982 decline in pesticide manufacturing capacity utilization may be attributable in part to the Payment-in-Kind (PIK) program, which took 48 million acres of farm land out of production.[52] Some PAIs are produced every 2 or 3 years

TABLE 4-4. PESTICIDE MANUFACTURING FACILITIES BY FACILITY AGE, 1986[a, 53]

Pesticide Type	Number of Years						
	<5	5 to <10	10 to <20	20 to <30	30 to <40	40+	All[b]
Fungicides	0	2	5	3	1	0	11
Herbicides	1	4	5	5	1	4	20
Insecticides	1	3	3	4	3	3	17
Other Pesticides	0	0	1	2	4	1	8
Multiple Types of Pesticides	0	0	7	7	8	8	30
All In-Scope Facilities	2	9	21	21	17	16	86[b]

[a]Facility age is the number of years the facility has been producing pesticides.
[b]Some facilities did not report facility age.

TABLE 4-5. U.S. PESTICIDE PRODUCTION CAPACITY UTILIZATION RATES, 1980-1989 (%)[54]

Year	Herbicides	Insecticides	Fungicides	All Pesticides	Annual Percent Change All Pesticides[a]
1980	77	79	84	78	NA[b]
1981	74	72	68	73	-6
1982	84	68	70	80	10
1983	66	33	71	54	-33
1984	67	29	73	52	-4
1985	62	56	66	61	17
1986	64	63	61	65	7
1987	63	61	59	62	-5
1988	75	76	59	75	21
1989[c]	72	76	63	81	8
Average Capacity Utilization	70.4	61.3	67.4	68.1	Average Annual Change 4

[a]The rate for all pesticides may be higher than those for herbicides, insecticides, or fungicides. This difference is due to the inclusion of detailed information on capacity rates associated with pesticides either classified as rodenticides or unclassified.
[b]Not available.
[c]Projected.

(referred to as a campaign basis) instead of on an annual basis. Therefore, pesticide production capacity utilization rates may fluctuate over time. This delayed production typically occurs when the pesticide is used on a low-volume specialty crop, or for those pesticides with high concentrations that allow for reduced volume.[55]

More recent data on production capacity utilization rates are unavailable at this time. The rates reported in Table 4-5 were developed from a plant-level survey administered by the USDA. This survey was discontinued in 1988.

4.2.3 Employment

Employment data for pesticide producers, SIC 2869 and SIC 2879, are reported in Table 4-6. Employment has been steadily increasing in SIC 2869 since 1986. SIC 2879 followed much the same trend until 1991 when this industry experienced a 7 percent drop in employment. The Office of Pesticides and Toxic Substances also reports a decline from 11,000 employees employed in pesticide production in 1988 to 10,000 employees in 1991.

4.2.4 Current Trends

Consolidation of production facilities among fewer companies continued in 1991 in response to the increasing cost of R&D and environmental regulations.** The high cost of stringent toxicity tests conducted in compliance with environmental regulations and the increasing difficulty of finding substitutable products have boosted R&D costs for a single new pesticide to more than $50 million in 1991, compared with an average cost of $6 million in 1976.[56] In the process, average development time has lengthened to 9 years.[57]

**The U.S. pesticide market of the 1980s was characterized by restructuring of the industry resulting largely from the imposition of new environmental regulations.[58]

TABLE 4-6. EMPLOYMENT IN THE PESTICIDE INDUSTRY, 1986-1991[59,60,61,62,63,64,65]

	All Employees	Production Workers
SIC 28694[a]		
1987	3,600	2,300
SIC 2869[b]		
1991	101,000	58,400
1990	100,300	58,800
1989	97,900	58,300
1988	N.A.	N.A.
1987	N.A.	N.A.
1986	86,700	51,300
SIC 2879[c]		
1991	16,400	9,100
1990	17,700	10,200
1989	17,400	9,800
1988	N.A.	N.A.
1987	16,100	9,100
1986	14,800	8,800
Basic Pesticide Production[d]		
1991, 1990	10,000	N.A.
1989	10,000	N.A.
1988	11,000	N.A.
1987	N.A.	N.A.
1986	N.A.	N.A.

