An Analysis of the Pesticides Industry in Canada

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AN ANALYSIS OF

THE PESTICIDES INDUSTRY IN CANADA

Sector Analysis Division
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INTRODUCTION

The segment of the chemicals industry that is engaged in the production and supply of products for the control of crop infestations has become an indispensable economic factor in the world's food production system. Some authorities believe that improved human and animal nutrition, assured through the use of chemicals in the production of food, is even more important to human welfare than the major disease control contributions made by the chemical industry through water purification, sanitation and medicines.

Throughout the world, as populations rise and increasing amounts of agricultural land are lost through soil erosion and urban and industrial development, progressively more dependence is placed upon technology-based methods of intensive agriculture to maintain and increase food production.

With present technology, only eight per cent of Canada's land area has any agricultural potential. Marginal farmland is being abandoned and the remaining undeveloped arable land is uneconomic. Accordingly, there is increasing dependence on methods to enhance crop harvests and prevent losses from infestations. The use of chemical pesticides has proved to be one of the most efficacious technologies to improve both quality and yields and to reduce unit production costs.

The production and use of pesticides is influenced not only by the interplay of the relative impact of farm input costs on marginal cash income and the efforts of the chemical industry to develop and promote efficacious products, but also by government agricultural

policy and regulations aimed at preserving health, safety and the environment. While the immediate economic advantages to agricultural production of mechanization, high yielding seed strains, monoculture, irrigation, fertilizers and pesticides are readily apparent, the longer term implications and complex interactions of many practices often are not clear. The ecological impact from extended use of many pest control agents is now known to be far-reaching and, as is the case with other technological advances, society is viewing the benefits with increasing ambivalence.

I. SECTOR DESCRIPTION

A. INDUSTRY IN PERSPECTIVE

Overview

The pesticides industry in Canada consists of about 40 firms that are engaged in one or more aspects of producing, formulating and distributing biologically active chemical products that are subject to regulation under the Pest Control Products Act, 1968-69. The Act defines a pest control product as "any product, device, organism, substance or thing that is manufactured, represented or sold for directly or indirectly controlling, preventing, destroying, mitigating, attracting or repelling any pest". These products include the broad spectrum of synthetic chemical compounds as well as the so-called "biorational" pest control products such as viruses, bacteria, protozoa, fungi and other naturally occurring biochemicals that can be usefully employed to control life forms that in some way interfere with human activity. The diverse uses of pesticides include the control of competing plant life in agriculture; the control of insects, arthropods, nematodes, molluscs, worms and rodents; seed and plant treatment against diseases; the control of vegetation along powerlines and rail and road sides; wood preservation; fabric protection; sanitation; and the control of algae in swimming pools.

Pesticides of commercial significance today are almost entirely of synthetic organic chemical origin. These compounds are rarely used in the form of the pure or technically pure synthetic chemical (i.e., the active ingredient) but are formulated or admixed with dilutents and other substances to facilitate application and enhance effectiveness. Formulation and application techniques are critical to both the effectiveness and economic use of pesticides, particularly in the case of insecticides of recent discovery.

Formulations may be marketed as dusts or granules (usually containing five to 10 per cent of active ingredient) or wettable powders or emulsifiable concentrates (40 to 80 per cent active ingredient). Those to be sprayed are further diluted with water, oil or other solvents, and brought to concentrations ranging between 0.01 to one per cent before application.

In 1979 the industry in Canada, with shipments of own manufacture* estimated at $154 million, was a small fragmented sub-sector within the chemicals industry sector (SIC 371-379). These shipments accounted for only 1.6 per cent of total chemical industry shipments of nearly $9.5 billion. In the same year there was a deficit in pesticides trade of $166 million, equivalent to 21 per cent of that in manufactured chemicals. Although industry shipment value of pesticide active ingredients and formulated products of own manufacture (Table 15) increased from $27 million in 1971 to $154 million in 1979, representing an average real annual growth rate** of 15.5 per cent, growth has been far from uniform. Virtually all of it occurred in the years 1972 and 1973, with an average of only 2.8 per cent per year real growth taking place during the period 1974 to 1979. This can be contrasted with real growth in the apparent domestic market of 16.4 per cent per year from 1971 to 1979 and 6.0 per cent annually in the six years from 1974 to 1979. Imports, which showed a real, average annual increase of 9.7 per cent during the latter period, contributed the largest part of that market growth.

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* Manufacture shipment value excludes the value of imported finished product for resale and some distributor margins that form part of total industry sales value (see Table 15).

** Real annual growth rate: when industry shipment values are deflated by pesticide manufacturing selling price index shown in Table 25 (e.g., expressed in 1971 dollars, shipments of own manufacture were $61.6 million in 1974 and $58.9 million in 1978).

Manufacturing activities of the pesticides industry in Canada can be divided into two sectors. One involves a small amount of chemical processing related to the manufacture of a limited number of chemical intermediates, and the conversion of these into pesticide active ingredients. This activity amounts to approximately six per cent of the total sales value of all active ingredients. In the other sector, approximately 30 per cent of the value of pesticides registrants' sales can be attributed to the manufacturing activity of formulating and packaging active ingredients into the finished product form.

During 1977 a protective tariff of 15 per cent was imposed on the importation of phenoxy herbicides, a major class of active ingredient that was being manufactured in Canada at some competitive disadvantage due to both small plant scale and obsolescent process technology. As well, for reasons of regulatory consistency with respect to safety, the right of users to import unregistered products was withdrawn. It was expected that these measures would encourage greater domestic manufacture due to larger volumes flowing through the domestic distribution system, which would also facilitate better service and technical assistance to users. However, data for 1977 and 1978, coupled with estimates for 1979, indicate that real growth in shipments of own manufacture has only marginally exceeded growth in the apparent domestic market, i.e.:

	Per Cent Real Growth	
	Shipments of Own Mfg.	Apparent Domestic Market
1978	14.6	12.2
1979	17.0	15.5

Although active ingredient manufacture is acknowledged to be a minor part of the industry in Canada, the three* corporations (Dow, Uniroyal and Monsanto) engaged in this activity are broadly based in formulating, packaging and distribution as well. These three firms accounted for about 28 per cent of estimated industry employment and 50 per cent of all production employees.

Formulating primarily involves mechanical mixing to dissolve, disperse or emulsify active ingredients along with agents to enhance the performance and stability of the preparation. It is generally integrated with packaging and distributing. Five major formulators, only two of which are wholly Canadian owned companies, dominate this activity in Canada.

Overall, the pesticides industry in Canada is dominated by 25 major multinational chemical industry suppliers of imported active ingredients and formulated products. Many of these firms are domestically involved throughout the formulation, packaging and distribution phases either by direct participation or through subsidiary ownership.

Historical Background and Trends

Prior to the mid-1940s, inorganic compounds such as the highly toxic lead arsenate, sulphur and some naturally derived organic substances -- nicotine, strychnine, rotenone, pyrethrum and petroleum distillates -- were the main weapons in the struggle against crop infestations. The introduction of DDT, a highly effective and relatively stable chemical with broad insecticidal properties and low mammalian toxicity, marked the beginning of modern synthetic organic pesticides.

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* With the announced closure of Dow Chemicals phenoxy herbicide plant in Fort Saskatchewan, Alberta, in June 1980, there now are two active ingredient manufacturers. To maintain confidentiality of data and provide an indication of the importance of integrated operations within the industry it was necessary to include Dow's phenoxy plant activity.

The success of DDT in controlling certain insect carriers of human diseases, as well as many major crop pests, provided the encouragement for research that produced an array of organochlorine pesticides. Among these were the phenoxy plant growth hormones 2, 4-D and MCPA which were introduced commercially in 1946 for use as broad leaf weed control agents. The development of herbicides has ultimately been of greater economic significance to Canadian agriculture than the contribution of insecticides, since our temperate climate is less hospitable to many insect species that devastate crops in warmer countries. Before the introduction of phenoxy herbicides there was almost total reliance on less effective, labour intensive methods of weed control by cultivation.

During the past twenty years, several perplexing problems have confronted the industry, tending to increase investment risks and costs of pesticide manufacture, as well as making it more difficult for countries such as Canada to successfully develop an indigenous competitive pesticides manufacturing capability. One such problem has been a high rate of product obsolescence, with users gradually becoming aware of a loss of effectiveness of once dependable pesticides. Study showed that this effect was due to genetic selection and the attendant development of pesticide resistance in target organisms. In the case of herbicide treatment of crops, the weed-flora balance became disturbed allowing populations of resistant species of weeds to compete more effectively and requiring the continued introduction of new, more selective products.

A second problem has been the persistent effects of certain pesticides in the food chain and the consequent ecological and health concerns of the public.

Over the years these factors have been manifested in increased costs of obsolescence. The requirement to develop replacement pesticides for those that had lost effectiveness or proved unsafe, and to institute safe manufacturing processes that would meet regulatory requirements for product performance and registration all led to significant cost increases. The average cost of development of a new pesticide is estimated to have been about U.S.$10 million in 1973, with about five years required for testing. By 1978, it had increased to some U.S.$20 million with the time required to obtain sufficient environmental impact and toxicity data to permit registration extended to as much as 10 years.

Because of the costs and risks associated with development and marketing, the rate of introduction of new pesticides has declined. In the mid 60s the introduction rate was about 20 per year but during the 1970s it declined to some 15 per year. It is believed that only one or two new chemical entities were introduced in 1978. The result is that the introduction of new pesticides seems destined to become increasingly the domain of a smaller number of large integrated chemical companies with multinational interests.

Partly owing to the problems described, and partly as a result of considerably expanded knowledge, a new approach known as integrated pest management (IPM) is evolving that may alter traditional growth patterns of the chemical pesticides industry. IPM attempts to make optimum use of chemical, biological and cultural control methods and depends upon a much more highly developed service element in the control of pests than has been customary in the traditional chemical pesticide supplier/user relationship. It has been estimated by advocates of IPM that these methods could further reduce grain losses, while possibly reducing pesticide use on major crops by as much as 75 per cent. The impact of IPM may, however, be offset by other

technological innovations such as zero-tillage (planting without plowing) which would increase the need for chemical weed control.

The Industry in an International Context

The number of producers of synthetic organic pesticides has grown to some 650 chemical manufacturers in 18 countries, producing about 90 per cent of the more than 1.8 million tonnes of pesticides consumed in the world in 1978. Their output includes some 1500 active pesticide ingredients of which only about 200 are of major economic importance.

However, the world pesticides industry is dominated by a relatively small number of chemical producers that supply a large number of technical (i.e., active ingredients) and formulated pesticide products to worldwide markets from a few centralized manufacturing facilities. In most cases these are producers of petrochemicals capable of making the basic chemical starting materials and intermediates and possessing integrated facilities where by-products can be utilized and environmental protection and waste disposal systems shared with a broad range of other fine chemical products for different end-use markets. Approximately 30 United States producers supply 45 per cent of world output of active ingredients, with 14 responsible for supplying 38 per cent of world requirements.

Most pesticides are crop/pest specific with similar uses found in many parts of the world. Since individual active ingredients are used in comparatively small quantities and can be shipped at relatively low cost, there are few products for which individual markets are large enough to support economic manufacture. Accordingly, pesticide active ingredients are extensively traded in world markets. Formulated products, on the other hand, tend to be designed for

specific climatic and crop conditions and application methods and more often are manufactured within local markets.

Competition in the pesticides industry for any given market segment is mainly between producers of different chemical compounds (active ingredients) and proprietary formulations of these compounds, and not between multiple producers of a single chemical entity, primarily due to extant patent rights. Seldom does any one chemical entity enjoy market dominance within a particular crop/pest market for many years before competitors successfully introduce competitive offerings. For this reason, firms engaged in pesticide product research and development and having large integrated fine chemicals complexes and a broad product base are better able to compete.

The distribution of the world market for pesticides is shown below:

Geographic Distribution of World Pesticides Markets (1977)

	Per Cent
United States	33
Western Europe	25
Latin America	10
Eastern Europe and U.S.S.R.	9
Japan	9
Far East and Australia	7
Africa and Middle East	5
Canada	2
	100

Source: Groupement International des Associations Nationales de Fabricants de Pesticides (GIFAP) Directory 1979

Canada and the United States together produce about 20 per cent of the world's coarse and cereal grains, use nearly 36 per cent of the world's output of pesticides, and account for close to 50 per cent of the world consumption of herbicides. While Canada's grain

production equals one-sixth of U.S. grain production, its consumption of pesticides is only one-sixteenth of the amount used in the U.S., and of herbicides only slightly more than three per cent of the amount used throughout the world (Table 1).

It is estimated that more than 90 per cent of pesticide active ingredients used in Canada are imported; nearly 80 per cent of these enter the country in the formulated state.

The comparison of United States and Canadian pesticide industries in Table 2 underlines Canada's dependence on imports and its underdeveloped manufacturing potential. While the Canadian market is only one-sixteenth the size of that in the U.S., this country uses about one-quarter the number of pesticide active ingredients considered to be of major importance in the U.S. market, and one-eighth the number of formulated products. On average the Canadian active ingredient market is 25 per cent of that in the U.S., while the average registered formulated product market is one-half as large. However, the Canadian industry has less than seven per cent the number of basic producers (and makes less than one per cent of the number of active ingredients) and only slightly more than one per cent of the number of formulators as compared with the U.S. industry.

Specifically, in 1979 some 3,300 U.S. formulators* reportedly shared a pesticide market of U.S. $5,050 million, while 40 Canadian formulators shared a domestic market estimated at U.S.$320 million. These figures suggest that the Canadian formulator has only one-fifth the number of competitors per unit of market as his U.S. counterpart. The greater concentration in the Canadian pesticide industry could indicate that market competition is less intense in Canada than in the United States.

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* See Table 2, footnote 3

Although the bulk of the world output of active ingredients for pesticides is still largely concentrated in the developed countries, more of the less developed countries (LDCs), encouraged by official agricultural development policy, are paying greater attention to this line of activity. Brazil and Mexico in particular have made significant strides towards this end in the last few years.

Until recently the major application of pesticides in Japan was in rice cultivation and domestic suppliers had developed their own kind of pesticides specific to this crop's particular needs. As late as 1974, the foreign agrochemicals industry was not well represented. The major domestic producers are: Sumitomo Chemical Co., Ltd., Mitsui Toatsu Chemicals Inc., Mitsubishi Chemical Industries Ltd., Takeda Chemical Industries Ltd., and Sankyo Co. Ltd. All told, some 50 companies process basic materials into finished agrochemical products. But Japan's industry is still, in one form or another, very much dependent on imports of active ingredients. Some 27 per cent of the pesticides formulated in the country is based on direct imports of active ingredients and another 18 per cent is formulated with active ingredients produced by Japanese firms in which there is strong foreign participation. About 80 per cent of imports come from the United States West Germany and Switzerland. The U.S. share in these imports is just under 44 per cent, the major exporters being Du Pont, Chevron Chemicals and Stauffer Chemicals.

