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PESTICIDES IN THE EC

April 1994

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ABSTRACT

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Sales of pesticides for agricultural use are assessed at national level on an EC scale. Besides, regions and crops within the EC with a high use of pesticides are identified. Also, the ways these pesticides are treated in the market system, in terms of the infrastructure of distribution networks and patterns of sale, are examined. Recent initiatives regarding the collection of packaging material and the disposal of unused stocks are reviewed.

Annual sales of pesticides for agricultural use in the EC consist of about 340-350 million kg of active ingredients. Usage levels differ largely among countries, regions and crops. They are highest in areas with intensive farming practice, because of the subsequent risks of the occurrence of pests and diseases. The costs of pesticides per hectare are highest in regions specialized in horticulture (e.g. northern Italy, the south coast of France, the south-east coast of Spain and the Netherlands) and regions in France with emphasis on specialist cereals and general field cropping (e.g. Ile de France and Picardie). Output of crop production is highest in regions with relatively high costs of pesticides.

A series of recommendations are formulated in order to contribute to the objectives of the Fifth Environmental Action Programme of the EC. They focus on the registration of sales of pesticides at national, regional and crop level as well as on research in future development trends of the use of pesticides in the EC.

Pesticides/EC/Pesticide sales/Usage levels/Agriculture/Environment/Distribution network

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PREFACE

The Agricultural Economics Research Institute (LEI-DLO) was commissioned by the Ministry of Housing, Spatial Planning and Environment (VROM) in the Netherlands to undertake a project on pesticides in the European Community. The study was commissioned by this Ministry also on behalf of the Commission of the European Communities. Funds were made available by the Directorate-General of Environment, Nuclear Safety and Civil Protection (DG XI) of the CEC and the Board of Drinking Water, Water, Agriculture (DWL) of VROM. This support is gratefully acknowledged.

The study is to contribute to a broader effort in which the Ministry of Housing, Spatial Planning and Environment in the Netherlands is conducting a review of current pesticide use (agricultural and non-agricultural) in the European Community with a view to formulating recommendations for a more integrated and environmentally friendly future policy at Community level. This project was initiated by the Commission of the European Communities.

Parallel to the project of LEI-DLO, a study was also undertaken by the Centre for Agriculture and Environment (CLM) in the Netherlands entitled "Towards a future EC pesticide policy".

The study was guided by two Steering Committees, one under the responsibility of VROM and the other one under the responsibility of the EC.

The Committee by the Ministry of VROM included the following members:
D. Eskes (Coordinator of the project on behalf of the Ministry of VROM);
H. Hoving (VROM)
R. Marcelis (VROM)
H. de Baan (VROM)
A. Roos (VROM)
T. Trouwborst (VROM)
P. van Tilburg (Ministry of Agriculture, Nature Management and Fisheries, LNV);
R. Faassen (Institute for Inland Water Management and Waste Water Treatment, RIZA).

The Committee by the CEC included the following members:
J. Vennekens (CEC, DG XI/A.3) (chairperson)
M. Debois (CEC, DG XI/A.2)
D. Eskes (VROM)
S. Jakobsen (CEC, DG VI/F II.3)
P. Murphy (CEC, DG XI/A.2)
M. Scheele (CEC, DG VI)
F. Steenhoff (CEC, DG VI/FII.2)

P. v. Tilburg (LNV)
H. Versteylen (CEC, DG VI/01)

We gratefully acknowledge the critical remarks and useful suggestions made by the Committees during all stages of the study.

Many people contributed to the completion of the report. Information was made available by institutes in all Member States, including chemical industry and their national associations, Ministries of Agriculture, the Environment or Health, farmers' unions, the agricultural business sector as well as numerous research institutes with expertise in the field of agriculture and the environment. A full list of organizations who provided information to the study is listed in Appendix A of the report. We are very grateful to the wide support, useful suggestions and critical remarks we received in all Member States.

We highly appreciate the great support we received, in response to our request, from the Offices of the Agricultural Council of the Netherlands in all Member States. These Offices proved to be a great resource and a big help in the study. They contributed largely to the identification of the appropriate institutions and key resource persons to contact in the Member States. In this respect we would like to mention the support received from G.J. Hegemans (Belgium and Luxembourg), R. Nijland (Denmark), A. Wegen (Germany), S. Sagriotis-Grootendorst (Greece), R. Jaanus (France), C.W. Zwitser (Italy), P.J. Jorna and E. Iglesias (Spain), C.J. Heringa (Portugal) and H. de Boer (United Kingdom and Ireland).

A final draft of the report was reviewed by external experts in the field of agriculture, pesticides and the environment. We highly appreciate the important remarks made on the report and suggestions given in response to our request by D. Baldock (Institute for European Environmental Policy, London, United Kingdom), T. van der Linden (National Institute of Public Health and Environmental Protection, Bilthoven, the Netherlands), A.J. Oskam (Department of Agricultural Economics, Wageningen Agricultural University, Wageningen, the Netherlands), P. Rainelli (Institut National de la Recherche Agronomique, Station d'Economie et Sociologie Rurales, Rennes, France) and S. Rude (Statens Jordbrugsøkonomiske Institut, Institute of Agricultural Economics, Copenhagen, Denmark).

Several people of LEI-DLO also made contributions to the project. We gratefully acknowledge the contributions made by A.D. Verhoog (for the provision of data from the SPEL model) and A. Pronk (to review the available data on trade flows of pesticides). Useful comments and suggestions to the report have been made by J. Buurma, J. Dijk, K.J. Poppe, J.H. Post, N. Verhaegh and C.J.M. Vernooy.