[a] Pesticides and other synthetic organic agricultural chemicals; Census data only reported for 1987 for this SIC code.
[b] Industrial Organic Chemicals, N.E.C.
[c] Agricultural Chemicals, N.E.C.
[d] Based on Pesticide Sales and Usage Data

4.3. FIRM CHARACTERISTICS

4.3.1 Ownership

The legal form of ownership may affect the cost of capital, availability of capital, and effective tax rate faced by the firm. Business entities that own pesticide manufacturing facilities will generally be one of three types of entities:

- sole proprietorships,
- partnerships, and
- corporations.

Each type has its own legal and financial characteristics that may influence how firms are affected by the regulatory alternatives. Table 4-7 provides information about the legal form of ownership of firms for the relevant SIC codes 2869 and 2879. Figure 4-2 compares the legal form of ownership of all firms in the U.S. and the pesticide industry.

4.3.1.1 Sole Proprietorship. A sole proprietorship consists of one individual in business for him/herself who contributes all of the equity capital, takes all of the risks, makes the decisions, takes the profits, or absorbs the losses. Behrens reports that sole proprietorships are the most common form of business.[66] The popularity of the sole proprietorship is in large part due to the simplicity of establishing this legal form of organization. For 1987, Internal Revenue Service (IRS) data indicate that nonfarm sole proprietorships represented almost 72 percent of U.S. businesses but accounted for only 6 percent of business receipts. The 1987 Census of Manufactures reports, however, that very few firms in the U.S. pesticide industry are sole proprietorships--only 4 of the 491

TABLE 4-7. LEGAL FORM OF FIRM ORGANIZATION IN THE PESTICIDE INDUSTRY: 1987[67]

Item	Legal form of organization				
	Corporation	Sole Proprietorship	Partnerships	Other	Total
SIC 2869					
Single facility firm	254	0	19	19	292
Multi-facility firms	195	4	0	0	199
All firms	449	4	19	19	491
SIC 2879					
Single facility firms	150	NA	NA	NA	164
Multi-facility firms	67	NA	NA	NA	69
All firms	217	3	0	13	233

firms under SIC 2869 and 3 of the 233 firms under SIC 2879. This type of business organization accounts for a minimal proportion of both industries.

Legally, the individual and the proprietorship are the same entity. From a legal standpoint, personal and business debt are not distinguishable. From an accounting standpoint, however, the firm may have its own financial statements that reflect only the assets, liabilities, revenues, costs, and taxes of the firm, aside from those of the individual.

When a lender lends money to a proprietorship, the proprietor's signature obligates him or her personally of all of his/her assets. A lender's assessment of the likelihood of repayment based on the firm and the personal financial status of the borrower is considered legal and sound lending practice because they are legally one-and-the-same. Table 4-8 highlights the advantages and disadvantages of this ownership type.[68]