In the Comecon countries comparatively greater activity in the production of agrochemicals has been observed during the 70s. In the U.S.S.R. in particular the agrochemical sector was given top priority in the five-year plan 1976-1980, during which time 20 plants were to be commissioned. At present, there are 30 pesticides plants in operation in that country producing some 50 products, well under the 180 to 200 products anticipated in the plan. Indeed, the initial target of 615,000 tonnes (encompassing 234,000 tonnes of herbicides and 125,000 tonnes of insecticides) by 1980, which would have provided 80

to 85 per cent of the U.S.S.R.'s needs relative to the 75 per cent level attained in the mid-70s will not be reached. The major drawbacks purportedly encountered by the Soviet industry, particularly in herbicide production, were deficiencies in the supply of intermediaries and widespread shortage of equipment designed to stand up to highly corrosive conditions.

Among the other Comecon countries, Hungary and Romania have been recording high rates of growth in the production of agrochemicals during the last few years, enabling them to supply part of the U.S.S.R.'s requirements through barter arrangements. It is felt, however, that the growth in the aggregrate output of the Comecon countries will not substantially change the overall supply conditions of pesticides in the foreseeable future.

Generally, in the LDCs, there is as yet little production that includes all the stages of synthesis and final formulation of pesticides. As in the case of the planned economies, the increased capacity being put in Brazil, India and Mexico is unlikely to alter significantly the global supply position in pesticides for some time to come. The acceleration of agrochemical production in those countries dates from 1972/73, with the world commodity boom and the heavy purchases of grains by the U.S.S.R. which seriously depleted world food reserves. The balance of payments problems that were being incurred by the LDCs at the time prompted them to take advantage of the high commodity prices and to concentrate on greater production of exportable cash crops, to speed up the modernization of their agriculture as far as their sources of capital would allow and, in order to reduce their import bill, place greater emphasis on their domestic output of agrochemicals.

Brazil's National Agricultural Plan of 1973 called for 50 per cent self-sufficiency in pesticides by 1979. This policy, coupled with the anticipated imposition of import duties, has induced more

companies to produce a greater proportion of their requirements of active ingredients domestically. At present, the national output of pesticides set for 1987 amounts to 110,000 tonnes per year, divided into 24,000 tonnes of herbicides, 33,000 tonnes of fungicides and 54,000 tonnes of insectides.

Similarly, the Andean Common Market countries have instituted a cooperative program for the manufacture of pesticides. Mexico also appears ready to expand its agrochemical industry.

On the other hand, there remain some countries, including Ecuador, Kenya and Turkey, which still produce natural pyrethrins, a botanical insecticide extracted from the flowers of the pyrethrum plant. Overall, notwithstanding some increase in capacity, the LDCs with the possible exceptions of Brazil and Mexico will still depend heavily on imports to meet their requirements of pesticides throughout the 80s.

International financing activities oriented towards agricultural development, and the ensuing linkages, are bound to affect the world pesticides industry. The International Fund for Agricultural Development, with initial resources of U.S.$1 billion, is an example. In recent years, the international aid agencies, as well as an increasing number of bilateral aid arrangements, have been placing much greater emphasis on agriculture. In particular, the World Bank substantially increased its agricultural programs to some U.S.$1.8 billion in the mid-70s. During the second half of the 70s more than 75 per cent of its $12 billion worth of investment in agriculture was directed to the production of foods. For the 1980s, it is committed to giving much greater assistance to agricultural and rural development in the LDCs and anticipates lending between $20 and $25 billion to the agricultural sector of those countries during the first half of the decade in support of $50 billion of planned agricultural projects.

The OECD has also been devoting a greater share of its aid commitments to agriculture in LDCs through the auspices of its Consultative Group on Agriculture Research. It has been examining ways to make better use of the LDCs' agricultural research facilities to raise the productivity of the sector. It is also attempting to improve cooperation in research in key areas related to tropical as well as temperate agriculture. The Consultative Group on Food Production and Investment established at the last World Food Conference may also help further enhance the coordination and the effectiveness of the assistance extended by donor countries and multinational institutions to the LDCs.

As they develop, these projects are likely to impose a considerable demand on the world agrochemicals industry's resources in research and production.

B. COMPETITIVE STRENGTHS AND WEAKNESSES

The Canadian pesticides industry consists of some 40 companies. Fifteen of these, constituting more than two-thirds of industry sales and employment with estimated sales of pesticides totalling more than $200 million in 1979, provided current information related to industry and corporate structure, ownership, relative importance of the pesticide business to the corporation, and regional distribution of pesticide business activity. As well, the financial strength of the industry was established from consolidated financial performance data provided by Statistics Canada for seven firms selected for both their importance in the industry and significance of pesticides sales to total corporate earnings.

Corporate Structure

All 15 of these corporations are subsidiaries of large diversified chemical companies: 11 United States and four European. There is some evidence that a considerable amount of management autonomy has been granted to a number of these agrochemical subsidiaries in Canada. Three corporations are structured to be entirely dedicated to the agrochemical business, eight are divisionalized with respect to pesticide manufacture and sales while the other four have pesticide marketing departments only.

Of the 15 corporations, only three -- foreign-owned subsidiaries established to engage in the agrochemicals business in Canada -- obtain their entire corporate sales revenue exclusively from pesticides. Of the remaining 12, three obtain 50 to 75 per cent of corporate revenues from pesticide sales, one between 25 and 50 per cent, and eight less than 25 per cent.

In terms of pesticide business participation, eight firms derive more than 95 per cent of their pesticides sales revenue from either distribution or formulation/distribution activities with only

one firm obtaining between 75 and 95 per cent of pesticides revenue from the production of active ingredients (Tables 3 and 4). Twelve of the 15 companies are active in the distribution of imported products, six distribute products of Canadian manufacture, and 11 either engage in formulating activity and/or contract out the formulation and packaging of their products. Eight of the 11 companies derive less than 25 per cent of corporate revenue from this source, with three deriving less than five per cent. Only four pesticides firms engage in direct sales to users.

Of the 22 companies that constitute an estimated 90 per cent of the Canadian pesticides industry sales value in 1979, three firms have sales value of own registered products of more than $30 million, 14 between $5 million and $30 million, and five have sales of less than $5 million (Table 5).

Measured in terms of sales value, the industry can be considered to be moderately concentrated with three firms enjoying 45 per cent of industry sales and 10 firms (25 per cent of the total number) accounting for nearly three-quarters of total sales in 1979 (Table 6). In terms of specific pest/crop market segment or specific pesticide chemical entity, both markets and industry participation can be judged to be highly concentrated, as can be seen from Tables 13 and 14.

Structure of Productive Facilities

Production facilities for the small number of active ingredients produced in Canada involve dedicated batch chemical processes used for the manufacture of chemical intermediates, classes of chemical products or steps in the sequence of chemical reactions, e.g., the chlorination and fractionation of cyclic hydrocarbons as intermediates for phenoxyacetic acids and penta-chlorophenol, esterification and amine salt formation of organic acids. The capacity

of the facilities dedicated to the production of a class of product, such as the phenoxy herbicides, is based upon the expected size and product diversity of the markets, the sensitivity of products to cross contamination and the optimum economic scale for the process. In general, the scale of the facilities in place at this time is less than optimum competitive size both with respect to the domestic market and world markets in the case of products that are capable of being exported.

Formulation facilities, consisting of agitated mixing and blending equipment, holding tanks, metering, weighing and packaging machinery tend to be dedicated to product class or type, with considerable care taken to avoid cross contamination between major classes of products. For example, in some cases herbicides may be prepared in entirely separate buildings from insecticides to avoid the possibility of crop losses that could accidentally occur.

While plants vary in age, many have been built since 1970 and the formulating and packaging equipment is considered to be as modern as any in the United States or Europe. It is believed that equipment designed to control contaminants in the work environment and other forms of pollution is generally efficient and exceeds the requirements for this industry.

The industry usually operates at an average annual rate of 60 per cent of capacity due to the seasonal nature of the pesticide business. For this 1979 represented about 65,000 tonnes of a potential capacity of 110,000 tonnes of formulated product, or about 17,000 tonnes of active ingredients, processed by Canadian formulators.

During the second half of the 70s, the world pesticide industry operated substantially below capacity. In 1979 the operating rate was between 70 and 75 per cent, and even lower for herbicides, especially the phenoxy type which constitute the principal domestic

output of active ingredients and for which there are, at present, indications of worldwide excess capacity.

Regional Structure

Active ingredient manufacture is carried out in four locations in Alberta, Ontario and Quebec with the largest volume of production (phenoxy herbicides) occurring in Alberta. Fifty-six per cent of the pesticides industry personnel are employed in Quebec and Ontario, with 42 per cent located in the four western provinces and Atlantic Canada accounting for the remaining two per cent. Nearly one-half of the 21 formulating/packaging operations are in Ontario, with the remainder in Alberta, Saskatchewan, Quebec and Manitoba. Over four-fifths of firms (85 per cent) engage in wholesale distribution in Ontario and the prairie provinces, with considerably less participation in distribution elsewhere.

Product research and development activities are conducted in every province, with 12 firms (80 per cent) carrying out R&D in Ontario, nine or 10 in the prairie provinces (Table 7).

Management and Labour Characteristics

Management -- Managers of pesticide firms would be expected to have specialized or had some form of training in the agricultural sciences. Their employment history would likely include product development and marketing. In the case of the broadly based multinational operation, where the pesticide division is one of many, the manager may not have an agriculture-related background, as his responsibility for pesticides may be on-the-job training for purposes of assuming greater responsibility within the organization. While in most cases managers would be Canadian citizens, certain managers of some multinational subsidiaries may be individuals on a two to three year assignment in Canada from the American or European parent.

Because of the specialized nature of the pesticide business, there tends to be less turnover in all management levels than is the case in the chemical industry as a whole. In the case of smaller formulators, the manager is the owner or co-owner of the company and as such will remain in his position indefinitely.

The typical manager will have or will be expected to serve a term as an executive of the Canadian Agriculture Chemical Association (CACA) which embraces all the significant players in the pesticide industry (technical manufacturers, formulators, distributors, importers and suppliers of various raw materials).

Management in this industry is considered to be of fairly high quality, owing in large part to the resources at the disposal of the many multinational participants.

Labour -- Employment in the manufacture of active ingredients, formulation and distribution of pesticides in Canada in 1980 is estimated to have been about 1,200 for the 22 firms that are responsible for over 90 per cent of activity. An average of 54 persons per firm was indicated for the 15 companies surveyed who together employed 913 people in that year. About one-third of these firms employ fewer than 25, while one-fifth have between 75 and 200 employees in their pesticide-related business activities.

Industry employment is distributed among personnel classifications as follows:

	Per Cent
Administration	15.1
Sales and Service	36.4
Production	30.9
Research and Development	15.9
Other	1.7
	100.0

Source: Chemicals Branch, based upon information obtained from 15 Canadian pesticide firms.

The relatively high proportion of sales and research and development personnel (52 per cent) is an indication of the industry's orientation to the exploitation of specialized market segments as well as the considerable amount of product field testing required to demonstrate safety and efficacy of products on different crops under various growing conditions.

During 1978 and 1979, industry employment is estimated to have increased at a compound annual rate of about 15 per cent. This rather remarkable growth rate is attributed to not only broadly based industry performance, but also greater than average increase in personnel within six major firms anticipating further growth. Growth in total employment for the 15 firms that constitute more than two-thirds of industry sales and employment is projected to be 7.2 per cent per year during 1980/85 (Table 8). Nine of the firms that are or will be engaged in production activity forecast an annual growth rate of 9.6 per cent for production employment and 6.0 per cent growth for all other classes of industry personnel.

It should be noted that these employment projections incorporate perceived opportunities for general growth in markets, anticipated changes in business structure as well as assumptions concerning the success of competitive marketing strategies of the individual firms. Optimism with respect to the latter factor tends to create an overall upward bias on industry employment growth projections

since marketing strategies cannot be equally effective for all competitors. If the apparent 7.2 per cent per year industry growth in employment is coupled with a relatively modest increase in productivity of two per cent per year, a real annual growth rate in industry output of 9.3 per cent would be indicated during the 1980/85 interval. This suggested growth rate has not been supported by market projections independently determined for major domestic crops (Table 13). Only a dramatic increase in pesticide costs (i.e., decreased productivity) and/or a considerable increase in domestic active ingredient manufacture, formulation and exports, or a combination of these could reconcile these projections.

Relationship with Other Industries

The manufacture of pesticides active ingredients requires the support of a strong chemicals industry infrastructure both at the national and corporate levels. Examination of the corporate structure and business activities of the principal pesticide manufacturing firms generally reveals extensive diversification of chemical products manufacture, and frequently these firms are vertically integrated in the production of petrochemicals, pesticide synthesis, formulation and distribution of pesticide products. However, corporate chemical processing infrastructures are not uniform. Some firms are highly integrated from petroleum production, refining, and petrochemicals manufacture through pesticides manufacture and sale while others purchase the required petrochemical starting materials and restrict their chemical processing to the synthesis of a number of fine chemicals, including pesticides. The two manufacturers of pesticides active ingredients in Canada are in the latter category. Virtually all pesticide active ingredient manufacturers are involved in at least one other area of chemical specialty such as pharmaceuticals, food additives, dyestuffs, rubber and plastics additives, veterinary products and fertilizers. Some corporations are showing increased interest in plant breeding and seed supply as well.

Generally, manufacturers of pesticides do not have any significant equity in corporate agribusiness in Canada. Linkages between pesticide manufacturers and farm production is limited to ownership or rental of small farm acreage (or crop treatment agreements with growers) necessary for evaluating new pesticide formulations and crop treatment methods.

A small number of independent Canadian firms without chemical industry affiliation or substantial technological depth and formerly involved only in the wholesale distribution and dealer trade in fertilizer, seeds and other farm supplies have successfully integrated backwards into pesticide formulation by the strength of their hold on distribution channels.

Market Structure

Pesticide markets are subdivided by agricultural specialists and by the pesticide industry according to crop, location, and target pest organism. However, for purposes of this analysis, only the broader market-use sectors (i.e., agriculture, industry, home and garden) as well as major crops within the agriculture-use sector have been used in examining the relationships between the major pesticide markets and functional product classes (i.e., herbicides, insecticides, fungicides).

A comparison of the uses of pesticides in Canada and the United States within the major market sectors reveals marked differences. The most notable is the much greater dependence of the Canadian industry on agricultural uses of herbicides, which account for 73 per cent of the total Canadian pesticides market. This is particularly the case in the use of herbicides to control wild oat infestation in Canadian grain and oilseed crops.

Of 51 pesticide active ingredients that constitute products contributing considerably more than 75 per cent of aggregate pesticide sales in Canada, 30 are herbicides, 11 insecticides and eight

fungicides. Of the 30 major herbicides, none approaches the phenoxy class in terms of consumption.

Coarse and cereal grains account for 54 per cent of all agricultural pesticide use by value. Of this amount, the broad leaf herbicides, principally the phenoxy acids, esters and amine salts (2,4-D/MCPA) account for 31 per cent. While nearly 7,000 tonnes of phenoxy type (2,4-D/MCPA) herbicides, the largest chemical class, are consumed in Canada, domestic production capacity now exists for only about one-quarter of this amount from one supplier. Herbicides for the control of wild oats, annual grasses and other non-beneficial plant life account for 66 per cent of pesticide use by value.