The Director,

L.C. Zachariasse

The Hague, April 1994

SUMMARY

Objective of the study

The Dutch Ministry of Housing, Spatial Planning and Environment is conducting a review of current pesticide use (agricultural and non-agricultural) in the European Community (EC) in order to formulate recommendations for a more integrated and environmentally friendly future policy at Community level. This project was initiated by the Commission of the European Communities. The present report is to contribute to this effort.

The aim of the study is twofold. Firstly sales of pesticides for agricultural use are assessed at national level. Besides, regions and crops in the EC with a high use of pesticides are identified. Secondly, the ways these pesticides are treated in the market system, in terms of the infrastructure of distribution networks and patterns of sale, are examined. In addition recent initiatives in several Member States regarding the collection of packaging material and the disposal of unused stocks are discussed as well.

The study is to contribute to the basic purpose of the Fifth EC Environmental Action Programme. The first objective of the study provides the basic elements of necessary actions in order to achieve a significant reduction of pesticide use per unit of land under production. The second objective of the study provides insight in those parts of the chain between production, sales and use, where action might be most effective.

The study is based on an extensive analysis of existing data sources and other literature on the use, market and treatment of pesticides in agriculture. Experts from industry, farmers' organizations, ministries and research institutes have been consulted in all Member States.

Available data on the costs of pesticides

Data on the sales of pesticides are available from government statistics and national industry associations. Total sales of pesticides in the EC amount to some 5.8 billion ECU per year. The major markets of sales of pesticides are in France, Germany and Italy. These three countries already cover about two thirds of the total sales of pesticides in the EC.

Information is also available on the costs of using pesticides in agriculture. First, the Farm Accountancy Data Network (FADN) of the European Commission provides averages of the costs of pesticides of a group of farms, i.e. averages by farming type. This source of information provides information at farm level, but it does not represent the small

farms. This might explain the underestimation of FADN compared to data from market surveys. Data on the costs of pesticides are also available at crop level in the SPEL/EC model. The annual average for the three years' period 1988/89 to 1990/91 on the costs for crop protection in EUR 12 amounts to 5.4 billion ECU according to FADN and almost 5.7 billion ECU according to SPEL. Interpretation of the SPEL data is difficult in Portugal, because the costs of pesticides from the economic accounts (around 320 million ECU) are very high compared to the national data from FADN and other sources.

Sales of pesticides at national level

Sales of pesticides are monitored at national level in all Member States. Statistics are presently available for all Member States on the sales in kilogramme of active ingredients. Data mainly originate from national associations of producers, manufacturers and importers of pesticides.

Annual sales of pesticides for agricultural use in the EC are estimated to be around 340-350 million kilogrammes of active ingredients. This is considered to be a best available guess of the actual use of pesticides for agriculture in the EC. Italy and France already account for 50% of the total sales of pesticides in the EC. Fungicides cover about half of the total sales of the EC.

The use of pesticides per hectare of arable land and land under permanent crops ranges from less than 3 kg per hectare (Denmark, Spain, Ireland and Portugal) to over 10 kg per hectare (Belgium and the Netherlands). Sales are about the average of the EC (4.5 kg per hectare)

Table 1 Annual sales of pesticides for use in agriculture by product group and country (in 1,000 kg of active ingredients)

Country	Year	Herbicides	Fungicides	Insecticides	Nematicides	Other	Total
Belgium	1992	2,560	3,292	387	857	770	7,866
Denmark	1991	3,429	1,678	241	65	206	5,619
Germany	1990	16,970	10,984	1,525	-	3,667	33,146
Greece	1989	3,440	10,280	3,248	250	6,259	23,477
Spain	1990-92	1,750	32,700	2,800	10,000	5,000	52,250
France	1992	27,281	44,786	6,110	1,835	4,697	84,709
Ireland	1992	1,001	663	63	81	264	2,072
Italy	1989	10,600	57,100	11,100	9,500	2,800	91,100
Luxembourg	1991	121	113	10	-	9	253
Netherlands	1992	2,987	4,192	557	6,762	1,423	15,921
Portugal	1992	1,192	3,932	754	-	239	6,117
United Kingdom	1992	13,039	6,708	1,043	-	3,010	23,800
EUR 12		84,370	176,428	27,838	29,350	28,344	346,330

Table 2 Annual sales of pesticides in agriculture by product group (in kg of active ingredients per hectare of arable land and land under permanent crops) and by Member State

Country	Sales of pesticides by group (kg/ha)					
	herbicides	fungicides	insecticides	nematicides	other	total
Belgium	3.5	4.5	0.5	1.2	1.0	10.7
Denmark	1.3	0.7	0.1	<0.1	0.1	2.2
Germany	2.3	1.5	0.2	-	0.5	4.4
Greece	0.9	2.7	0.8	0.1	1.6	6.0
Spain	0.1	1.6	0.1	0.5	0.2	2.6
France	1.4	2.3	0.3	0.1	0.2	4.4
Ireland	1.1	0.7	0.1	0.1	0.3	2.2
Italy	0.9	4.8	0.9	0.8	0.2	7.6
Luxembourg	1.5	1.4	0.1	-	0.1	3.1
Netherlands	3.3	4.6	0.6	7.4	1.6	17.5
Portugal	0.4	1.2	0.2	-	0.1	1.9
United Kingdom	2.0	1.0	0.2	-	0.5	3.6
EUR 12	1.1	2.3	0.4	0.4	0.4	4.5

in Germany and France. They are between 3 and 4 kg per hectare in Luxembourg and the United Kingdom. They are also relatively high in Greece and Italy (6 to 8 kg per hectare). The use of pesticides is highly correlated to the output from crop production. Countries with a relatively high output level per hectare tend to have a high usage of pesticides.