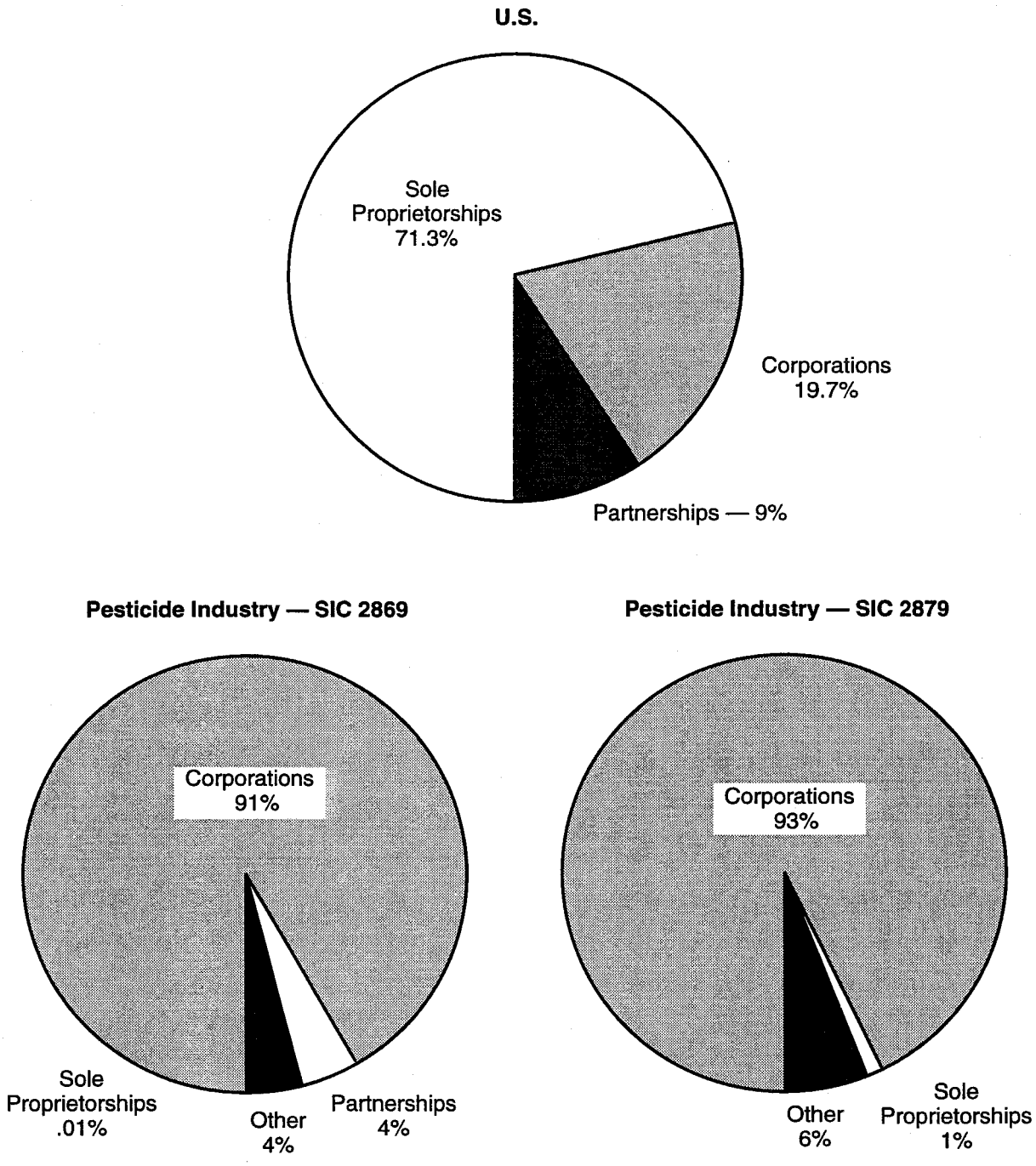


Figure 4-2. Comparison of the legal form of organization for firms in the U.S. and pesticide industry: 1987.[69,70]

TABLE 4-8. ADVANTAGES AND DISADVANTAGES OF THE SOLE PROPRIETORSHIP[71]

Advantages	Disadvantages
Simplicity of Organization	Owner's possible lack of ability and experience
Owner's freedom to make all decisions	Limited opportunity for employees
Owner's enjoyment of all profits	Difficulty in raising capital
Minimum legal restrictions	Limited life of the firm
Ease of discontinuous	Unlimited liability of proprietor
Tax advantages	

Note: A brief evaluation of these advantages and disadvantages is available in Steinhoff and Burgess (1989).

4.3.1.2 Partnerships. For 1987, IRS data on business tax returns indicate that partnerships represented only 9 percent of U.S. businesses and accounted for an even smaller percentage of business receipts--4 percent. For 1987, the Census of Manufactures reports 19 partnerships for SIC code 2869 and no partnerships for SIC 2879.

A partnership is an association of two or more persons to operate a business. In the absence of a specific agreement, partnerships mean that each partner has an equal voice in management and an equal right to profits, regardless of the amount of capital each contributes. A partnership pays no federal income tax; all tax liabilities are passed through to the individuals and are reflected on individual tax returns. Each partner is fully liable for all debts and obligations of the partnership. Thus, many of the qualifications and complications present in analyses of proprietorships (e.g., capital availability) are present--in some sense magnified--in analyses of partnerships. Table 4-9 lists the advantages and disadvantages of this ownership type.

TABLE 4-9. ADVANTAGES AND DISADVANTAGES OF THE PARTNERSHIP[72]

Advantages	Disadvantages
Ease of organization	Unlimited liability
Combined talents, judgement, and skills	Limited life
Larger capital available to the firm	Divided authority
Definite legal status of the firm	Danger of disagreement
Tax advantages	

Note: A brief evaluation of these advantages and disadvantages is available in Steinhoff and Burgess (1989).