Although relatively more important, herbicide use in Canadian agriculture is considerably less intensive than in the United States (approximately 65 per cent of U.S. herbicide intensity). This observation, along with estimates of market penetration attained by pesticides on principal crops in Canada, gives the impression that there remains a large unsatisfied potential demand. However, intensity of pesticide use is related to the nature of agriculture practiced. Since much of Canadian grain production is based upon a higher proportion of extensive agriculture, the potential to reach U.S. levels of pesticide treatment is improbable in the foreseeable future. Moreover, infestations infrequently involve all areas where a particular crop is grown and market saturation can be reached at a market penetration rate considerably below 100 per cent of crop acreage.

Domestic and International Price Trends -- Severe worldwide and regional supply/demand dislocations in basic feedstocks and organic chemical intermediates have had profound influences on prices of petrochemical end products over the past number of years. Pesticide manufacturing costs have not escaped these influences. However, pesticide prices ultimately are influenced more by competitive market forces that establish the value of crop protection products

relative to the alternative of increases in other farm inputs such as seed, land, fuel and labour. The price of an individual pesticide active ingredient is influenced not only by the demand for it but also by the comparative functional value of any substitute chemical entity. Generally, the demand for pesticides has been found to be price inelastic, attributable to a normally high return-to-cost ratio in crop treatment. It is, of course, subject to the purchasing power of the grower. Super-imposed upon these underlying determinants of price in Canada is a farm policy that is intended to keep costs of agricultural inputs as low as possible. Part of this policy is manifested in duty-free entry of active ingredients and formulations. Also, prior to March 1977, farmers were permitted to import unregistered pest control products for their own use. This practice was inconsistent with the intent of the Pest Control Products Act and was discontinued by amendment to that legislation in March 1977.

Consequently, the Canadian pesticide industry structure has evolved to supplying products in Canada that are now quite comparable in price to those in the United States. An analysis of the April 9, 1980, report of Agriculture Canada's committee on pesticide prices and supply shows that, after adjustment for currency values, 15 of 27 pesticide products were higher in price by an average of 12 per cent while 12 were lower in price by 15 per cent. Moreover, the eight most highly used herbicide formulations in prairie grain and oilseed production had prices nearly 16 per cent lower than the U.S. retail level. Furthermore, prices in Canada have increased somewhat more slowly than in the United States during the 1971/79 period.

During the 1970's period of enormous cost increases in petroleum products, pesticide industry prices performed much better at the manufacturer's selling price level (Table 25) than fertilizers or organic chemical prices. Manufacturer's selling price indexes for pesticides increased during the 1971/79 period at an average annual compound rate of 10.4 per cent compared to 12.0 per cent per year for fertilizers and 15.2 per cent per year for organic chemicals. Farm input prices over the same interval increased at annual rates of 15.7 per cent for pesticides, 12.8 per cent for fertilizers, and 14.9 per

cent for seeds, suggesting that margins for pesticide distributors and dealers may have improved considerably over this period.

Seasonal/Cyclical Factors -- The consumption period for pesticides in Canada is quite short, generally only one to three months. The severity and timing of infestation that determines the need for pesticide applications is frequently difficult to predict with any precision because the primary influence is the weather. As a consequence, the grower, the formulator and the distributor must anticipate pesticide requirements. A constant concern for all is the possibility that either supplies will be short or they will be faced with a carry-over of inventories at the end of the season, needlessly tieing up working capital. Companies attempt to minimize the costs by designing formulating plants with flexible productive capacities so that they can respond to sudden demands. In the three or four months preceding the season in which the bulk of pesticides are used, these plants warehouse a substantial part (perhaps 50 to 75 per cent) of the year's forecasted requirements; relying on extra capacity, including extra shift operations, to meet the peak demands at the height of the consuming season.

It is also evident that a large part of the research and development activity of the industry must be geared to the growing season. The seasonal demand for temporary research workers is readily filled by student agronomists, plant biologists, entomologists and other disciplines who are employed to assist with field trial evaluations.

Supply Factors -- The structure of the pesticide industry makes Canada rather vulnerable to supply disruption. In the United States, which supplies 75 per cent of pesticides used in Canada, 14 firms account for 85 per cent of total sales. These are concentrated in 200 products. Fewer than 20 active ingredients account for three-quarters of the Canadian market. Accordingly, Canada is

dependent on a relatively small number of large companies. However, Canadian pesticide demand is relatively unimportant to the overall operations of these corporate entities and Canadian supply might well suffer first in the event of material shortages or other problems. Fortunately, U.S. basic petrochemical capacity to the mid-1980's appears to be ample to permit the expansion of pesticide production capacity to match the predicted annual growth rates in domestic consumption and exports of about 1.0 and 2.7 per cent respectively to 1990.

International Trade

Trade Balance -- During the 1970-79 period, Canada has consistently incurred a trade deficit in pesticides. The deficit grew at an average annual rate of about 32 per cent in volume terms and 31 per cent in value terms increasing from $15.4 million in 1970 to $166.2 million in 1979. The most rapid rate of advance in the deficit, some 42 per cent per annum, took place during the years 1971-74. In part, this rise reflected the significant boost given to the international price for pesticides by the commodity boom of the early seventies.

In the eight-year period 1970-77, the value of Canadian exports of pesticides amounted on average to about 10 per cent of the total value of Canadian pesticide sales, peaking at 15.6 per cent in 1976. Over the same period, imports averaged some 49 per cent of the Canadian domestic market, reaching a high of 58 per cent in 1976-77. The greater proportion of Canada's foreign trade in pesticides is conducted with the United States.

Exports -- During the 1970-79 period, Canadian exports of pesticides increased at an average yearly rate of 9.5 per cent by value, with high rates of growth in the period 1973-75 and again in

1979 (see Table 15). Reflecting the sharp rise in prices for the commodity during the first half of the seventies, the value of Canadian exports advanced at an average annual rate of just under 26 per cent for the ten-year period. As expected, the highest rates of advance were recorded during the years 1973 to 1975 with an average annual increase of 84 per cent to a peak level of $15.9 million in 1975. Subsequently, export values fell on average by just under 22 per cent annually until 1979 when they recovered sharply to $11 million.

The major export market for Canadian pesticides is the United States, which over the previous decade accounted for about 62 per cent by volume and some 50 per cent by value of exports. Next are Central America and the West Indies which together account for about 13 per cent by volume and 18 per cent by value of the total. The EEC is Canada's third major market (11 per cent by volume and 16 per cent by value). Since 1974, relatively more Canadian exports of pesticides have been directed to Africa and the Middle and Far East. During the six years to 1979, these regions have been absorbing on average 5.5, 2.4 and 3 per cent by volume, and 5.2, 2.7 and 2.1 per cent by value of total Canadian exports of pesticides (Tables 20, 21).

Imports -- During the ten years to 1979, the volume of Canadian imports of pesticides increased by an annual average rate of just under 28 per cent, with the peak increase in 1972. However, the volume of imports fell on a year-to-year basis in 1977 and 1979. In value terms, imports grew at 30 per cent per annum during the ten-year period, with the highest annual rates of increase registered in 1973-75. While the peak in exports, in real and nominal terms, was reached in 1975, that for real import volume occurred in 1978 (92,462 tonnes) and the highest import value, $172.4 million, was recorded a year later.

Canada's major supplier of pesticide active ingredients is the United States followed by Britain, BLEU and West Germany (Tables 22, 23). Imports of these ingredients represent a smaller part of

total pesticide imports. In 1978, formulated products accounted for 68 per cent by value of total imports.

During the 1970-79 period, herbicides accounted for 68 per cent of the volume of these formulated imports, insecticides 14 per cent, and fungicides 18 per cent. These types of pesticides accounted for 72, 12 and 16 per cent of total import value respectively. The quantity of herbicides imported has generally increased up to 1977, especially during the latter four years. Since then, however, it has declined. Insecticides' share of total imports of formulated pesticides fell from 17 to 11 per cent during the 1970's, while that of fungicides grew from 14 to 22 per cent. Imports of seed treatment material have been negligible, amounting to less than one-half of one per cent of total imports of formulated pesticides.

The United States was also Canada's principal supplier of formulated pesticide imports. Throughout the 1970s it accounted for 78 per cent by volume and 72 per cent by value of formulated herbicide imports, 92 and 90 per cent of formulated insecticide imports, and 80 and 76 per cent respectively of formulated fungicide imports. The EEC was the second largest supplier with average shares in total imports by volume and value at 14 and 18 per cent for herbicides, 5 and 6 per cent for insecticides, and 20 and 23 per cent for fungicides.

Not only is the industry in Canada dominated by multinational firms, but it is highly specialized with a few individual firms holding the greater share of specific markets. The major producers of pesticide active ingredients are also more often than not engaged in the formulation of the end-product either in their country of origin or in their export markets. Canadian affiliates often fulfil the role of importer/distributor, and even of dealer, not only for the parent company's products, but also for the specialities of other multinational firms in order to offer a fuller range of products to the end-user. There are thus strong indications that the pesticide industry in Canada operates within oligopolistic, and possibly in some instances monopsonistic market conditions.

Canada's pesticide industry is not structured to be internationally competitive and the results of this constraint can be readily observed from trade statistics. The consistent deficit in Candian pesticides trade throughout the 70s clearly indicates that the main thrust of the industry's activities is aimed almost entirely at the domestic market. In 1979, out of a market estimated at $185 million for active ingredients valued at the basic producers level or an estimated apparent domestic market of $320 million, Canada's imports of active ingredients and formulated products amounted to $177 million. As in every year throughout the 70s, the U.S. was the major supplier, accounting for $139 million or just over 78 per cent of total imports. Of that amount, 28 per cent was active ingredients for further processing in Canada and 72 per cent was formulated products. The following table illustrates Canada's relatively high reliance on imports of formulated products.

UNITED STATES PESTICIDES EXPORTS, 1978

Country	U.S.$millions	Not Formulated % of Total Value	Formulated % of Total Value
Canada	108.9	32	68
Belgium	110.2	38	62
Brazil	90.9	38	62
Japan	60.8	44	56
Mexico	20.5	55	45
Colombia	23.9	66	34
Britain	24.2	74	26
West Germany	21.0	76	24
Venezuela	17.9	77	23
The Netherlands	36.9	80	20
Nicaragua	16.3	84	16
Switzerland	44.4	94	6
Others	326.1	59	41
Total	901.9	54	46

Source: U.S. International Trade Commission, U.S. ITC Publication 1001, 1978

Further evidence of this reliance on importation of formulated products is obtained by examining herbicides, the major market segment. During the second half of the 70s, Canadian imports of U.S. active ingredients for herbicides have, on average, increased in volume at only one-third the pace of formulated herbicides. In value terms, the proportion of formulated herbicides, relative to active ingredients, has been upwards. For instance, in 1979 formulated

products accounted for 85 per cent of the total import value of herbicides of U.S. origin. This would suggest that the domestically-located formulating industry has been unable to take advantage of market growth to expand its processing activity due to market constraints.

The Canadian chemicals industry has not responded to the sustained growth of world demand for pesticides in recent years, particularly in the developed countries. During the period of fastest growth in world demand for pesticides, from 1968 to 1976, West Germany, the United States, Britain and the Netherlands contributed 26, 18, 11 and 6 per cent respectively to the total value of world exports. Canada's share was barely one-half of one per cent. Even Japan, which at the time was only a minor participant in the world trade for pesticides, accounted for 4 per cent of total world exports.

West Germany and Britain export about half their output of pesticides, three-quarters being herbicides, and the United States exports 36 per cent of output, one-sixth herbicides and one third insecticides. Canadian exports have improved only slightly from an average 10 per cent of domestic shipments at manufacturers' prices in 1970-74 to 12.3 per cent in 1975-79. Much of this improvement took place, however, during the years 1975 and 1976 when the world pesticide industry experienced shortages of capacity and when Canadian exports rose to, respectively, 15.4 and 18.4 per cent of domestic shipments. Since 1977, when the world pesticide industry entered a period of excess capacity, Canadian exports have been falling in both absolute and relative terms to between seven and nine per cent of shipments, levels comparable with those registered during similar conditions in the early 70s. This, combined with the relative lack of real growth in shipments of own manufacture in recent years, indicates that the domestic industry has made little progress in its penetration of foreign markets during the past decade.

Unfortunately, this inward orientation shows little sign of abating. The Canadian chemicals industry does not appear to have given serious consideration to the high growth of demand anticipated from the third world, especially Latin America and South East Asia, during the next two decades.

The apparent poor competitive stance of the domestic producers of active ingredients has been compounded by changing market requirements. Current facilities were designed for the production of herbicides based on phenoxyacetic acid and butyl esters of relatively high volatility. These are now being replaced by esters and amine salts of lower volatility, greater stability and economy in application. The additional capital investment required, together with the scale of operation, has tended to make production in Canada less economically viable. Moreover, the focus of market growth has become more centred on wild oat and other annual grass herbicides, the demand for which accounts for some 75 per cent of total domestic demand for herbicide use in agriculture as against 25 per cent for phenoxies. In relative terms, this former class of herbicide continues to become relatively more important to Canadian than to U.S. agriculture.

There is, however, one indication of a modest improvement in the competitiveness of the Canadian pesticide industry. This relates to selling prices. During the period 1971-79, prices for pesticides at user level increased by 300 per cent in the U.S., whereas in Canada, they rose by about 183 per cent. Some caution is required in interpretation, since the disparity in price movement may be due in part to the comparatively lower base from which U.S. prices have risen. In addition, the comparatively higher proportion of relatively few large volume herbicides used in Canada may have had a greater downward pressure on the overall price level for pesticides.

Tariffs -- In Canada, all active ingredients for pesticide formulation are imported duty-free with the exception of 2,4-D/MCPA for which the current MFN rate is 14.8 per cent ad valorem, to be reduced to a bound rate of 13.5 per cent ad valorem under the MTN agreement. All ready-to-use pesticide formulations or preparations are imported duty free, with the exception of packaged products of three pound lots or less for retail trade on which duty is levied at a rate of 7.5 per cent ad valorem.

Prior to MTN, the United States import duty consisted essentially of a specific levy of 1.7 cents per pound, plus an ad valorem duty of 12.5 per cent. Under the Tokyo round agreement this standard rate of duty was converted into several rates, each of which is specific to one of three categories of imports. The EEC and Japan reduced nominal rates of import duties by some 45 and 30 per cent respectively. Taking account of these changes (Table 17), the U.S. rates of import duty on pesticide active ingredients and formulations will remain higher than those in place in most other developed countries (Table 18).

As in Canada, the structure of import duties applied in other countries (Table 18) is more straightforward than that in the U.S., with one rate of duty for bulk pesticides (active ingredients and formulations) and another rate for imports of small lot shipments destined to the retail trade. The only exceptions are found in some Latin American countries whose rate structures are also more selective.

Relative Production Costs

It is generally acknowledged by the industry that Canadian manufacture of the limited output of pesticide active ingredients has not been internationally competitive due to both the small plant

scale and obsolete facilities. However, the formulation/distribution aspects of the pesticides industry are much less scale sensitive and are considered to be competitive with comparable facilities in the United States.