Regions and crops with a high use of pesticides

The available estimates on the use of pesticides at crop and regional level are based on different approaches: registration at farm level or registration of sales from industry. Registration of sales might also take place at the level of manufacturers.

The use of pesticides is highest in areas with intensive horticulture (northern Italy, the south coast of France, the south-east coast of Spain, and the Netherlands). The use of pesticides to grow vegetables and fruit is high along the south-east coast of Spain (Murcia, Comunidad Valenciana and Andalucia) and northern Italy (Valle d'Aosta, Trento-Alto Adige, Veneto, Liguria and Emilia-Romagna). The use of fungicides to grow grapes is highest in regions with relatively high precipitation levels. It is high in the northern parts of Italy (Veneto and Emilia-Romagna) and Spain (Galicia). Data are available on the use of pesticides to grow grapes in Germany (around 20 kg), Spain (around 30 kg) and Italy (around 45 kg).

Differences among regions and countries are large in their use of pesticides to grow arable crops. They range from 3 kg (Germany) to 22 kg of active ingredients per hectare (the Netherlands). The use of pesticides to grow cereals is lower than the use of pesticides to grow other field crops (e.g sugar beet and potatoes). The high share of other field crops in the Netherlands is an important phenomenon in this respect. The use of pesticides to grow potatoes in the Netherlands may exceed 100 kg per hectare (starch potatoes). This is mainly due to the high use of nematicides for soil disinfection (around 90 kg per hectare).

Infrastructure of distribution networks

The infrastructure of distribution networks of pesticides shows no big differences among the EC Member States. Manufacturers and importers of pesticides deliver to wholesale traders (private companies and cooperatives). Manufacturers and importers primarily operate at international markets, associated in producer organizations at a national level and at the European level (through the European Crop Protection Association).

In most countries wholesale traders are the sole link between manufacturers and importers of pesticides and farmers, except for Germany, Spain, Portugal and the United Kingdom, where part of the wholesale trade is distributed by retail merchants. The share of private companies and cooperatives in wholesale trade varies considerably. The share of cooperatives ranges from about 15% in the UK to about 50-60% in Germany, France and Italy. Cooperatives in Greece have a share of around 70% of the market of pesticides. Direct sales from manufacturers to farmers are uncommon, except for the UK, where about 5% of all sales is directly sold to (big) farmers.

Collection of contaminated packaging and disposal of unused stocks

In all countries, except for Portugal, there is a tendency to deliver contaminated packaging at chemical waste sites. The crucial success factor for a systematic collection depends on the availability of an infrastructure of chemical waste companies. Such an infrastructure does not exist or is poor in Portugal, Ireland, Luxembourg, Spain and Italy; in other countries the infrastructure of chemical waste companies is better developed. Industry is often involved in improving the way of disposal of packaging. IVA in Germany for example arranged the organization of a collection system of contaminated packaging.

In comparison with packaging, unused stocks are hardly considered to be a problem. There is often a transition period in which it is still allowed to use the product after it has been banned. Unused stocks of banned products in Belgium, Denmark, Germany, Italy, the Netherlands and the UK have to be delivered at the distributor or the chemical waste site; costs of disposal sometimes have to be paid by farmers. Recently

temporary schemes for the disposal of unused stocks in Ireland, France (Pic Agri) and in the UK (National Pesticides Retrieval Scheme) were launched. In Ireland this was initiated by industry; in France and the UK it was a joint action of authorities, industry, distributors and farmers.

Recommendations for monitoring and research

A significant reduction of pesticide use per unit of land is required under the Fifth Environmental Action Programme up to the year 2000. Sales and use of pesticides also need to be registered and controlled. These objectives need to be supported by research efforts and monitoring programmes. Recommendations are formulated in order to contribute to the objectives of the Fifth Environmental Action Programme.

In total seven recommendations are formulated, for monitoring as well as research. It is among others recommended to register sales of pesticides at national level by an independent body. Such a registration might be organized by making use of the experiences in Germany and Italy. It is also proposed to initiate research on future development trends in the use of pesticides in EC agriculture.

1. INTRODUCTION

1.1 Pesticides and the EC Environmental Action Programme

Agriculture, together with industry, energy, transport and tourism, has been selected as target sector of the Fifth EC Environmental Action Programme. The target sectors chosen are those '... where a Community approach is the most efficient level at which to tackle the problems these sectors cause or face' (CEC, 1992:6). The basic aim of this EC programme is to achieve an ecologically sustainable economic development, and the five target sectors play a crucial role in the attempt to achieve sustainable development. Main objective with reference to agriculture is the maintenance of basic natural processes by conservation of water, soil and genetic resources. The input of pesticides needs to be reduced to the extent that none of these processes are affected. Actions needed are amongst others the registration and control of the sales and use of pesticides and the promotion of integrated pest control and bio-agriculture (CEC, 1992:37). Policy targets in the Programme up to the year 2000 among other things aim to achieve a significant reduction of pesticide use per unit of land under production. The Programme also proposes to broaden the range of policy instruments. This includes the consideration to broaden the scope from present legislation towards the inclusion of instruments that are conform with the market. Also important is the need to improve the quality of environmental data. Improvements might be required in such a way that environmental data become more comparable across the European territory.