4.3.1.3 Corporations. According to IRS business tax returns for 1987, corporations represented only 19.7 percent of U.S. businesses but accounted for 90 percent of all business receipts. For 1987, the Census of Manufactures reports that 91 percent of firms listed under SIC code 2869 are corporations while 93 percent of firms listed under SIC 2879 are corporations.[73,74] Therefore, corporations represent the vast majority of the business entities involved in manufacturing pesticides.

Unlike proprietorships and partnerships, a corporation is a legal entity separate and apart from its owners or founders. Financial gains from profits and financial losses are borne by owners in proportion to their investment in the corporation. Analysis of credit availability to a corporation must recognize at least two features of corporations. First, they have the legal ability to raise needed funds by issuing new stock. Second, institutional lenders (banks) to corporations assess credit worthiness solely on the basis of the financial health of the corporation--not the financial health of its owners. A qualification of note is that lenders can require

(as a loan condition) owners to agree to separate contracts obligating them personally to repay loans. Table 4-10 highlights the advantages and disadvantages of this ownership type.

TABLE 4-10. ADVANTAGES AND DISADVANTAGES OF THE CORPORATION[75]

Advantages	Disadvantages
Limited liability to stockholders	Government regulation
Perpetual life of the firm	Expense of organization
Ease of transferring ownership	Capital stock tax
Ease of expansion	
Applicability for both large and small firms	

Note: A brief evaluation of these advantages and disadvantages is available in Steinhoff and Burgess (1989).

4.3.2 Size Distribution

Table 4-11 presents the size distribution of the 54 facilities in SIC codes 2869 and 2879 as reported by number of employees.

4.3.3 Vertical and Horizontal Integration

The extent to which firms in an industry are vertically integrated may influence both the difficulty of new entry and their competitive position vis-a-vis one another. In general, vertical integration increases the difficulty of new entry and bestows some comparative advantage on the incumbent integrated firms. Vertical integration is a potentially important dimension in firm-level impacts analysis because the regulation could affect a vertically integrated firm at several levels. For example, a regulation may affect companies for whom pesticide production is only one of several

TABLE 4-11. PESTICIDE FACILITY SIZE, 1987[76,77]

	Establishments	
	Number	Cumulative Percent
SIC 2869		
1-4	97	14
5-9	80	25
10-19	91	38
20-49	137	58
50-99	99	72
100-499	151	94
500-999	27	98
1000+	17	100
TOTAL	699	
SIC 2879		
1-4	69	19
5-9	47	42
10-19	56	62
20-49	50	80
50-99	31	91
100-499	17	97
500-999	2	98
1000+	5	100
TOTAL	277	

processes in which the firm is involved. A regulation that increases the cost of producing the PAI will also affect the cost of the formulated pesticide products which use the PAI as an input and, in turn, reformulating the final package.

According to the Census data that EPA collected and reported in its EIA, both small and large firms tend to be vertically integrated, engaging in R&D, manufacturing, and formulating/packaging of pesticides. Compared to the development and manufacture of PAIs, the formulation and packaging of pesticide products is often less expensive but often adds substantial value to the end product. The EIA report also indicates that 50 of the 90 pesticide manufacturers surveyed also engaged in pesticide formulating/packaging.

In addition to in-house formulating/packaging capabilities, many firms contract out some aspects of the production process, typically the formulating/packaging process. EPA reports that an estimated 80 percent of the formulated pesticide business is controlled by PAI manufacturers, either directly with in-house capacity or indirectly through contracting.[78]

Horizontal integration is also a potentially important factor in firm-level impacts. Two reasons include:

- A diversified firm may own facilities in unaffected industries. This type of diversification would help mitigate the financial impacts of the regulation.
- A diversified firm could be indirectly as well as directly affected by the regulation. For example, if a firm is diversified in manufacturing pollution control equipment (an unlikely scenario), the regulation could indirectly and favorably affect it.

No data are currently available to suggest the level of horizontal integration of manufacturers of pesticides.