A comparison of relative materials and labour costs for the year 1977 between the industry in Canada, represented by seven corporations with major business activity centered upon the formulation and distribution of pesticides, and that in the U.S., based on 338 firms primarily engaged in the formulation or preparation of ready-to-use agricultural and household pest-control chemicals, reveals that the Canadian industry incurred considerably higher materials costs and relatively lower labour input costs, with a resultant lower value added by manufacturer as a proportion of shipment value. The higher combined costs of materials, salaries and wages in Canada, some 41 per cent greater than the U.S. level, largely reflect the lower manufacturing content of the large amount of formulated product imported for resale by Canadian firms, as well as any intrinsic inefficiencies which may have existed. In terms of a labour productivity comparison, the value added per Canadian employee in 1977 was only 3.7 per cent lower than the comparable U.S. figures expressed in national currencies, or 9.4 per cent lower when the prevailing foreign exchange rate* is taken into account (see Table 19).

Technology and Innovation

It is estimated that the pesticides industry in Canada employs approximately 190 research and development personnel, with expenditures of about $9 million or nearly three per cent of sales at the manufacturer's level. The largest part of these R&D expenditures are devoted to market development and compliance testing for registration purposes, involving evaluation of the products' effects on crops, environmental impact studies, residues testing and formulation development. There is very little activity in Canada aimed at the discovery of new pesticide chemical entities.

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* 0.940 U.S./$ Canadian, average for 1977.

Such research is carried out by only one company, which spends less than five per cent of total industry R&D. That work has, however, had some notable success in the field of systemic fungicides.

On the broader front, a declining rate of increase in the cumulative number of pesticides would seem to indicate that innovation in this industry is unlikely to be rapid. Discoveries are proving more elusive: in 1977 it was necessary to evaluate 12,000 compounds to obtain one commercial success, whereas in 1970 it required 7,400 and in 1956 only 1,800. In addition, there is increasing research emphasis on non-chemical methods (i.e., biological) of pest control that exploit the use of natural plant and insect preditors or pathogens.

Basic research on insect and plant physiology combined with biotechnology are expected to yield discoveries that will lead to inexpensive production of specific insect toxins, viral and bacterial pathogens as well as improved genetic resistance to disease in plant species. These discoveries will ultimately affect chemical pesticide usage. For example, the Forest Pest Management Institute of Environment Canada is conducting an experimental program involving the use of a biological agent, Bacillus Thuringiensis, for the control of the spruce budworm close to inhabited areas where the use of toxic chemical pesticides is considered undesirable. However, it is unlikely that such developments will have advanced sufficiently to exert any appreciable commercial impact over the medium-term. At the present time, the industry in Canada has no program to engage in this area of research or development.

Technological developments in integrated pest management (IPM) services are reported to have met with some initial commercial success in the Okanagan Valley fruit-growing area of British Columbia. Once established as an effective practice in fruit crop protection these services are likely to be offered in other fruit growing and market garden crop areas of the country.

Canadian farmers have been extremely slow in adopting no-tillage agriculture — seeding without plowing, followed by chemical weed control. As increased yields from fallow land are required and moisture conservation, soil erosion and depletion of organic matter become more critical factors in maintaining land fertility, no-tillage farming will undoubtly gain widespread acceptance and have a very significant impact on the amount of herbicide used. The U.S. Department of Agriculture (Science, 6 June, 1980, p. 1108) expects that no-tillage farming will increase from the present 1.5 per cent of cropland to between 45 and 60 per cent by the year 2000.

Over the medium-term, the technological thrust of the pesticides industry in Canada is likely to continue to centre mainly on the identification of potentially useful candidate chemical pesticides of foreign manufacture for evaluation, field testing and the development of formulations suitable for application to Canadian agriculture. Because of the high costs and uncertainties involved in the approval and registration process, developments will likely be confined more to chemicals with potentially high volume use on the important cereal grain crops. There will also be developments to further improve the efficiency of pesticide use, both in application methods and product effectiveness. As well, considerably more development work can be expected in the search for acceptable substitute pesticide combinations in anticipation of the voluntary or forced market withdrawal of some products now being reviewed.

Investment and Financing

Measures of profitability for seven companies, chosen as being representative of Canadian corporations with business activity concentrated in the pesticides industry (80 per cent of corporate sales derived from pesticides in 1979), were compared with three major chemicals industry sectors for the years 1976 to 1978 (Table 24). The summary figures following indicate that these firms, with aggregate

corporate sales totalling almost $300 million in 1978, had an average pretax net profit on equity of 27.9 per cent, compared with 24.1 per cent for manufacturers of pharmaceuticals and medicines (SIC-374), 17.1 per cent for manufacturers of industrial chemicals (SIC-378) and 19.6 per cent for miscellaneous chemical industries (SIC-379). By comparison, the five-year average before-tax return on equity for 39 U.S. manufacturers of pesticides in the years 1972-76 was 16.2 per cent relative to 15.6 per cent for the entire U.S. chemicals industry in the same period.

The relatively low rate of return on sales (3.6 per cent for the seven Canadian firms) is indicative of the lower capital investment per pesticide sales dollar compared to the more capital intensive chemical process activities of other chemical industry sectors.

Comparison of Return* on Sales, Assets and Equity

	Sales	Assets	Equity
		(per cent)	
Pesticide industry	3.6	12.0	27.9
Miscellaneous chemicals industry (SIC-379)	7.2	10.5	19.6
Manufacturers of pharmaceuticals and medicines (SIC-374)	9.3	12.6	24.2
Manufacturers of industrial chemicals (SIC-378)	9.4	6.1	17.1

* Average net profit before income tax for 1976 to 1978.

The results for the pesticide industry as represented by the seven corporations are, of course, influenced heavily by the spectacular improvement in profitability in 1978 when pre-tax net profit reached 6.3 per cent of sales, 19.8 per cent on assets, and 48.7 per cent on equity. While there was some improvement in the other sectors in that year, it was not nearly as dramatic.

The improved profitability of the industry in 1978 can be attributed to product sales revenue increasing by 7.2 per cent more than the cost of sales combined with an improved assets utilization resulting from a growth in sales of 40 per cent. Since the apparent

domestic market grew by only 16.8 per cent in current dollars, the performance of these seven firms may be somewhat atypical of the industry although their pesticide revenues represent a very large proportion of estimated total industry sales. As well, the importance of these firms may be somewhat exaggerated by implicit inclusion of interfirm transactions, other commodities and distribution margins. In addition, they may have enjoyed price increases that exceeded the 3.8 per cent average increase in the pesticide products selling price index reported for 1978 as well as possible inventory profits. Furthermore, the salaries and wages component of expenses only rose 60 per cent of the level of increase in the overall cost of sales.

Capital investments made by 10 firms in the 1975/79 period totalled $19.2 million, 86 per cent of which was directed to formulation activities and 14 per cent to the manufacture of active ingredients. These firms expect to invest approximately $116 million in the 1980/84 five-year period, with about 80 per cent intended for active ingredient manufacture and 20 per cent for formulation. It should be pointed out that some plans may preempt the investment intentions of others, making it doubtful that the global forecast will be fully realized.

(C) ROLE OF GOVERNMENT

Framework Policies

Agricultural policy, broadly defined as including food production and marketing related policies, exerts an overriding influence on the prospective growth and development of the pesticides industry in Canada. It takes on substance in a complex array of programs, incentives and other support measures including federal agriculture research programs, farm price stabilization programs, grain transportation subsidies, elevator terminal construction, product marketing boards, and low interest farm loans extended by both federal and provincial governments. To a considerable extent the effective interaction of these various components of government agricultural policy are principal determinants of production and the export of farm products.

One of the main thrusts of federal government policy has been to address the decline in Canada's share of world agricultural markets. In an attempt to increase the Canadian contribution to the world food supply, transportation and marketing aspects of the problem have received most attention. Efforts to expand export markets and improve ability to deliver are expected to provide the incentive for Canadian farmers to bring more land into production and induce changes in agricultural practices that will raise productivity. A prerequisite to achieving these objectives will be even greater dependence upon weed and pest control methods.

Sector Specific Policies

Pest Control Products Act -- The importation and the sale of products used for the control of pests have been regulated in Canada since 1927. The Pest Control Products (PCP) Act administered by the Minister of Agriculture, was promulgated in 1939. Revisions to that statute and its regulations were made in 1972 and 1977. The act requires that pesticides imported, manufactured or offered for sale in Canada must be registered. This legislation provides for the regulation of manufacturing premises, storage, distribution, display and use of pest control products. It also makes provision for concerns related to human health, wildlife, forest, water and environmental quality, interlocking with the relevant regulations of the Food and Drug, Environmental Contaminants, Fisheries and Migratory Birds Convention Acts (Diagram I, Appendices). Product registration is granted only when sufficient information is provided by the registrant or manufacturer to demonstrate that the product is safe and effective under the proposed conditions of use. The certificate of registration has a term of five years.

Agriculture Canada's regional research facilities are used in evaluating pesticides through the study of their efficacy and their effects on the environment. In addition, Health and Welfare Canada's Health Protection Branch conducts testing for tolerances of pesticide residues on food products to assess compliance with regulations of the Food and Drugs Act. The regulatory status of a particular pesticide emerges from these various sources of information and establishes the uses for which the product may be sold. Implicit to the registration process is "label compliance" which includes the directions for use, restrictions, and a listing of eligible purchasers. Where concern may exist over environmental contamination or safety with respect to a particular pesticide, a use permit and signing requirement may also be stipulated.

Most provincial governments have enacted legislation with accompanying regulations that are complementary to the federal PCP Act -- controlling sales outlets, vendors and users of pesticides as well as the licensing of applicators in some provinces. No conflict is encountered between federal and provincial statutes since the more restrictive regulation applies, although the multiple regional jurisdictions make the introduction or continuance of a pesticide more costly and uncertain.

The federal registration process has become a topic of considerable debate in recent years. In the process of evaluating an application for registration the Department of Agriculture makes unrestricted use of all sources of information at its disposal including any relevant supporting data generated by previous registrants. This eliminates potential duplication of submission for information that may have been required of a preceding registrant. It is felt in some quarters that any restrictions that might be imposed on the use of registrants' data would constitute an effective extension of a monopoly which is properly limited to that enjoyed by patent rights granted, and that it would be inconsistent in patent law to extend special privileged status to one industry sector but not to others.

The pesticide industry contends that the regulatory agencies unrestricted and uncompensated use of registrants' data has resulted in easy market entry for competitive products with the result that profitability has been reduced to such an extent as to encourage companies to cut back or abandon pesticide research programs. This issue has become a "cause célèbre" for the industry, particularly in the United States following an unsuccessful attempt by the U.S. National Agricultural Chemicals Association to have the Senate adopt an "exclusive use of data" provision in the 1971/72 amendments to the Federal Insecticides, Fungicides and Rodenticides Act (FIFRA). Since then the House of Representatives has passed an amendment to provide a five-year period of exclusive use to be followed by a five-year period of compensation.

In spite of these concessions to initial registrants, 17 companies have requested the U.S. federal courts to strike down the 1978 FIFRA amendments because of a disagreement with the provisions on data disclosure and use. They contend that the law abridges the companies' property rights guaranteed under the U.S. Constitution and that the Environmental Protection Agency (EPA) applies the law improperly by considering studies on pesticides other than those the applicant presents.

The EPA has concluded that any exclusive use of data provision in FIFRA would adversely affect competition as well as impede progress in simplifying the registration process through the establishment of generic standards and thereby restrict market entry by smaller firms.

It is clear that any move in the U.S. to restrict the use of relevant data from prior registrations or other studies or to compensate prior registrants for data supplied would further serve to intensify market concentration. As well, it would result in pressure for Canada to adopt similar practices in the administration of the PCPA. A consequence of such a carry-over would be delay or preemption of any possible increased competition in active ingredients manufacture or formulation activity by Canadian-controlled formulators as patents expire.

Environmental Contaminants Act -- The Environmental Contaminants Act (ECA) constitutes residual legislation proclaimed by the federal government in 1976 to regulate contamination of the environment by chemicals and other substances not covered by other specific legislation. The ECA influences the pesticides industry primarily at the point of manufacture of starting materials and chemical intermediates used in the manufacture of pesticides. While the ECA empowers Environment Canada and Health and Welfare Canada to act jointly to ban or restrict the use, manufacture or importation of any chemical deemed harmful to humans or ecosystems, provincial governments, other federal departments and agencies must be consulted on the effects of any proposed regulatory action to determine if other legislative action to eliminate the hazard would be preferable.

In a report dealing with the problems of chemical contamination and the legislation available to address them, the Canadian Environmental Advisory Council (Report No. 8; Ecotoxicity: Responsibilities and Opportunities, August 1979) concluded that present legislation "cannot cope with the realities of industrial production and indiscriminate use of chemicals". In particular, it noted that existing legislation is generally "better adapted to coping with single chemical-single effect relationships than with the often subtle and indirect effects of chemical complexes, often acting in minute quantities over long periods of exposure". It further pointed out that the classical toxicological studies as now performed for registration and other purposes are inadequate to define the real hazards, and suggested that more complex and costly testing of products and combinations of products for synergistic effects may be required in the future.

Should these recommendations be acted upon, registrations and other costs of chemical pest control products are likely to rise

even more rapidly than in the past, constituting a further stimulus to industry concentration.

Health and Environmental Concerns -- The pesticide industry has become a focal point for much of the public concern that has resulted from disturbing associations that have been made between certain chemical substances and ecotoxicity, including the potential for unacceptable risks to human health. Chemicals such as DDT, hexachlorophene, pentachlorophenol, polychlorinated biphenyl, chlorobenzilate, aldrin, chlordane, chlodecone, dechlorane and endrin are among a growing list that have been severely restricted in use or banned altogether. A number of studies, which formed the basis of prior approvals, have become subject to question, casting doubt on others. Some chemicals are now being condemned by generic association and the actions of what the industry terms "political environmentalism" before reliable studies reveal that an untenable risk/benefit relationship exists for the specific products or a particular use. The completion of such studies is hampered by limitations in the science of quantitative risk measurement which permits only a rough indicator of the level of human risk. For these and other reasons, it has proven difficult for industry and objective authorities to respond in a timely, appropriate manner to public concern over safe usage.

A possible adverse effect could be restriction in application of widely-used chemicals such as 2, 4-D. This is of particular concern in the case of many halogenated cyclic hydrocarbons. Fortunately, chemical companies have successfully developed many herbicides and insecticides which are less persistent, of a lower order of ecotoxic concern, and not based upon these chemical entities. Nevertheless, these events have raised considerable uncertainty over the potential future discovery of new relationships between pesticide usage and health problems and the possible ramifications on pesticide industry investments.

Policies in Other Countries

Government regulations on the use of pesticides have revolved primarily around both acute toxic effects and tolerances, that is, the maximum residue considered safe to humans and to the environment that will remain on the treated crop when shipped. Although such regulations on the use of pesticides have been of long standing in the western economies, no universal tolerance standards have yet been established. In the EEC, each member country applies its own regulatory program, although members have been discussing for some time the possibilities of harmonizing their respective tolerances into one standard. Increasingly in recent years attention has been directed towards more subtle long-term effects of carcinogenicity, mutagenicity and teratogenicity of the toxic chemical substances.

In Britain, the Pesticides Safety Precautions Scheme (PSPS) is the program concerned with the market introduction of new pesticides or with the extension to other uses of existing ones. It is being administered by an Advisory Committee on Pesticides and other Toxic Chemicals, itself supported by a Scientific Sub-Committee and a Scientific Secretariat. The members of these committees are leading authorities in toxicology, pharmacology, other medical sciences, agriculture, food and wildlife. It is the Scientific Sub-Committee which recommends the precautions that are to be taken and the interval that must elapse between final treatment and harvest. These recommendations are then submitted to the Advisory Committee for consideration and ultimate approval.