The poor quality of water is identified as one of the critical issues of environmental concern to the European Community (EC). The release of pesticides into the environment and the subsequent leaching processes cause serious deterioration effects on the quality of soils and water. The 1991 seminar on groundwater of EC ministers concluded that pesticides presently are observed in groundwater of all EC Member States. This conclusion was supported by the 1991 report from the National Institute of Public Health and Environmental Protection (RIVM) and the Institute for Inland Water Management and Waste Water Treatment (RIZA) on the actual threats to the groundwater systems in the EC. The same report also concludes that the EC standards for the sum of pesticides per liter water (0.5 microgram) is exceeded in approximately 65 percent of all utilized agricultural areas.

with the practice for the disposal of unused stocks are dealt with in chapter 8. In the final chapter some concluding remarks on the major findings and recommendations for future research and harmonisation of data collection are made.

2. THE MARKET OF PESTICIDES IN THE EC

2.1 Costs of using pesticides

Some characteristics of the market of pesticides are analysed in this chapter. The major markets of pesticides within the EC are examined, for both countries and crops. The value of the sales of pesticides is first given for all Member States. Values are also given by product group for those EC countries that are in the top twenty of world sales. A distinction is made into the product groups of herbicides, fungicides, insecticides and other pesticides. Nematicides generally are not separated in market surveys from the remaining group of other pesticides because of its limited share in total sales.

Sales of pesticides in the EC

The development, production and trade of pesticides increasingly becomes 'global business'. Main producers of pesticides in Europe are Bayer (Germany), Ciba (Switzerland), Rhône-Poulenc (France), ICI/Zeneca (United Kingdom), Hoechst and Basf (both Germany). Pesticide production by German companies already accounts for 25% of the international market (Financieel Dagblad, September 22, 1993).

Table 2.1 EC pesticide market by country (million ECU), 1991

Country (code)	Sales
France (F)	2204
Germany (D)	929
Italy (I)	728
United Kingdom (UK)	594
Spain (E)	509
Netherlands (NL)	231
Denmark (DK)	190
Greece (GR)	141
Belgium (B)	136
Portugal (P)	92
Ireland (IRL)	48
Luxembourg (L)	15
Total (EUR 12)	5817

Source: Agrow's West European Fact File.

The global pesticide market in 1991 at end-user level reached 21.9 billion ECU, equivalent to 19.6 billion ECU at distribution level (County NatWest Woodmac, 1992). The United States and Japan are the two leading countries with highest market shares. The US for example, have a market share of almost 24%. The leading market region is that of Western Europe (including EC and EFTA), with an estimated 31% share of the total market. Western Europe, North America and the Far East represent in sum over 80% of the total world market.

Total sales of pesticides in the EC in 1991 is assessed to some 5.8 billion ECU (table 2.1). This type of information originates from government statistics and national industry associations (see also Harnden, 1993).

Sales of pesticides by product group and crop

The seven EC countries with highest sales in successive order are France, Germany, Italy, the United Kingdom, Spain, the Netherlands and Denmark (table 2.1). Market surveys also indicate their position in the global market. These seven countries are presently ranked third (France), fourth (Germany), fifth (Italy), eighth (United Kingdom), tenth (Spain), seventeenth (Netherlands) and nineteenth (Denmark) (County Natwest Woodmac, 1992).

The pesticide market of the seven countries with highest sales is represented by product group (table 2.2). The share of herbicides in total sales of pesticides is relatively high in northwestern Europe (Denmark, Germany and the United Kingdom). Sales of herbicides to grow cereals and maize are high. Sales of insecticides are relatively high in Spain and to a smaller extent also in Italy. Climatic conditions also need to be considered in this respect since they can largely affect the occurrence of pests and diseases. For instance, treatment against insects is much more important in Spain than the treatment against fungi, mainly due to the

Table 2.2 Sales of pesticides in 1991 by product group in seven countries of the EC (percentage of total sales)

Country	Herbicides	Fungicides	Insecticides	Others
France	38	38	16	8
Germany	53	35	10	2
Italy	37	36	23	4
United Kingdom	49	33	9	9
Spain	34	22	35	9
Netherlands	46	32	16	6
Denmark	55	35	8	2
Western Europe	40	32	19	9

Source: County NatWest WoodMac, 1992.

Table 2.3 Sales of pesticides in seven countries of the EC by crop in 1991 (percentage of total sales)

Country	Cereals	Sugarbeet	Fruit/grapes/ vegetables	Oil-seeds	Other crops
France	39	5	26	7	23
Germany	46	11	19	10	14
Italy	14 a)	8	56 d)	22	
United Kingdom	61	6	11	11	11
Spain	16 b)	4	65 c)	d)	15
Netherlands	11	12	18	d)	59 e)
Denmark	47	18	11	12	12

a) Grains only; b) Including rice and maize; c) Including olives (6%), citrus (16%), vegetables (21%), grapes (8%) and other fruit (14%); d) No data available since this crop is of marginal importance in the country; e) Including potatoes (25% of total sales).
Source: County NatWest WoodMac, 1992.

rather dry and hot climate in most of the country. The share of fungicides in total sales of pesticides is therefore rather small in that country.

The EC's number one crop, in terms of share in pesticide sales, is cereals (table 2.3). The market share of Europe on the global pesticide usage to grow cereals is high as well. Only about 8% of the global land area used for this crop is in western Europe. However, approximately 80% of cereal fungicide sales are made in the EC, notably in France, Germany and the United Kingdom.