SECTION 5
PESTICIDE MARKETS AND TRENDS

5.1 PRODUCTION

Worldwide sales of pesticides amounted to approximately $25 billion in 1991 based on wholesale prices. The U.S. constitutes approximately one-third of world production, 75 percent of which is sold domestically and one fourth exported. Long-term growth in the world market is forecasted at 2.5 to 3 percent per year for the next 5 years, while real growth of the U.S. market should be less than 1 percent annually.[79]

5.1.1 Domestic Production

Domestic production and sales of pesticides from 1985 to 1990 are shown in Table 5-1. Production of all pesticides declined from 1985 to 1987 then began to rise again from 1988 to 1990. The percentage of pesticide products in inventory averaged approximately 20 percent. In 1990, total pesticide production was approximately 1.2 billion pounds with 20 percent of that remaining in inventory. Domestic production and sales values as reported by the Office of Pesticide and Toxic Substances are presented in Table 5-2.[80] The average value per pound of domestically produced pesticide increased steadily from $5.16 per pound in 1988 to $6.08 per pound in 1991.

Table 5-3 reports the U.S. percentage of the world market for pesticides from 1988 to 1991. The U.S. share of the world market has increased from 27 percent in 1988 to 32 percent in 1991. The U.S. insecticide market as a percentage of the world insecticide market increased the most dramatically from

TABLE 5-1. PRODUCTION AND SALES OF PESTICIDES, 1985-1990 (1,000 pounds)[81,82]

		1985	1986	1987	1988	1989	1990
All Pesticides	Produced	1,234,914	1,180,042	1,039,537	1,163,833	NA	1,225,125
	Sold	1,021,715	940,338	910,595	935,174	NA	971,443
	% Inventory	17%	20%	12%	20%		20%
Fungicides	Produced	109,038	113,271	104,610	109,564	NA	96,168
	Sold	94,102	89,254	93,365	89,354	NA	85,054
	% Inventory	14%	21%	11%	18%		12%
Herbicides and plant growth regulators	Produced	755,844	724,740	556,056	701,779	NA	696,674
	Sold	635,577	578,959	519,353	529,392	NA	577,137
	% Inventory	16%	20%	7%	25%		17%
Insecticides and rodenticides, soil conditioners, and fumigants	Produced	370,032	342,031	378,871	352,490	NA	384,793
	Sold	292,036	272,125	297,877	316,428	NA	278,843
	% Inventory	21%	20%	21%	10%		28%

TABLE 5-2. U.S. PRODUCTION AND SALES VALUE OF PAI[83,84,85]

	1988	1989	1990	1991
U.S. Production (10^9 pounds)	1.43	1.30	1.30	1.28
Sales Value ($\$10^9$)	$7.30	$7.50	$7.60	$7.78
Avg. Value/pound ($/pound)	$5.16	$5.77	$5.85	$6.08
U.S. Imports (10^9 pounds)	0.15	0.20	0.18	0.20
Sales Value ($\$10^9$)	NA	$7.50	$1.61	$1.76
Avg. Value/pound ($/pound)	NA	$7.50	$8.94	$8.80
Total Supply (10^9 pounds)	1.58	1.50	1.48	1.48
U.S. Exports (10^9 pounds)	0.45	0.40	0.39	0.40
Net Domestic Supply (10^9 pounds)	1.13	1.10	1.09	1.08

TABLE 5-3. U.S. PERCENTAGE OF WORLD MARKET, AT USER LEVEL, 1988-1991[86,87,88]

	U.S. Percentage of World Market				
	Herbicides	Insecti-cides	Fungi-cides	Other	Total
1988	36	20	17	35	27
1989	38	33	18	39	33
1990	NA	NA	NA	NA	NA
1991	38	31	19	38	32

20 percent in 1988 to 31 percent in 1991 while herbicides, fungicides, and other pesticides remained relatively stable.

5.1.2 Foreign Production (Imports)

United States imports remained relatively stable from 1988 to 1991 averaging 18 billion pounds (approximately 12 percent of total U.S. supply) over the 4 years (see Table 5-2). The average value of imports increased from $7.50 per pound in 1989 to $8.80 per pound in 1991 (see Table 5-2). Historical import values for all pesticides imported to the U.S. are reported in Table 5-4. More specific data on U.S. pesticide imports by class is unavailable at this time but may be available by product code from the Foreign Trade Division of the Bureau of Census.