In the United States, the Environmental Protection Agency (EPA) is responsible for the registration of pesticides and pest control materials under FIFRA and establishes the accepted tolerances for pesticide residues in or on human food and animal feeds in compliance with the Food, Drug and Cosmetic Act. The latter act is designed to: assure the safety of the national food supply; ensure

that the industry can prove that the residues left in food are safe to the consumer; make certain that pesticides are cleared by the federal authorities before use; and provide the right of seizure and destruction of agricultural commodities containing residues in excess of the established norms. In this role, the EPA outlines the information to be supplied by industry and the procedures to be followed in establishing residual tolerances on raw agricultural commodities and processed foods. These requirements are being continually revised, however, in the light of new scientific data being brought to the attention of the federal authorities. Furthermore, the EPA has been given authority to ban altogether pesticide products already on the market, or to respecify the uses to which they may be put.

There have been some attempts at establishing international standards for tolerances with respect to pesticide residues, notably by the EEC in cooperation with the FAO and the WHO. In 1960, the latter set up a program for the systematic evaluation of new compounds of pesticides that might be used in public health. The objective was to challenge insect resistance in emerging situations, to recognize and influence trends in pesticide development, to further knowledge on the toxicology and safety of different groups of compounds and to approach the subject of environmental pollution with a greater sense of realism. Between 1965 and 1975, some 45 companies, and a number of universities and institutes participated in the scheme and 1800 compounds were submitted for examination. This consisted of seven evaluations of the product, three in the laboratory and four in the field, each successive stage being more exacting than the former with regard to effectiveness and safety.

To date, 1,500 of the compounds have been actively examined. Over the years, however, the number of submissions of compounds has been declining steadily for several reasons. Perhaps the most important is that the WHO's requirements for pesticides are not usually

sufficiently large to enable production on an economic scale. As a result, the WHO must often wait until the producer embarks on the production of a pesticide compound for agricultural purposes before it can avail itself of the product for public health application. There is also the fact that industry is reluctant to acquire patent rights on compounds produced by or in cooperation with non-industrial institutes.

II MEDIUM-TERM OUTLOOK

Medium-Term Market Forecast

International Market Trends -- The United States is both the dominant world market for pesticides (33 per cent of world consumption) and the major world supplier (45 per cent of world capacity), exporting about one-third of its pesticide chemical output. Estimates of future world market growth suggest that in volume terms, the U.S. domestic market is approaching maturity. As new pesticide technology and more eco-conservative agricultural practices are adopted, physical volume growth in U.S. consumption is conservatively estimated (Predicasts Inc.) at one per cent per year to 1990. Reflecting the potential for considerably greater growth in demand in other world markets, the same source expects the export component of U.S. shipments to grow at a rate of 2.7 per cent over the next decade.

Based upon the importance of cash crops to the respective national economies and the potential benefits that can be derived from intensified crop protection programs, it has been predicted (SRI International) that the markets of Central and South America, Mexico, Canada, Australia, New Zealand and the Philippines collectively estimated to account for 16 per cent of world consumption will grow to 20 per cent by 1985. It has also been predicted (Information Research, London) that the relative consumption of the developed Western and Eastern Europe and North American markets is likely to decline from 70 per cent of world demand to about 60 per cent by 1990 due to the faster growth in other geographic areas. If it is assumed that these more mature markets will share the average growth expectations for U.S. shipments of 1.5 per cent per year to 1990, then, taking account of predictions for the redistribution of world market shares, the average world market growth rate would be 2.5 per cent per year, with the average growth rate for the combined markets of Central and South

America, Mexico, Canada, Australia, New Zealand and the Philippines being 5.5 per cent per year, with residual world markets growing at about 3.5 per cent annually.

Domestic Market Trends -- The pesticides industry in Canada, as in most of the developed world's food producing countries, is essentially driven by the need for the nation's agriculture to remain internationally competitive as the world demand for grain and oilseed increases. While Canada produced only three per cent of world grain in 1978, the value of this production amounted to nearly $5 billion, of which more than 50 per cent was exported. In the same year, expenditures by farmers for pesticides were estimated at about $225 million or about 3.2 per cent of total farm operating expenses. The value of production attributable to these expenditures has been estimated at over $1 billion, an amount that exceeded Canada's trade surplus in agricultural products.

Agriculture accounts for about 90 per cent of Canada's pest control chemical use by value, with 80 per cent of that amount spent on herbicides for the control of plant life that competes with crops for space, moisture and nutrients (Table 9). Although Canada's use of all pesticides represents only about five per cent of the North American total, or about two per cent of world use, this country now accounts for nearly eight per cent of North American herbicide consumption.

It is clear that the use of pesticides has become a firmly entrenched practice in Canadian agriculture and has a vital economic significance. Future growth in the quantity of pesticides used clearly will arise from increased demand for Canadian agricultural products as well as any greater intensity of chemical application in crop protection measures.

Estimates of expected growth in the domestic agricultural markets for pesticides have been made for the years 1985 and 1990.

These were based on the predictions of 11 participating industry members for further market penetration expressed in terms of the percentage of principal crop and land expected to be treated with pesticides in these years. The result indicates an average real rate of growth of only 2.0 per cent per year to 1990 (Table 13).* This type of market growth projection is free of the influence of competitive corporate expectations arising from marketing strategies. It should also be noted that this two per cent growth rate estimate is independent of any major changes in technology relating to pesticide types, optimum usage, application methods, crop mix, or major changes in agriculture intensity or land use.

The latter factor could have a very significant influence on pesticide sales forcasts. It is generally believed that some expansion of grain growing areas or grasslands will be necessary to meet future export market demands. An intermediate-range objective of the Canadian Wheat Board is to reverse the trend to a declining share for Canada in world grain exports by enabling a 50 per cent growth in foreign shipments by 1985. While improvements to the grain shipping/handling system are prerequisite to the attainment of this objective, sustained growth of this magnitude must be ultimately reflected in an increase in grain production of about 10 million tonnes per year. At present it is expected that about one-half of this increase could be achieved through improved production yields that may be obtained from the combined effects of intensified inputs and higher yielding varieties on the existing land base, with the remainder from an additional two million hectares of land being brought into production by 1985. Should the export goal be achieved through these means, the overall agricultural market for pesticides would grow at a rate of nearly four per cent per year during the first half of the 1980s.

* The product of the average or most commonly stated estimates of market penetration rates (Table 12) for pesticides expected to be used on seven principal crops (accounting for 85 per cent of agricultural pesticide use in 1979) and the relative sales values of pesticides used on these crops in 1979 (Table 11) provided a measure of the expected overall market growth.

If most of the growth in grain production centres on wheat, the increase in this segment of the pesticide market could be as much as 45 per cent by 1985 and nearly 70 per cent by 1990, expressed in terms of 1979 dollars. This would suggest an average rate of growth for pesticides in cereal grains of about eight per cent per year to 1985 or more than five per cent annually to 1990, the greater part being in herbicides for wild oat, other annual grasses and perennial weeds.

If growth in overall demand for pesticides is to exceed the fairly modest rates of growth indicated to 1990, the industry must depend upon more rapid advances in agricultural technology that will support expanded product applications, possibly accomplished through greater crop diversity, changes in land use patterns, and increased selectivity of pesticide types. As well, the industry will have to concentrate more effort on products suited to less developed market segments and place more emphasis on the development of export markets.

Factor Supply

The critical factor of production in Canadian pesticide manufacture is the active ingredient raw material. More than 90 per cent by value of pesticide active ingredients used in Canada are imported, with nearly 80 per cent of this value originating in the United States. The historic reliability of the U.S. and EEC suppliers can be attributed to rapid growth in pesticide usage within these economies which provided the incentive to sustain sufficient surplus manufacturing capacity to assure adequate supplies for domestic agricultural production as well as a modest rate of increase in exports.

Pesticide markets in the U.S. and Europe are now near maturity with annual growth rates in the one per cent range. On the other hand, foreign markets, with annual rates of increase ranging from

three to 10 per cent, have now grown to represent about one-third of U.S. and European production. Although it is expected that sufficient excess capacity will be available to assure that these sources continue to be stable suppliers over the medium term, it is possible that in the longer term a number of factors, especially greater dependence of these economies upon more expensive petroleum and increased requirements for capital investments in alternative energy sources, may make it more difficult for them to sustain exports of pesticide raw materials and formulations at competitive prices. This would argue for active ingredient plants in fast-growing markets. As well, from the view point of security of supply considerations, it would seem to be a sound policy for a greater share of the world's production of critical agricultural inputs to be dispersed more widely.

The projected medium term growth in employment represents an increase of about 50 per cent in the sector workforce by 1985, or some 600 employees. As discussed previously, this increase is predicated on corporate sales forecasts which exceed market forecasts. However, should the former materialize, little difficulty is anticipated in obtaining the skilled managerial marketing and production personnel which would be required. Moreover, barring any major change in industry characteristics, the fixed capital requirements to create these jobs would be about $24 million in 1978 dollars, well within capital investment expectations and the industry's capacity to finance growth.

Technological Developments

Over the medium term, only a very small number of new chemical entities are likely to be registered for sale in Canada. This can be attributed to an increased share of active ingredient manufacturers' research budgets being devoted to toxicological testing for regulatory compliance, expanded chemical process research and more stringent examination of data presented for product registration by regulatory authorities. Specifically, only a few new selective

post-emergent herbicides and synthetic pyrethroid insecticides may be approved for use by 1985.

During the period to 1985, the following areas of technological endeavour are most likely to have greatest impact upon pesticide usage and the pesticides industry in Canada:

1. Carrier Systems

The focus of these developments will be upon achieving greater cost efficiency by improving pesticide formulation carrier systems, reducing the amounts of expensive and toxic solvents in use. Specifically, dry-flowable formulations may begin to replace emulsifiable concentrates over the next few years.

2. Application Systems

Innovations here will provide the means for more judicious use of pesticides. More efficient application methods will result in greater safety in handling, enhanced protection of the environment and economy in usage. Controlled droplet and electrostatic spray systems are reported to lower both pesticide application rates and dilution ratios. Better timing of applications will also be encouraged to reduce quantities needed. Finally, formulators can be expected to capitalize on the opportunities inherent in the service element of IPM methods.

3. Packaging

Returnable corrosion-proof containers will come into general use, contributing to greater shelf-stability and handling safety.

4. Zero tillage

In response to the need for increased production, arising in part from potential growth in exports, and reduced energy consumption, the use of herbicides to eliminate mechanical tillage of fallow land will reach commercial significance.

Role of Government

The Department of the Environment (DOE) is at present developing an environmental protection policy and related principles as the basis for new legislation designed to improve the management of toxic chemicals. This will likely have a significant effect upon the chemical industry in the medium term with respect to handling, waste management, and use of toxic chemicals, as well as greater regulation over new product introductions.

On July 1, 1980, DOE set up the Toxic Chemicals Management Centre (TCMC) as part of the Toxic Chemicals Management Program (TCMP), the major objective of which is "to prevent or control the entry of harmful quantities of toxic chemicals into the environment - air, water, land, biota and man". The major new thrust will be to assess chemicals on a priority basis and formulate integrated plans of action for such control. TCMC will undertake the priority setting role, with the operational work being carried out in the appropriate line directorates of DOE. It will also act in a coordinating capacity, working with other departments, producers, importers, users, the provinces and other governments to develop and implement a set of principles that will clarify the respective responsibilities of these groups in toxic chemicals management.

As one aspect of improving the management of toxic chemicals, the Department of Agriculture has proposed new initiatives with respect

to administering the Pest Control Product Act and the related regulatory process. These include:

i) Development and implementation of modern registration and analytical standards designed to: quicken response time; provide greater consistency in regulatory action; tighten control of chemical specifications; increase control over marketing of pesticides; and ensure that registration guidelines are tailored to Canadian needs.

ii) Identification and investigation of gaps in the technical data base to: facilitate the setting of priorities in selecting chemicals for re-evaluation.

iii) Re-evaluation of pesticides currently registered but never subjected to an in-depth assessment with respect to their safety, merit or value to ensure that all registered products meet modern registration standards.

iv) Development of "risk/benefit" assessment capabilities, and identification of certain sectors of the population and environment as potentially at "high risk", which will add credibility to regulatory decisions and facilitate appropriate action.

v) Creation of information processing systems to enable rapid and accurate tracking of all submissions within the regulatory systems, which will save time and ensure rapid, accurate assimilation and dissemination of pesticide information to all concerned.

vi) Formulation of alternatives to pesticide use.

Provincial jurisdiction in such areas as hazardous waste disposal and the sale and use of pesticides is clear. However, the provinces look to the federal government for leadership in the management of toxic chemicals for several reasons, including the transboundary nature of the problem, arising from importation and shipment across the country. In addition, the cost involved in the research and technology of testing toxic chemicals is beyond the financial capacity of some provinces. Federal leadership is demonstrated in the solution of common technical problems.

It can be expected that federal/provincial cooperation will increase in the medium term due to the complexity of the problems and the interlocking regulatory relationship. Provinces are looking for increased federal effort in a number of areas, including hazard and risk assessment, the formulation of sampling and analytical methodology, and the development of new and improved pollution control technology. A current example involves work on legislating the requirements for hazardous products labelling, with Labour Canada and the Department of Consumer and Corporate Affairs, participating on the federal side.

Strains in the federal-provincial relationship can also be anticipated. For instance, conflict can arise when proprietary data held by the federal government is requested by provinces. Furthermore, unilateral action can be expected when provincial legislatures perceive hazards to their publics, as witnessed in the banning of 2,4,5-T in British Columbia and Ontario. Municipalities can also be expected to act independently, as in the restrictions on the use of 2,4-D around schools and playgrounds.

International Policy Environment

It is generally acknowledged that the greater thrust in agricultural development will take place in the developing countries

during the 1980s. Accordingly, these nations are expected to register growth rates in the utilization of pesticides substantially higher than those in the traditional, major crop-producing countries. While the bulk of the world output of pesticides will for some time originate from the industrialized countries, the agricultural policies of some of the more advanced of these states are supporting greater domestic pesticide production. Cases in point are Brazil and Mexico where significant strides are being made towards this end.

This trend towards greater self-sufficiency in pesticides in developing countries will probably be reinforced during the next decade by the activities of the international aid agencies. Since the mid-seventies, the proportion of total financial aid extended by the multilateral aid agencies for agricultural development has been rising appreciably as compared with the two previous decades. The World Bank in particular has committed itself to provide the developing countries with even greater assistance for their agricultural and rural development programs during the 1980s. For the first half of the decade alone, it anticipates disbursing between U.S.$20 and $25 million in support of planned agricultural projects of an aggregate value in excess of U.S.$50 billion. Moreover, in response to the United Nations' declaration of "the international drinking water supply and sanitation decade" the World Bank in a cooperative effort with several related UN agencies is to contribute to this program, which if successful would cost $140 billion.

If carried out as anticipated these agricultural and rural development programs will impose considerable demands on the agrochemicals industries of the developed countries for some time. Even so, the principal flows of international trade in pesticides are likely to continue to be between North America, the European Economic Community (EEC) and Japan and, to a lesser extent, other western and eastern European countries, particularly as the Tokyo Round reductions in import duties are fully implemented.