The group of grapes, fruit and vegetables are in second position in pesticide sales. It covers well over half of the market of pesticides in Italy (56%) and Spain (65%). The market share of pesticides to grow 'other crops' is relatively high in the Netherlands. This is mainly due to the costs of pesticides to grow potatoes (25% of national sales) and horticultural crops (18% of national sales).

Costs of using pesticides by farming type: FADN

Information from government statistics and national industry associations on the sales of pesticides (table 2.1) is also compared to the costs of using pesticides in agriculture. This kind of information is available from other data sources. The first data source examined is the Farm Accountancy Data Network (FADN) from the Commission of the EC. FADN provides averages on the costs of pesticides of a group of farms, i.e. averages by farming type. The annual average for the three years' period 1988/89 to 1990/91 on the total costs for crop protection in EUR 12 amounts to some 5.4 billion ECU (table 2.4). That amount is composed of the costs of pesticides at farms which are represented by the FADN and this amount is smaller than the total sales during 1991 in

Table 2.4 Crop protection costs in the Member States by farming type (average 1988/89 - 1990/91 in million ECU) a)

Farming type	B	DK	D	GR	E	F	IRL	I	L	NL	P	UK	EUR 12
Specialist cereals	.	19	27	13	46	265	10	64	.	.	12	179	636
General field cropping	42	64	241	61	81	637	11	214	.	126	6	323	1806
Specialist horticulture	10	5	14	11	92	31	.	43	.	69	3	22	313
Specialist vineyards	.	.	32	8	7	231	.	105	1	.	4	.	387
Specialist fruit and citrus fruit	5	2	9	33	82	59	.	124	.	9	11	10	342
Specialist olives	.	.	.	7	19	.	.	17	.	.	0	.	43
Various permanent crops combined	1	1	4	14	8	15	.	55	.	3	5	6	110
Specialist dairying	9	30	90	0	3	128	6	20	1	19	2	23	332
Specialist cattle - rearing and fattening	1	.	4	0	1	28	2	5	0	1	1	2	43
Cattle - dairying, rearing and fattening combined	3	.	17	0	1	29	2	9	0	2	1	2	67
Sheep, goats and other grazing livestock	.	.	0	1	1	15	3	3	.	.	1	8	32
Specialist granivores	1	10	6	0	2	14	.	3	.	4	0	2	43
Mixed cropping	7	6	42	24	49	99	.	105	.	4	32	35	402
Mixed livestock, mainly grazing livestock	4	6	39	0	2	20	.	13	0	.	4	3	91
Mixed livestock, mainly granivores	2	2	16	.	1	18	.	0	.	3	0	1	45
Field crops - grazing livestock combined	28	13	123	4	8	210	9	31	0	6	6	63	501
Various crops and livestock combined	6	27	79	2	6	27	.	12	.	4	7	11	182
All types	120	187	744	178	419	1824	45	825	3	249	95	687	5378

a) An explanation of the country code is given in table 2.1.
Source: FADN/LEI-DLO.

EUR 12, assessed from government statistics (table 2.1). The FADN generally does not represent the smaller farms. The total costs of using pesticides in agriculture should therefore by definition be higher than the aggregated total of all farms represented by FADN. This consideration already might be a plausible explanation of any differences between the sales of pesticides in table 2.1 and the costs of pesticides from table 2.4. Differences might of course also result due to the different years considered. Differences are rather small in Belgium, Denmark and Ireland. The group of general field cropping farms has the highest share in crop protection costs of all countries, except for Spain and Portugal. This group of farms accounts for about a third of the total crop protection costs in the EC.

Costs of using pesticides at crop level: SPEL

The SPEL/EC model allows to quantify the costs of pesticides at crop level. The Sectoral Production and Income Model for Agriculture (SPEL) is aimed to constitute the basis for (i) checking the consistency of the agricultural statistics of Eurostat; (ii) monitoring the present situation in the

agricultural sector; (iii) ex-post analyses of sectoral developments and (iv) forecasts and policy simulations of the effects of alternative agricultural policies from short-term and medium-term viewpoints (Eurostat, 1992). Information at national level on the total costs of pesticides for agriculture is based on the economic accounts, published primarily by the Statistical Offices in the Member States. Costs of intermediate consumption are identified at crop level through the so-called standard cost margins in Belgium, Germany, the Netherlands and the United Kingdom. Costs of intermediate consumption in the other Member States are based on FADN. Standard cost margins allow for more detailed assessments at crop

Table 2.5 Costs of pesticides in the Member States by crop (average of the period 1988-1990 in million ECU) a)