5.2 CONSUMPTION

5.2.1 Domestic Consumption

Domestic pesticide use by type of pesticide for 1984 to 1991 is reported in Table 5-5. Total pesticide use has remained relatively unchanged between 1984 and 1991, averaging around 1,079 million pounds of active ingredient. The high was 1,130 million pounds in 1988 with a low of 1,077 million pounds in 1991. The volume of PAI used in the U.S. by sector is reported in Table 5-6. The shares of PAI use by sector have remained unchanged between 1988 and 1991 with agriculture accounting for 76 percent of PAI use, industrial/commercial/institutional accounting for 18 percent of PAI use, and home/lawn/garden accounting for 6 percent of PAI use.

5.2.2 Foreign Consumption (Exports)

Japan is the largest export market for U.S. pesticides, accounting for almost 10 percent of U.S. export sales.[89] Four countries--Australia, Columbia, France, and Hong Kong--together account for 16 percent of U.S. exports, but the rate

TABLE 5-4. U.S. HISTORICAL IMPORT VALUES FOR ALL PESTICIDES[90]

Year	Value of Imports	Percentage Change
1978	260,098	-
1979	268,846	3
1980	317,718	18
1981	307,553	-3
1982	284,196	-8
1983	271,512	-4
1984	322,874	19
1985	413,772	28
1986	402,782	-3
1987	414,800	3

TABLE 5-5. U.S. ANNUAL VOLUME OF PESTICIDE USAGE, BY TYPE, 1984-1991[91]

	(millions of pounds of active ingredient)							
	1984	1985	1986	1987	1988	1989	1990	1991
Herbicide	675	670	655	645	660	655	644	628
Insecticide	270	300	295	260	268	226	245	249
Fungicide	80	82	86	122	132	111	116	120
Other	55	60	60	60	70	78	81	80
TOTAL	1,080	1,112	1,096	1,087	1,130	1,070	1,086	1,077

TABLE 5-6. U.S. VOLUME OF PESTICIDE ACTIVE INGREDIENT USED IN U.S. BY SECTOR, 1988-1991[92,93,94]

	Percentage of U.S. Market			
	1988	1989	1990	1991
Agriculture	75	75	77	76
Industrial/ Commercial/ Institutional	18	18	17	18
Home/Lawn/Garden	7	6	6	6

TABLE 5-7. U.S. HISTORICAL EXPORT VALUES FOR ALL PESTICIDES[95]

	Value of Exports	Percentage Change
1978	304,671	NA
1979	358,331	18
1980	301,474	-16
1981	294,367	-2
1982	289,169	-2
1983	268,194	-7
1984	345,073	29
1985	239,421	-31
1986	251,425	5
1987	204,867	-19

of increase of exports to these four countries is high enough to put them among the leading consumers of pesticides before 1995.[96] Total U.S. exports has declined from 0.45 billion pounds in 1988 to 0.40 billion pounds in 1991. Historical values for U.S. exports are reported in Table 5-7. The data indicate a 33 percent decrease in the value of exports from 1978 to 1987.

5.3 OTHER FACTORS AFFECTING THE PESTICIDE INDUSTRY

A continuing competitive problem for U.S. firms is the protection of intellectual property rights for pesticides. While countries in South and Central America and Southeast Asia are making some efforts to control these violations, there remains a significant problem of inexpensive generic versions of U.S. pesticides for sale in world markets.[97] Environmental issues also continue to pose major challenges for the industry. Because of this, some feel that increased environmental taxes related to pesticide use, particularly at the state level, are likely.[98] If so, these taxes could impose substantial costs on the U.S. industry and adversely affect its current competitiveness in world markets. Taxes and proposed legislation to control exports of pesticides explain the growing trend among major U.S. producers to conduct R&D efforts and set up manufacturing facilities overseas.

Another important factor affecting the pesticide industry is the outcome of the Uruguay Round of negotiations of the General Agreement on Tariffs and Trade (GATT). If liberalized trade is the result, U.S. trade balances should improve, given the pesticide industry's high productivity and competitiveness.[99] Economic liberalization in Eastern Europe should open new opportunities for U.S. companies as agricultural sectors are developed in those countries. An agreement is expected in late 1993.

SECTION 6
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