Disparities in national tolerances concerning pesticide residue in food products will remain the major impediment to trade among these nations. In the EEC, attempts at harmonizing the member countries' respective tolerances into one Community standard have been under way for some time. The EEC has also been cooperating with the UN Food and Agricultural Organization (FAO) and the World Health Organization (WHO) with the view to establishing such standards. And in 1978 the Organization for Economic Cooperation and Development launched a three-year program with the object of reaching international agreement on such matters as standards of laboratory practices and confidentiality of data for producers. Progress has generally been slow in this area. The major achievement made so far has been the publication of a set of guidelines, under the joint auspices of the FAO and the WHO, governing pesticides entering international trade

III POSSIBLE DIRECTIONS FOR SECTORAL EVOLUTION

In view of the moderate but steady growth expected in domestic consumption of pesticide products, as well as the unsatisfactory level of both pesticide active ingredient manufacture and formulation in Canada, there appears to be ample scope for further development of this segment of the Canadian chemicals industry. Canada's consumption of pesticides, although only two per cent of world demand, represents a particularly significant and growing market for selective herbicides used on coarse and cereal grains and oilseed. Herbicides used in Canada account for 3.4 per cent of world consumption and represent the dominant class of chemical pesticides in the medium-term forecast of four per cent annual growth. Several herbicides of increasing importance to Canadian agriculture have attained, or are destined to soon, consumption levels ranging between 1,000 and 2,000 tonnes. For certain single pesticide chemical entities this volume range can be considered sufficiently large to support an economically competitive operation, particularly where access to foreign markets can be assured.

As pointed out under the discussion of international market trends in the medium-term market forecast, Central and South America, Mexico, Australia, New Zealand and the Philippines, expected to grow at about 5.5 per cent per year to 1990, represent export market opportunities for the Canadian pesticides industry that equal or exceed those of the domestic market. Among possible candidates for consideration of domestic production are the herbicides atrazine, triallate, linuron, glyphosate isopropylamine and trifluralin. Once established, trade in active ingredients will provide a synergistic influence upon export trade in formulated products as well. A prerequisite to attaining access to these markets is world scale production facilities for a limited number of active ingredients used heavily in both Canada and foreign markets.

Until a recent point in time, Canada was able to demonstrate a comparative advantage in the production of many petrochemical-based products due to the combined effects of lower energy costs, a secure feedstock supply position, a currency exchange rate that favours export trade and corporate taxation treatment that encourages investment. Not withstanding the recent contraction in phenoxy herbicide manufacturing capacity, there appeared to be increasing interest among major suppliers in Canada to expand manufacturing activity in both active ingredients and formulations. Some of this interest may have been defensively inspired as patents neared expiry for products that continue to increase in consumption or products with exclusive markets are threatened by potential applications for compulsory licences to manufacture.

At the same time, present conditions largely related to "bad press" and distorted public perceptions of the industry have caused some chemical companies to reconsider long-term investment commitments to the pesticide industry in favour of more attractive alternative business interests. As a result of steadily increasing demands by regulatory agencies for additional toxicological and environmental impact studies, greater costs and risks in research expenditures, and greater uncertainty caused by post-market product deregistrations, the number of acquisitions (such as that of Gulf Canada pesticides division by Velsicol in 1980), mergers and failures to support product registrations in marginal markets is likely to increase. While this will lead to greater concentration in the industry, it also presents an opportunity for improved manufacturing economies through plant and product rationalization. For example, Dow Chemicals has closed its 2,4-D/MCPA manufacturing facility in Fort Saskatchewan, Alberta, and decided not to invest in modernized facilities. This provides an opportunity for Uniroyal, the only other 2,4-D/MCPA active ingredients manufacturer in Canada, to consider increasing its domestic production capacity. Of course, this particular investment possibility is somewhat clouded by the concern over the re-examination of 2,4-D/MCPA with respect to health safety.

Not only do conditions favour consideration of domestic manufacture of herbicides that are used in large volume in Canada, but opportunities also exist to encourage mandates for the manufacture of new pesticides for both special application to Canadian agricultural needs and potential adoption for use in other world markets. Canada could exercise leadership in encouraging the development of new pesticides of lower order eco-toxicity or of manufacturing methods that provide products free of unwanted toxic contaminants. An indication that such product mandates are a practical reality is demonstrated in the initiative of Uniroyal (Canada) in the development of a family of systemic organic fungicides for seed treatment that eliminated the need for toxic mercury compounds. These products now enjoy substantial export sales that are well in excess of the domestic market.

The major constraint to the development of a broadly based Canadian pesticides manufacturing capability continues to be the inherent size of the domestic market. The average annual consumption of all registered active ingredients in Canada amounts to 75 tonnes per ingredient compared with United States average production of nearly 600 tonnes per active ingredient registered. Even the consumption of the 50 most used pesticide active ingredients barely reaches 500 tonnes per ingredient per year in Canada. This disparity can be attributed not only to the proportionately larger U.S. domestic consumption and the strong U.S. export position in these commodities but also to the more fragmented nature of markets in Canada where, with only five per cent of the U.S. consumption levels, Canada makes use of more than 30 per cent of the number of active ingredients registered for use in that market.

Under these circumstances, only a very small number of pesticide active ingredients could be economically manufactured for domestic consumption alone. Even in cases where volume is sufficient and manufacturing costs are competitive, there are other factors discouraging location of production in Canada. The major one, particularly for active ingredients but also for formulated products,

has been the unhindered access to the Canadian market of surplus pesticide production from the U.S. and EEC. Canada's effective duty-free tariff policy for farm inputs, including chemical pesticides, is not reciprocated by the major supplying nations. Although Canada has a GATT bound tariff rate of 13.5 per cent on active ingredients, full duty protection is applied only to phenoxy types (2,4-D/MCPA) while all others are permitted free entry. In addition, all classes of formulated pesticides imported into Canada in package sizes over three pounds are bound free. In contrast, after allowing for full implementation of the Tokyo Round MTN concessions, the U.S. tariff rates are 6.8 per cent for herbicide active ingredients and 9.7 per cent for all pesticide formulations. The EEC will have a tariff rate of 7.6 per cent under full implementation.

Under these conditions of effective free entry into Canada and substantial tariffs entering the markets of our major suppliers, there is little incentive to manufacture active ingredients or to import active ingredients over formulated products, except in those cases where competition commands domestic formulation because of freight cost considerations. Rather, there is a decided incentive to locate additional increments of production capacity within the large protected markets and export surplus production to Canada and other unprotected or dependent markets. In the absence of normal protection of the Canadian market, development of the fine chemicals industry will be hindered and the negative trade balance will be exacerbated. In contrast, basic chemical production which has enjoyed a degree of tariff protection has become internationally competitive.

Two aspects of the regulatory environment will also influence the direction of the sector. The more stringent requirements for testing, evaluation and impact studies may well lead to reduced participation in this sub-sector. While some positive aspects (rationalization) may arise from this trend, excessive or exaggerated demands could produce very adverse consequences. Although the responsibility for providing all necessary data related to the safety

and use of pesticides is assumed by the registrant, there is a point at which the burden of additional toxicological and environmental impact studies will render investment unprofitable. The industry and government regulatory authorities will then be faced with decisions involving withdrawal of a product or reduction of new compliance requirements. In the event of a potential withdrawal by industry of a product essential to agricultural competitiveness, it is conceivable that there would be a requirement for public expenditures for compliance testing to assure its continued availability or for Agriculture Canada to again permit the importation of unregistered products by users. Effectively, the former would constitute an extension to conventional agriculture research which has long been the subject of strong public support. The latter, by encouraging importation of formulations, could result in a significant erosion of production in Canada, as well as undermining the regulatory intent of the PCP Act.

A related problem concerns the proliferation of government interests arising from the complex relationships between pesticide usage and incidental effects on non-target organisms. Not only have demands for additional information and toxicological evaluations by regulatory authorities increased, but the mandates, legitimate concerns and interests of the federal departments of Agriculture, Health and Welfare, Environment, and Fisheries and Oceans in examining these issues have expanded as well. Although Canada's regulatory process is acknowledged to be considerably less complex and difficult than that of the U.S. EPA, problems of coordination of information exchange between the departments have tended to lengthen the time required for pesticide product registration, thereby delaying the introduction of technological developments by the industry. Earlier registration of pesticides, consistent with health and safety considerations, could encourage the pesticides industry to make new products available, thereby enhancing the competitiveness of Canadian agriculture. The industry has identified the lack of suitable toxicological assessment facilities for pesticides as one factor in delaying the commercial

availability of new pesticides in Canada. If studies of comparable quality to those conducted in centres in the U.S. and Europe were being undertaken in Canada regulatory judgements could be made more readily.

In summary, certain factors including cost and supply considerations for selected raw materials, an advantageous exchange rate and a competitive tax regime favour an expansion of manufacturing activity in Canada. However, a number of other factors must be addressed before these positive aspects of the investment climate can be translated into investment. In particular, it will be essential to address the ease of access to the Canadian market of production originating in the major markets relative to the price of access to large world markets. Furthermore, it will be necessary to inspire Canadian and head office management to incorporate selected product mandates in the strategy for the operation of the Canadian subsidiary. In the absence of such initiatives it is most unlikely that balanced development will occur in the pesticide industry, with the most likely outcome being quite restricted active ingredient manufacture and a level of formulating activity far below potential, both contributing to a growing trade deficit.

APPENDICES

PESTICIDE INDUSTRY MEMBER FIRMS

CONTACTED FOR SECTOR ANALYSIS

Allied Chemical Services Ltd.

Chemgro Limited (Bayer)

Chipman Inc. (CIL)

Ciba Geigy Canada Ltd.

Cyanamid of Canada Ltd.

Diamond Shamrock Canada Ltd.

Dow Chemical of Canada Ltd.

Dupont Canada Ltd.

Eli Lilly and Co. (Canada) Ltd.

Gulf Agricultural Chemicals Co. Ltd.

Hoechst Canada Inc.

Interprovincial Co-operatives Ltd.

May and Baker Canada Ltd.
(Rhône-Poulenc)

Monsanto Canada Inc.

Niagara Chemical (Reichhold Limited)

Pfizer Chemicals & Genetics Ltd.

Plant Products Co. Ltd.

Rohm & Haas Canada Ltd.

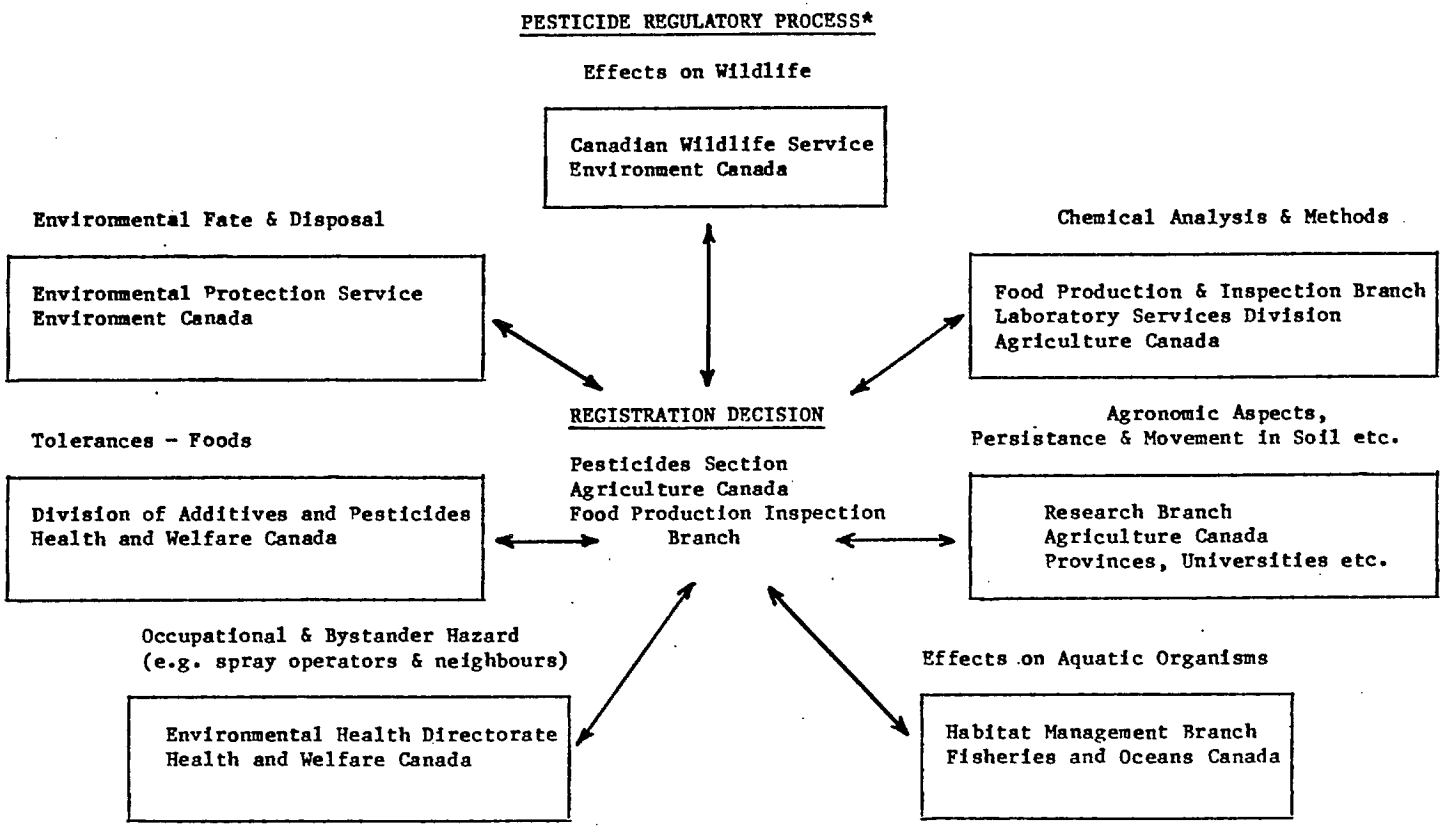
Shell Canada Ltd.

Shamrock Chemicals Ltd.

Union Carbide Agricultural Products Co. Inc.

Uniroyal Ltd.

Velsicol Corporation of Canada Ltd.



* SHOWING AGENCIES THAT DO TESTING AND/OR ARE CONSULTED FOR EXPERTISE AND ADVICE.