	B	DK	D	GR	E	F	IRL	I	L	NL	P	UK	EUR 12
Soft wheat	32	34	150	8	16	478	1	27	0	17	9	165	945
Grass/grazing	2	11	7	3	18	483	33	76	0	2	2	32	684
Fodder plants on arable land	9	25	26	0	8	230	6	53	0	4	1	145	510
Barley	14	51	117	8	24	150	2	10	1	2	2	88	467
Other fruits	2	1	25	10	49	33	0	140	0	1	84	8	344
Other final crop products	1	4	113	12	37	40	0	10	1	4	38	16	270
Sugar beet	41	7	66	0	8	63	1	24	0	24	0	34	264
Other vegetables	13	2	17	3	63	34	0	47	0	29	9	34	249
Apples, pears and peaches	6	1	17	10	5	28	0	29	0	7	99	9	215
Maize	1	0	14	11	5	124	0	14	0	0	16	0	188
Rape and turnip rape seed	0	17	69	0	0	55	0	0	0	1	0	42	180
Potatoes	15	4	14	3	21	24	1	3	0	44	10	31	171
Grapes for other wine	0	0	39	1	18	75	0	18	0	0	9	0	159
Grapes for table wine	0	0	1	2	11	54	0	54	0	0	22	0	143
Durum wheat	0	0	1	15	2	41	0	44	0	0	1	0	102
Sunflower seed	0	0	2	1	10	81	0	4	0	0	0	0	102
Pulses	0	7	2	0	2	58	0	3	0	2	1	19	96
Citrus fruits	0	0	0	4	57	0	0	18	0	0	3	0	84
Olives for oil	0	0	0	9	30	0	0	34	0	0	4	0	75
Tomatoes	1	0	0	7	19	2	0	29	0	1	3	0	61
Nursery plants	2	3	15	0	0	10	0	9	0	9	2	8	56
Flowers, ornamental plants	3	0	0	0	1	4	0	4	0	25	0	9	45
Other root crops	3	11	5	0	1	11	0	1	0	0	0	9	41
Paddy rice	0	0	0	2	8	4	0	17	0	0	8	0	38
Oats	0	1	16	0	2	14	0	2	0	0	0	3	38
Rye and meslin	0	4	20	0	1	4	0	0	0	0	1	1	29
Cauliflowers	2	1	1	0	3	6	0	6	0	1	0	6	28
Other cereals	0	0	7	0	0	15	0	1	0	0	1	1	24
Other oil-seeds	0	0	0	10	1	0	0	0	0	0	0	11	21
Soya beans	0	0	0	0	0	8	0	9	0	0	0	0	16
Table grapes	0	0	0	3	1	1	0	3	0	0	0	0	9
Other industrial crops	0	0	5	0	0	2	0	0	0	0	0	0	7
Tobacco unmanufactured	0	0	0	4	0	1	0	2	0	0	0	0	7
Flax and hemp	1	0	0	0	0	4	0	0	0	0	0	0	5
Table olives	0	0	0	2	3	0	0	0	0	0	0	0	5
Total	149	185	748	128	426	2139	45	693	2	174	323	669	5675

a) An explanation of the country code is given in table 2.1.
Source: Eurostat; SPEL/LEI-DLO.

level than the FADN does. The reason for it being that the FADN provides costs of intermediate consumption at farm level.

The EUR 12 total on the costs of pesticides from the SPEL model is almost 5.7 billion ECU (table 2.5). This is only slightly higher than the total costs of crop protection costs of farms represented by FADN. Differences between SPEL and FADN are large for some of the member countries.

According to the SPEL data five crops already account for more than half of the total costs of pesticides. Cereal crops, fruits and vegetables contribute largely to the total costs of pesticides.

Interpretation of the SPEL data is difficult regarding:

- Total costs of pesticides at the national level in the Netherlands and Portugal. The costs for crop protection in the Netherlands are about 250 million ECU, which is much higher than the amount mentioned in table 2.5 (174 million ECU). The costs of pesticides from the economic accounts are likely to be an underestimation, compared to sales from the national industry associations in table 2.1. The estimate for Portugal, which originates from the economic accounts (323 million ECU), is very high compared to the total identified from FADN and other sources. It is unlikely that the costs of pesticides are that high in Portugal. The amount of 92 million ECU (table 2.1) and 95 million ECU (table 2.4) are rather close to each other and seem to be a more realistic approximation.
- Costs of pesticides to grow grass are unlikely high in France.

A revised version of the SPEL model is foreseen to become available in the near future. Improvements are especially to be expected in Greece, Spain and Italy.

2.2 Patterns of trade of pesticides

The producers of pesticides increasingly operate on international markets. Patterns of trade are therefore also important in a reconnaissance of the market of pesticides. Import of pesticides in the EC Member States according to the statistics of international trade amount to 2,844 million ECU (table 2.6). The largest share (78%) originates from other Member States. Import from outside the EC is highest in France, Germany and the Netherlands. It must be mentioned that the definition of pesticides in this section is limited to formulated products which are available in small containers (unless otherwise stated). The statistics on trade patterns therefore underestimate the total value of import and export of pesticides. This is due to the fact that the statistics on international trade of pesticides only include products that are part of code 38.08. Trade of active ingredients is part of code 29 of the statistics of international trade. This code may include a wide variety of chemicals, even those not being formulated to pesticides. It is therefore not possible

to make a clear distinction between trade of active ingredients for the formulation of pesticides and trade of other chemicals.

The total export value of pesticides from the twelve Member States amounts to 3,467 million ECU (table 2.7). In total 58% (or the equivalent of some two billion ECU) of the total export value from EUR 12 is being exported to other Member States. The total export value to countries outside the EC is some 840 million ECU higher than the total import value from outside the EC. The EC therefore is a net exporter of pesticides. Some 35% of the total import value of pesticides in the EC is being imported by France. The countries with highest export levels are Germany (1.2 billion ECU), France and the UK (both about 0.8 billion ECU).

Table 2.6 Imports of pesticides in 1990 (in million ECU) a)

In/from	BLEU	DK	D	GR	E	F	IRL	I	NL	P	UK	EUR 12	Rest of world	Total
BLEU	x	0	55	0	1	41	0	9	37	0	20	163	27	189
Denmark	14	x	33	0	0	23	1	2	5	0	29	107	33	139
Germany	43	4	x	0	1	161	10	12	23	0	79	334	122	456
Greece	5	0	25	x	3	10	0	8	3	0	8	62	18	79
Spain	7	0	39	0	x	30	2	8	13	1	21	121	36	157
France	92	0	459	0	7	x	1	50	35	0	140	784	225	1,009
Ireland	0	1	5	0	0	2	x	0	2	0	28	38	3	41
Italy	38	1	62	0	4	52	0	x	17	0	20	192	36	228
Netherlands	40	1	48	0	1	40	1	3	x	0	29	163	84	247
Portugal	7	0	16	0	7	10	0	3	1	x	9	52	6	58
U.K.	20	1	76	0	1	72	4	9	18	0	x	201	42	243
EUR 12	267	8	817	0	25	440	19	103	154	1	382	2,215	629	2,844

a) Value based on costs, insurance and freight (c.i.f.) Trade limited to Code 38.08.
Source: Statistical Papers, United Nations/LEI-DLO.

Table 2.7 Exports of pesticides in 1990 (in million ECU) a)

From/to	BLEU	DK	D	GR	E	F	IRL	I	NL	P	UK	EUR 12	Rest of world	Total
BLEU	x	2	25	1	3	41	0	5	22	1	7	106	27	133
Denmark	0	x	2	0	0	0	0	0	0	0	1	3	9	12
Germany	38	35	x	20	38	397	4	60	55	15	79	740	460	1,201
Greece	0	0	0	x	0	0	0	0	0	0	0	1	2	2
Spain	1	1	4	2	x	8	0	4	0	6	1	27	8	35
France	41	17	184	12	42	x	4	46	34	9	76	464	348	811
Ireland	0	0	0	0	0	0	x	0	1	0	4	5	0	5
Italy	13	2	9	7	8	48	0	x	2	2	8	99	61	160
Nether-lands	37	6	23	3	14	44	2	16	x	1	21	165	170	335
Portugal	0	0	0	0	1	0	0	0	0	x	0	1	2	4
U.K.	32	27	76	8	21	129	27	22	36	8	x	387	383	769
EUR 12	163	89	324	52	126	667	36	153	151	41	197	1,998	1,469	3,467

a) Value based on free-on-board (f.o.b.). Trade limited to Code 38.08.
Source: Statistical Papers, United Nations/LEI-DLO.

These three countries already account for 80% of the total export value of pesticides from the EC. The countries that operate for a considerable part at markets outside the EC are also Germany (460 million ECU), the United Kingdom (380 million ECU) and France (350 million ECU).

Total production of pesticides in the EC is assessed to be almost 40% of the total global production (table 2.8). The production of pesticides in North America is less than ten percent of global production. This is much less than their share in global sales, which amounts to more than twenty percent. North America therefore is a net importer of pesticides. Western Europe has a market share of some 31% in global sales of pesticides (section 2.1). Its share in global production is higher, and therefore western Europe is a net exporter of pesticides.

Table 2.8 Global production of pesticides by region between 1981 and 1990 (in thousand metric tons of formulated products, not in active ingredients)

Region	1981	1985	1988	1989	1990
Africa	68	59	67	63	55
North America	148	149	123	157	177
South America	83	78	88	83	86
Asia	653	472	410	454	497
EC	732	783	792	835	813
EFTA	30	30	34	37	35
Eastern Europe	231	254	257	263	191
Other Europe	80	71	67	55	54
Former USSR	299	346	317	276	205
Total	2,323	2,244	2,154	2,222	2,113

Source: United Nations, Industrial Statistics Yearbook 1990, Volume II: Commodity Production Statistics 1981-1990.

Exports of pesticides from Germany are playing a major role in the EC market of pesticides. German export of active ingredients is about four-fold the national sales (table 2.9). Total sales in Germany amount to some 930 million ECU (table 2.1) and the export value is assessed to be only slightly higher (table 2.7). This difference supports the consideration that the statistics on international trade of pesticides (exclusive of trade of active ingredients) may largely underestimate the total value of trade. The four largest producers of pesticides in Germany (i.e. Bayer, Hoechst, BASF and Schering) have a market share of some 20% of the global production of pesticides (Financieel Dagblad, September 22, 1993). The supply utilization account includes sales of formulated products as well as of active ingredients that are formulated elsewhere. The major part of the production of pesticides in Germany is being exported, either as formulated products or as active ingredients, which are formulated abroad.

Table 2.9 Supply utilization account of pesticides in 1990 and 1991 in Germany by product group (in 1,000 kg of active ingredients)

Product group	Production	Import	Sales	Export	Stock change
1990					
Herbicides	44,081	13,003	15,443	40,604	1,037
Fungicides	34,608	7,547	9,956	30,172	2,027
Insecticides	20,370	3,445	1,965	22,627	-777
Other	26,037	509	2,519	23,902	125
Total	125,096	24,504	29,883	117,305	2,412
1991					
Herbicides	40,274	13,878	17,633	37,857	-1,338
Fungicides	38,827	7,815	8,483	29,482	8,677
Insecticides	17,886	3,875	1,264	21,551	-1,054
Other	23,440	383	2,300	13,233	8,290
Total	120,427	25,951	29,680	102,123	14,575

Source: Industrieverband Agrar e.V.