Source: Agriculture Canada

DIAGRAM 1

TABLE 1

COMPARISON OF WORLD, UNITED STATES AND CANADIAN PESTICIDE MARKETS(*) (1979)

	World[1]	U.S.[1] (million $U.S.)	Canada[2]	Per Cent of World Markets	
				U.S.	Canada
Herbicides	3867	1740	132	45	3.4
Insecticides	2900	800	18	27	0.6
Fungicides	1285	167	5	13	0.4
Other	334	167	3	50	0.9
Total	8386	2874	158	34	1.9

* valued at the basic producer sales level

(1) Economic Analysis Branch, Office of Pesticides Programs Environmental Protection Agency, Washington, DC

(2) Sector Analysis Division, Chemicals Branch, Industry, Trade and Commerce, Ottawa

TABLE 2

COMPARISON OF UNITED STATES AND CANADIAN PESTICIDES INDUSTRIES (1979)

	U.S.[1]	Canada[2]	Per Cent of U.S.
Basic producers	30	2	6.7
Formulators	3,300[3]	40	1.2
Active ingredients (AIs) registered	1,400	450	32.0
AIs in production	1,100	6	0.5
Major active ingredients	200	50	25.0
Formulated products	35,000	4,500	12.9
Sales value (user level) ($ million)	5,050	320	6.3

Sources: (1) Pesticide Industry Sales and Usage - 1979 Market Estimates
Economic Analysis Branch
Office of Pesticides Programs
Environmental Protection Agency
Washington (April 1979)

(2) Chemicals Branch estimates based upon information from the Canadian Agricultural Chemical Association, Agriculture Canada and industry contacts.

(3) The 1977 U.S. Census of Manufacturers puts the total number of agricultural chemicals establishments at 409. The higher EPA figure might refer to product registrants rather than formulations establishments.

TABLE 3

SOURCES OF CORPORATE SALE REVENUE FOR FIFTEEN

CORPORATIONS ENGAGED IN THE PESTICIDES INDUSTRY IN CANADA

	Per Cent of Canadian Corporation Revenue						
Corporate Revenue from:	0	0-5	5-25	25-50	50-75	75-95	95+
Pesticides							
- manufacture*	4	3	5	1	2	-	-
- distribution							
i) Canadian manufacture**	9	3	1	-	1	1	-
ii) imported product***	3	5	3	1	3	-	-
Drugs and biologicals	12	-	1	2	-	-	-
All other corporate products and services	2	1	3	1	-	5	3

* Sales from the manufacture of active ingredients, in plant and/or domestic contracted formulation of product sold under corporate label from either domestic or imported active ingredients.

** Sales from the distribution of product manufactured by Canadian formulators.

*** Sales from the importation and supply of fully formulated, bulk and/or packaged products to distributors, dealers and users.

TABLE 4

PESTICIDES INDUSTRY* SALES REVENUE BY TYPE OF PESTICIDE BUSINESS

Per Cent of Pesticides Sales Revenue	0	0-5	5-25	25-50	50-75	75-95	95+
	Number of firms						
Production of active ingredients	13	-	-	1	-	1	-
Formulation(1)	11	2	2	-	-	-	-
Formulation/distribution(2)	5	-	4	2	1	1	2
Distribution(3)	2	-	1	2	2	2	6
Application services	15	-	-	-	-	-	-

* Fifteen Canadian companies.

(1) Formulation for other accounts (i.e., toll formulation).

(2) In plant or contract formulation of active ingredient (imported or domestic) and their sale into distribution channels.

(3) Sales of imported active ingredients and/or fully formulated products to formulators, wholesale distributors, dealers or users; in addition to distribution of domestic formulated products not accounted for in (2).

TABLE 5
SIZE OF PESTICIDES INDUSTRY SALES (1979)

Sales Range ($ million)	No. of Companies
50+	2
30 - 50	1
10 - 30	6
5 - 10	8
- 5	5
	22

TABLE 6
CONCENTRATION OF PESTICIDES INDUSTRY SALES (1979)

Industry Sales (Per cent)	No. of Companies
45	3
56	5
73	10
90	22
100	40

TABLE 7

PROFILE OF PESTICIDES INDUSTRY* BUSINESS ACTIVITY BY PROVINCE

	Number of Firms Engaged in Each Activity									
	Nfld.	P.E.I.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.
Manufacture of active ingredients	-	-	-	-	1	1	-	-	2	-
Formulation and packaging	-	-	-	-	3	10	1	3	4	-
Wholesale distribution	3	8	6	8	11	13	13	13	13	8
Direct sales to users	2	3	3	3	3	3	4	4	3	1
Application services	-	-	-	-	-	-	-	-	-	-
Product development	3	7	5	6	7	12	9	9	10	7

* For fifteen companies.

TABLE 8

PESTICIDES INDUSTRY EMPLOYMENT* GROWTH PROJECTIONS

Employment Category	Number of Companies	1978	1980	Annual Growth 1978/80 (%/yr)	1985	Expected Annual Rate of Growth 1980/85 (%/yr)
Administration	15	106	138	14.2	173	4.6
Sales and service	15	250	332	15.2	453	6.4
Production	8**	214	282	14.8	447	9.6
Research and development	15	120	145	10.0	196	6.3
Other	5	5	16	79.0	25	9.3
Total		695	913	14.6	1294	7.2

* Source: 15 companies engaged in pesticide business activities with estimated pesticides sales of over $200 million.

** A total of nine companies expect to have production employees by 1985, inclusion of this additional firm in 1985 increases the growth rate in the 1980/85 interval by 0.7 percentage points (i.e., from 8.9% to 9.6%) in production employment growth rate.

TABLE 9

PESTICIDE INDUSTRY PRINCIPAL MARKETS BY PRODUCT CLASS IN CANADA (1979)

Principal Market	Product Class: Herbicides: Broad Leaf	Herbicides: Wild Oat	Herbicides: Other	Herbicides: Total	Insecticides	Fungicides	Other	Total
	(Per cent of sales revenue)							
Agriculture	19.9	49.3	13.0**	82.2	7.9	2.7	0.4	93.2
Industry/Commerce/Government	0.9	-	1.0	1.9	2.6	-	1.2	5.7
Household	0.1	-	-	0.1	0.6	-	0.5	1.1
Total	20.8	49.3	14.0	84.2	11.1	2.7	2.1	100.0

* Composite of 11 companies weighted sales revenue, representing total sales of over $200 million.

** Broad spectrum annual grass herbicides, sterilants, etc.

PESTICIDE USE EXPENDITURES IN THE UNITED STATES BY CLASS AND SECTOR, 1979 ESTIMATES

	Herbicides	Insecticides	Fungicides	Other	Total
			(per cent)		
Agriculture	40.7	17.8	2.4	2.4	63.3
Industry/Commerce/Government	11.0	4.8	4.6	4.6	25.0
House and Garden	4.2	4.5	1.5	1.5	11.7
Total	55.9	27.1	8.5	8.5	100.0

Source: Pesticides Industry Sales and Usage - 1979 Market Estimates (April 1979)
Environmental Protection Agency, Washington, DC

TABLE 10

CROP MARKET PENETRATION BY PESTICIDE CLASS - AVERAGE OF ESTIMATES (1979)

	Herbicides					
	Broad Leaf	Wild Oat	Other	Insecticides	Fungicides	Other
	(per cent of crop treated)					
Cereal Grains						
Wheat	75	40	7	5	11	5(1)
Barley	79	40	5	5	11	5(1)
Oats	65	-	-	5	10	
Mixed grains	60	20	20	7	10	
Rye	43		10		11	
Buckwheat	35		50			
Oil Seed						
Rape	78	67(2)		71	90	60(1)
Flax	65		52			
Mustard	75		65	60	10	
Sunflower	40		84	15		
Other Crops						
Corn	93		93	14	60(1)	
Soybean	78		95	80		90(1)
Beans	75		92		25	100(1)
Peas	53		41			
Potatoes	85		89	99	99	
Sugar beet	30		57	41		
Tame hay	20		8			
Tobacco	80		15	93		95(3)
Fruits	-		50	68	100	40

(1) Seed treatment
(2) Combined wild oat and other annual grass herbicides
(3) Growth regulants

TABLE 11

ESTIMATED SALES VALUE(1) OF PESTICIDES USED ON PRINCIPAL FIELD CROPS AND LAND IN 1979

($ Million)

	Herbicides						
	Broad Leaf	Wild Oat	Other	Insect -icides	Fungi -cides	Other	Total
Cereal Grains							
Wheat	27	57	1.5	0.3	0.3	1.5	87.6
Barley	15	21	0.5	0.1	0.1	0.6	37.3
Oats	5	N	N	N	N	N	5.0
Corn	2	-	23.0	1.0	0.1	-	26.1
Mixed grains	1	1.6	0.2	N	N	N	2.8
Rye	0.3	N	N	N	N	N	0.3
Buckwheat	0.1	N	N	N	N	N	0.1
Sub-total	50.4	79.6	25.2	1.4	0.5	2.1	159.2
Oil Seed							
Rape	0.3	55.2*	-	2.1	-	2.1	59.7
Flax	6.4	9.3**	-	N	N	N	15.7
Mustard	N	N	0.1	N	N	N	0.1
Sunflower	N	0.2	0.4	N	N	N	0.6
Sub-total	6.7	64.7	0.5	2.1	N	2.1	76.1
Other Crops							
Tame hay	0.2	-	-	N	N	N	0.2
Soybeans	3.0	-	3.2	N	N	N	6.2
Potatoes	2.0	-	2.9	6.5	9.2	0.1	20.7
Beans	1.4	-	2.0	N	0.3	-	3.7
Tobacco	1.5	-	0.8	3.1	0.7	0.3	6.4
Peas	0.8	-	0.5	0.5	0.2	1.1	3.1
Sugar Beets	N		0.4	0.4	N	N	0.8
Sub-total	8.9	-	9.8	10.5	10.4	1.5	41.1
Other Land Uses							
Summerfallow	0.3	-	1.4	-	-	-	1.7
Brush	-	0.1	0.3	-	-	2.5	2.9
Forests	-	-	-	0.7	-	-	0.7
Grasslands	0.1	-	0.5	-	-	-	0.6
Orchards	-	-	2.2	4.3	5.4	0.6	12.5
Floriculture	-	-	-	-	-	-	-
Vegetables	-	-	-	0.8	0.9	-	1.7
Sub-total	0.4	0.1	4.4	5.8	6.3	3.1	20.1
TOTAL	66.4	144.4	39.9	19.8	17.2	8.8	296.5

(1) Distributor prices (supplier or formulator list prices)
* Including other herbicides
N Negligible amounts estimated
- Estimates unavailable or not applicable

TABLE 12

PROJECTIONS OF PRINCIPAL* CROP TREATMENT ESTIMATES BY CLASS OF PESTICIDE

Crop	Year	Herbicides			Insect -icides	Fungi -cides	Other
		Broad Leaf	Wild Oat	Other			
		(Per Cent)					
Wheat	1979	75	40	7	5	11	5
	1985	82	50	15	11	16	8
	1990	86	57	22	16	19	13
Barley	1979	79	40	5	5	11	5
	1985	84	50	15	9	17	8
	1990	86	56	23	12	28	18
Oats	1979	65	-	-	5	10	-
	1985	68	-	10	8	12	10
	1990	71	-	30	13	15	22
Corn	1979	93	-	93	14	60(1)	-
	1985	95	-	94	19	60	5
	1990	95	-	95	25	60	20
Mixed Grain	1979	60	20	20	7	10	-
	1985	62	30	30	10	13	3
	1990	66	34	50	20	16	11
Rape Seed	1979	78	67(2)		71	90	60(1)
	1985	82	71		79	95	66(3)
	1990	82	74		86	95	73(3)
Flax Seed	1979	65	52				
	1985	69	56				
	1990	71	62				
Potatoes	1979	85	89		99	99	80
	1985	88	92		99	99	90
	1990	88	95		99	99	95

* Crops that account for over 80% of pesticide use.
(1) Seed treatment.
(2) Wild oats and other annual grass herbicides combined.
(3) Includes seed treatment, desiccants and regulants.

TABLE 13

1985/90 PROJECTIONS OF SALES VALUE FOR SELECTED PESTICIDE CLASSES ON PRINCIPAL(1) CROPS

Relative to 1979 pesticide sales value for all crops and land use = 100.

Crop	Year	Herbicides: Broad Leaf	Herbicides: Wild Oat	Herbicides: Other	Insect-icides	Fungi-cides	Other	Total	% Increase over 1979
Wheat	1979	9.12	19.25	0.51	0.10	0.10	0.51	29.59	-
	1985	9.97	24.06	1.09	0.26	0.14	0.82	36.34	22.8
	1990	10.46	27.43	1.60	0.32	0.73	1.33	41.87	41.2
Barley	1979	5.06	7.09	0.17	0.03	0.03	0.20	12.58	-
	1985	5.38	8.86	0.51	0.05	0.05	0.32	15.17	20.6
	1990	5.51	9.92	0.78	0.07	0.08	0.72	17.08	35.8
Oats	1979	1.69	N	N	N	N	N	1.69	-
	1985	1.77	N	N	N	N	N	1.77	4.7
	1990	1.85	N	N	N	N	N	1.85	9.5
Corn	1979	0.68	-	7.77	N	N	N	8.45	-
	1985	0.69	-	7.85	N	N	N	8.54	1.1
	1990	0.69	-	7.94	N	N	N	8.63	2.1
Rape Seed	1979	0.10	18.64(2)		0.71	N	0.71	20.16	-
	1985	0.11	19.75		0.79	N	0.78	21.43	6.3
	1990	0.11	20.59		0.86	N	0.86	22.32	10.7
Flax Seed	1979	2.16	3.14		N	N	N	5.30	-
	1985	2.29	3.38		N	N	N	5.67	7.0
	1990	2.36	3.74		N	N	N	6.10	15.1
Potatoes	1979	0.68	-	0.98	2.20	3.10	0.03	7.00	-
	1985	0.70	-	1.01	2.20	3.11	0.03	7.05	0.7
	1990	0.70	-	1.05	2.20	3.11	0.04	7.10	1.4
TOTAL	1979	19.49	57.55		3.04	3.23	1.45	84.77	-
	1985	20.91	66.51		3.30	3.30	1.95	95.97	13.2(3)
	1990	21.68	73.05		3.45	3.92	2.95	104.95	23.8(3)

N Estimates not available.
(1) Crops accounting for approx. 85% of sales value of agricultural pesticides used.
(2) Combined wild oats and other annual grasses pesticides.
(3) Compounded annual rate of growth indicated for 1979/85 and 1979/90 intervals = 2%/yr.

TABLE 14

MAJOR* PESTICIDE ACTIVE INGREDIENTS USED IN CANADA

Common Name	Number of Companies Listing Chemical	Class**	Common Name	Number of Companies Listing Chemical	Class**
Atrazine	3	H	Diuron	1	H
Alachlor	2	H	E P T C	1	H
Aminocarb	1	I	Endosulfan	1	I
Asulam	1	H	Fenvalerate/cypermethrin	1	I
Azinphos-methyl	4	I	Flamprop-methyl	1	H
Barban	4	H	Glyphosate isopropylamine	4	H
Benomyl	3	F	Lindane	3	I
Bromacil	1	H	Linuron	4	H
Bromoxynil	1	H	Mancozeb	1	F
Butylate	1	H	Maneb	1	F
Captan	2	F	M C P A/B	6	H
Carbaryl	1	I	Metribuzin	4	H
Carbathiin	1	F	Methyl isothiocyanate/ chlorinated hydrocarbon	1	O
Carbofuran	3	I	Metiram	2	F
Chlordane	1	I	Monolinuron	1	H
Chlorothalonil	1	H	Oxycarboxin	1	F
Cyanazine	1	H	Paraquat	1	H
Cypermethrin	1	I	Penta/Tetrachlorophenol	1	H, O
Diallate	2	H	Phosolone	3	I, O
Dicamba	3	H	Propanil	1	H
Diclofop-methyl	1	H	T C A	1	H
Difenzoquat	1	H	Thiram	3	F
Dinitroamine	3	H	Triallate	2	H
Dinoseb	1	H	Trifluralin	3	H
Diquat	1	H	2, 4 D/B	6	H
Disulfoton	1	I			

* Chemicals that contributed 75% or more of individual company pesticide sales in Canada in 1979, for 15 firms with total sales of more than $200 million.

** Class of pesticide: H, herbicide; I, insecticide; F, fungicide; O, other (soil fumigant, sterilants, growth stimulants, wood preservatives, acaracide, etc.).

TABLE 15

PESTICIDE INDUSTRY SHIPMENTS AND TRADE PERFORMANCE, 1970/78

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
						($ Million)				
Shipments of own manufacture[1]	26.6	27.1	46.8	66.2	87.5	121.3	89.6	103.2	122.8	154[4]
less, Exports[2]	2.8	3.2	2.8	4.4	6.6	15.9	14.0	10.4	7.6	11.0
Domestic Shipments	23.8	23.9	44.0	61.8	80.9	105.4	75.6	92.8	115.2	143
plus, Imports[3]	18.1	24.6	32.8	47.9	69.2	100.3	105.9	128.3	143.1	177.3
Apparent Domestic Market	41.9	48.5	76.8	109.7	150.1	205.7	181.5	221.1	258.3	320[4]
Imports as a % of Domestic Market	43.2	50.7	42.7	43.7	46.1	48.8	58.4	58.0	55.4	55
Exports as a % of Shipments	10.5	11.8	6.0	6.6	7.5	13.1	15.6	10.1	6.6	7

Source: (1) Statistics Canada, Miscellaneous Chemicals Industries, Cat. No. 46-216
(2) Statistics Canada, Exports by Commodity, Cat. No. 65-004
(3) Statistics Canada, Imports by Commodity, Cat. No. 65-007
(4) Chemicals Branch, Sector Analysis Div., Estimate

TABLE 16

SHIPMENTS OF GOODS OF OWN MANUFACTURE
PEST CONTROL PRODUCTS

($ '000)

	1970	1971	1972	1973	1974	1975	1976	1977	1978
Agricultural dusts and sprays	1,985	1,278	2,859	8,602	10,420	17,022	9,115	7,280	103,214
Herbicides	8,890	10,080	21,900	28,952	41,934	59,372	49,685	74,517	
Household & industrial insecticides	5,205	6,762	9,027	2,931	3,423	22,292	22,439	16,110	18,122
Rodenticides	344	283	285	480	534	466	561	-	
Other pest control products	4,065	5,083	8,299	3,082	1,898	786	680	5,342	-
Miscellaneous pesticides not included in above three classes	6,096	3,585	4,387	22,160	29,282	21,386	7,151	-	-
	26,585	27,071	46,757	66,207	87,491	121,324	89,631	103,249	121,336

Source: Statistics Canada, Cat. No. 46-216 - Miscellaneous Chemical Industries

TABLE 17

UNITED STATES TARIFFS

Category	Rate of Duty (under MTN Agreement)
I Active Ingredients ("not artificially mixed")	
a) a number of specified herbicides (including plant growth regulators)	6.8%
b) other, unspecified, herbicides	13.5%
c) a number of specified insecticides	6.9%
d) other, unspecified, insecticides	12.5%
e) all fungicides	11.1%
f) other types of pesticides, such as, fumigants, rodenticides, etc.	10.7%
II Formulations ("artificially mixed")	
- all pesticides (herbicides, insecticides, fungicides and others)	0.8¢/lb.+9.7%
III "(Pesticidal) products of a type not imported into the U.S. before January 1, 1978, nor produced in the U.S. before May 1, 1978."	
i) active ingredients	
a) herbicides (including plant growth regulators)	13.5%
b) insecticides	12.5%
ii) pesticidal formulations	0.8¢/lb.+9.7%

Note: For category III, the reduction in the rate was implemented as of July 1, 1980. In categories I and II, the reductions in the rate are being implemented in eight equal stages which started on July 1, 1980; the first two reductions to took place within the first six months, the remainder yearly thereafter.

TABLE 18

PESTICIDES - MFN RATES OF IMPORT DUTY IN SELECTED COUNTRIES, AS AT JUNE 1980

Developed Countries	Before MTN	After MTN
EEC	13.6%	7.6%
Greece(1)	9.6%	unchanged
Portugal(2)	(10 escudos (+15% ad valorem	"
Spain(2)	18%	"
Japan	8%	5.8%
Comecon		
Czeckoslovakia	from specific duties for a series of	
herbicides)	chemicals to	8.75%
insecticide)		1.75%
fungicides)		8.5%
Hungary	18%	unchanged
Poland	free	"
Rumania	10%	"
U.S.S.R.	by administrative decision	
Developing Countries		
Algeria	10%	unchanged
Egypt	15%	"
Libya	free	"
Morocco	50%	temporarily 10%
Tunisia	13%	unchanged
Bangladesh	12½%	"
India	50%	"
Indonesia(3)	50%(35% exemption)	"
Pakistan	92½%	"
Argentina	free, 20%, 30%, 32%, 35%	unchanged
Brazil	free(most), 15%, 25%, 37%(a few), 45%	"

(1) subject to a 25% import deposit
(2) subject to import deposit
(3) plus 10% import sales tax

TABLE 19

COMPARISON OF CANADIAN AND U.S. COST STRUCTURE

	U.S. Ag. Chem. Ind.(1) (SIC-2879)		Canadian(2) Pesticide Companies	
	$ U.S. Million	% of Shipment Value	$ Cdn. Million	% of Shipment Value
Value of shipments	2780.4	100	202.1	100
Cost:				
Materials and energy	1496.2	53.8	167.5	82.8
Salaries and wages	224.1	8.1	9.4	4.7
Total	1720.3	61.9	176.9	87.5
Contribution to overheads and profits	1061.1	38.1	25.2	12.5
Value added	1299.3	46.7	34.6	17.1
Value added/employee	$86,620		$83,426	

Source: (1) U.S. Department of Commerce, MC77-1-28G, Agricultural Chemicals, N.E.C. (SIC-2879)

(2) Statistics Canada, Business Statistics Division

TABLE 20

CANADA-PESTICIDES
MAJOR EXPORT MARKETS - 1970-79

(Tonnes)

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
Total Exports	2,712	1,938	1,804	2,719	2,616	4,947	4,376	3,121	2,420	3,634
of which:										
United States	1,827	281	1,179	1,967	1,623	3,796	2,232	2,087	1.041	1,680
BLEU	91	10	18	42	14	55	207	155	80	129
Britain	65	67	37	57	39	28	10	45	18	4
France	50	51	38	72	63	65	50	—	57	15
West Germany	6	6	Nil	39	47	46	108	Nil	1	9
The Netherlands	94	151	11	2	48	107	108	162	276	102
Italy	Nil	15	34	21	10	84	22	Nil	Nil	69
Switzerland	75	770	52	—	68	18	—	22	43	4
East Bloc	2	59	2	11	Nil	10	Nil	54	20	29
Australia	30	2	24	19	39	73	134	25	30	13
Japan	—	Nil	7	2	13	Nil	Nil	16	1	35
South America	9	28	178	45	102	202	675	267	22	11
Central America and West Indies)	462	400	116	293	145	345	486	96	195	1,299
Africa	Nil	Nil	2	61	115	36	145	112	422	112
Middle East	Nil	63	—	9	26	5	140	4	179	93
Far East	3	11	57	58	226	75	162	75	34	23

Note: - less than one tonne

Source: Statcan

TABLE 21

CANADA-PESTICIDES
MAJOR EXPORT MARKETS 1970-79

(Cdn. $ '000)

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
Total Exports	2,776	3,165	2,750	4,432	6,596	15,933	14,037	10,426	7,581	11,038
of which:										
United States	1,078	577	1,225	2,407	3,817	10,571	7,350	6,066	3,460	4,018
BLEU	106	54	82	134	73	365	878	1,094	413	577
Britain	151	130	133	127	109	226	57	231	52	44
France	375	217	191	318	326	421	487	1	128	61
West Germany	31	35	Nil	162	225	300	288	Nil	39	45
The Netherlands	61	113	15	11	132	311	288	519	182	435
Italy	Nil	44	22	90	54	555	201	Nil	Nil	99
Switzerland	86	697	47	—	44	97	—	34	65	14
East Bloc	8	84	6	44	Nil	51	Nil	447	190	278
Australia	48	9	46	45	161	257	585	132	194	394
Japan	—	Nil	4	14	18	Nil	Nil	58	7	97
South America	39	69	174	56	266	575	979	590	199	83
Central America and West Indies	532	1,008	671	710	758	2,054	1,819	524	744	4,135
Africa	Nil	Nil	2	87	205	82	399	472	1,245	423
Middle East	Nil	67	—	29	142	8	209	19	544	263
Far East	22	14	63	99	224	52	704	219	109	51

Note: -- negligible

Source: Statcan

TABLE 22

CANADA PESTICIDES - MAJOR SOURCES OF IMPORTS - 1970-79

(Tonnes)

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
Total Imports	11,323	14,732	29,946	33,219	39,893	53,014	71,555	60,014	92,462	74,797
of which:										
United States	8,740	10,214	14,337	26,074	32,370	40,406	62,666	53,168	81,626	63,549
BLEU	Nil	Nil	Nil	Nil	Nil	1,908	2,353	1,059	1,407	2,256
Britain	330	666	2,385	2,339	2,246	6,726	2,428	5,086	3,964	3,764
Denmark	358	537	492	406	481	608	378	385	470	338
Eire	Nil	Nil	Nil	Nil	Nil	Nil	Nil	8,604	Nil	Nil
France	264	358	316	95	103	250	768	888	325	573
West Germany	186	478	140	482	501	464	302	1,816	1,058	1,003
The Netherlands	305	1,671	465	1,945	2,809	1,902	2,579	2,623	2,355	1,110
Italy	64	43	316	31	78	21	44	273	287	56
Switzerland	739	1,964	1,726	1,383	972	97	207	771	707	1,296
Japan	17	83	138	112	126	17	68	92	64	148
Peru	65	70	75	46	56	72	79	38	35	43
Israel	—	Nil	Nil	1	1	40	92	3	57	25
Colombia	Nil	Nil	Nil	136	Nil	Nil	Nil	Nil	Nil	238
Argentina	Nil	Nil	Nil	Nil	63	32	35	5	Nil	Nil
Brazil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	244	Nil	146
Taiwan	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	16	67

Note: -- less than one tonne

Source: Statcan

TABLE 23

CANADA PESTICIDES - MAJOR SOURCES OF IMPORTS - 1970-79

(Cdn. $'000)

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
Total Imports	18,153	24,609	32,825	47,856	69,162	100,342	105,880	128,295	143,136	177,248
of which:										
United States	13,541	14,909	22,294	36,786	51,767	66,778	74,621	104,035	110,627	138,517
BLEU	Nil	Nil	Nil	Nil	Nil	10,186	11,652	4,730	4,870	7,941
Britain	481	1,356	2,886	3,141	5,272	10,112	7,147	10,397	12,121	13,049
Denmark	282	434	411	387	931	1,655	966	799	1,027	851
Eire	Nil	Nil	Nil	Nil	Nil	Nil	Nil	5,411	Nil	Nil
France	785	957	816	171	188	627	1,039	944	621	2,004
West Germany	356	697	712	908	1,253	1,595	1,345	3,970	4,411	3,905
The Netherlands	279	307	690	2,080	5,964	6,727	7,276	6,475	5,928	3,441
Italy	39	17	20	29	129	33	66	331	582	84
Switzerland	2,204	5,773	3,751	3,808	3,157	2,173	754	2,700	2,241	4,560
Japan	19	84	135	260	137	89	253	267	410	1,088
Peru	30	52	64	51	68	100	111	69	63	80
Israel	1	Nil	Nil	2	2	165	430	16	192	131
Colombia	Nil	Nil	Nil	140	Nil	Nil	Nil	Nil	Nil	735
Argentina	Nil	Nil	Nil	Nil	142	83	98	19	Nil	Nil
Brazil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	251	Nil	619
Taiwan	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	23	104

Source: Statcan

TABLE 24

FINANCIAL PERFORMANCE OF PESTICIDES AND OTHER CHEMICAL INDUSTRY SECTORS

	Pesticides Industry*			Manufacturers of Pharmaceuticals & Medicines (SIC-374)			Manufacturers of Industrial Chemicals (SIC-378)			Miscellaneous Chemical Industries (SIC-379)		
	1976	1977	1978	1976	1977	1978	1976	1977	1978	1976	1977	1978
	$ million											
Number of corporations	7	7	7	153	140	128	180	180	149	265	257	249
Total product sales	192.7	202.1	293.5	939.6	979.2	1135.2	1695.3	1959.6	2649.1	817.6	889.0	1087.8
Net profit before taxes	3.1	5.8	18.5	89.0	88.0	106.6	196.4	186.9	185.9	66.1	53.7	83.1
Total assets	46.4	60.4	93.8	685.1	736.6	820.6	2454.3	3413.9	3847.5	578.3	639.7	711.6
Total equity	18.1	33.0	38.1	364.8	369.8	437.8	900.9	1009.6	1691.7	300.6	339.4	397.3
	Net Profit before Taxes (Per Cent)											
Expressed on:												
Sales	1.6	2.9	6.3	9.5	9.0	9.4	11.6	9.5	7.0	8.1	6.0	7.6
Assets	6.7	9.6	19.8	13.0	11.9	13.0	8.0	5.5	4.8	11.4	8.4	11.7
Equity	17.3	17.6	48.7	24.4	23.8	24.3	21.8	18.5	11.0	22.0	15.8	21.0

* Based upon seven corporations with Canadian corporate product sales mainly derived from pesticides (two foreign owned and two Canadian owned formulator/distributors, three subsidiaries of foreign active ingredient manufacturers/formulators/distributors)

Source: Statistics Canada, Business Statistics Division

TABLE 25

COMPARISON OF PEST CONTROL PRODUCT, INDUSTRIAL CHEMICAL AND SELECTED FARM INPUT PRICE INDEXES (CANADA)

	Manufacturing Industry Selling Prices(1)			Selected Farm Input Prices(2)		
Year	Pest Control Products	Industrial Chemicals (Organic)	Mixed Fertilizers	Pesticides	Mixed Fertilizers	Seed
1971	100.0	100.0	100.0	100.0	100.0	100.0
1972	103.8	101.6	102.5	107.7	103.4	97.8
1973	104.2	107.8	117.2	108.7	117.3	124.6
1974	142.0	170.0	167.5	170.1	169.3	204.9
1975	187.9	201.2	204.0	235.8	208.0	234.0
1976	197.9	214.2	176.9	243.0	180.8	216.6
1977	200.6	228.1	180.2	249.8	183.7	224.0
1978	208.2	249.8	191.0	260.8	195.4	232.7
1979	223.3	289.0	228.2	290.5	241.5	234.1
1980	230.2*	338.6*	275.5*			

Source: (1) Statistics Canada, Industry Selling Prices, Cat. No. 62-011, Monthly
(2) Statistics Canada, Farm Input Price Index, Cat. No. 62-004, Quarterly

* 1st Quarter 1980