2.3 Concluding remarks

1. Data on the sales of pesticides are available from government statistics and national industry associations. Total sales of pesticides in the EC amount to some 5.8 billion ECU per year. The major markets of the sales of pesticides in the EC in 1991 are in France (2.2 billion ECU), Germany (0.9 billion ECU) and Italy (0.7 billion ECU). These three countries already cover about two thirds of the total sales of pesticides in the EC.
2. Market surveys indicate that cereals have a high share in total sales. Sales of pesticides to grow cereals are highest in France (39% of national sales), Germany (46% of national sales), Denmark (47% of national sales) and the United Kingdom (61% of national sales). Sales of pesticides to grow fruit, grapes or vegetables are highest (over 50% of national sales) in Italy and Spain.
3. Data on the sales of pesticides from market surveys and national industry associations differ from data on the costs for crop protection. Such data are available at crop level (SPEL) and at farm level from the Farm Accountancy Data Network (FADN) of the EC. Differences could be partly explained by the fact that FADN does not represent the smaller farms. Total crop protection costs in the EC of the farms represented by the FADN amount to some 5.4 billion ECU, which is about 0.4 billion ECU lower than data on sales. According to SPEL costs of pesticides are 5.7 billion ECU. The countries with highest crop protection costs according to FADN are successively

France (1.8 billion ECU), Italy (0.8 billion ECU), Germany and the United Kingdom (both 0.7 billion ECU) and Spain (0.4 billion ECU).

4. The available statistics on trade of pesticides are limited to formulated products in small containers (code 38.08 of the statistics of international trade). The EC is a net exporter of pesticides. The trade balance surplus was over 800 million ECU in 1990, according to the statistics of international trade. The total export value amounts to 3.5 billion ECU. The total import value is 2.8 billion ECU. Intra-community trade of pesticides amounts to some 2 billion ECU. The three countries with the highest export value of pesticides to other Member States are Germany (740 million ECU), France (465 million ECU) and the United Kingdom (385 million ECU). These three countries account for 80% for intra-community trade. The available statistics on trade of pesticides (exclusive of active ingredients) underestimate the total value of the trade of active ingredients and formulated products.
5. The export value of pesticides exceeds the import value in Germany (745 million ECU), the United Kingdom (526 million ECU) and the Netherlands (88 million ECU). The other countries are net importers of pesticides.

3. SALES OF PESTICIDES

3.1 Introduction

The main objective of the present chapter is to quantify the tonnage of pesticides marketed for agricultural use in the Community. Statistics on sales of pesticides are presented for all Member States. This type of information will provide the basic material to examine differences between countries. The main sources of information on the sales of pesticides are the national associations of producers and importers of agrochemicals and the Ministries of Agriculture. These associations provide annual statistics on the sales of pesticides, thus making comparisons among Member States possible. The following things however need to be considered when using and interpreting the information from these sources:

- Statistics on the sales of pesticides in some of the countries only specify the total sales without distinguishing between use in agriculture and use outside agriculture (gardens, households and forestry). Sales of pesticides for use outside agriculture are however small compared to sales for use in agriculture.
- Statistics which are provided by the national associations of producers of agrochemicals are limited to the firms that produce or import pesticides and are affiliated to them. Sales might also take place through other companies, although they are rather limited in most of the countries examined.
- Statistics about the sales of pesticides for use in agriculture differ from the actual use of pesticides in agriculture. This is due to the fact that a farmer might keep stocks. Important is the fact that the so-called matching-principle from accountancy is usually also applied to the Farm Accountancy Data Network of agriculture. This means that the use of pesticides is linked to the accounting year in which they contribute to the output of crops, although they might have been bought in a previous year.
- Information on the sales of pesticides might also be available from other sources in some of the Member States. Differences between the sources on the interpretation of statistics are discussed in this chapter wherever possible and appropriate.

In this chapter, the market of pesticides is limited to the use of pesticides for agricultural purposes, unless stated otherwise. The distinctive product categories are herbicides, fungicides, insecticides, nematicides and other pesticides. Growth regulators are distinguished as a different

category wherever available. Amounts are given in 1,000 kg of active ingredients unless stated otherwise.

3.2 Belgium

Statistics on the sales of pesticides for agricultural use in Belgium originate from the Ministry of Agriculture. All producers and importers of pesticides are assigned by Royal Decree to inform the Ministry of Agriculture on the amounts they produced, sold and stored. The information has to be provided on a quarterly basis. In principle, statistics on the sales of pesticides for use in agriculture also include the sales for use in gardens, parks and public roads. The statistics do not include sales of pesticides for indoor use. The registration of the sales of herbicides is considered to be treated in a different way than the other products. This is due to the fact that all herbicides are admitted by the Ministry of Agriculture, irrespective of whether or not they are applied in agriculture. All herbicides therefore are part of the statistics published by the Ministry of Agriculture, irrespective of where they are applied. Approximately half of the sales of herbicides is considered to be used outside agriculture (Verstraete, personal comment). Sodiumchlorate for example, is a kind of herbicide that already covers about a third of the total sales of herbicides in Belgium. This product is used outside agriculture. The procedure for the admission of insecticides and fungicides, which are used outside agriculture, differs from herbicides. These products are admitted by the Ministry of Health.

Total sales increased from about 9 million kg in 1985 until slightly over 10 million kg in 1992 (table 3.1). Altogether, total sales were rather stable during the past couple of years. Sales increased since 1985 for herbicides, fungicides and growth regulators. Herbicides cover about half the total sales of pesticides and fungicides cover some 30%. The sales of fungicides showed an increase since 1985 of well over 50%. The sales of insecticides and nematicides however decreased since 1985 by some 25%. The group of other pesticides, with sales in 1992 between brackets, mainly include mineral oils and additives (400 tons), repellents (28 tons), anti-sprouting (21 tons), acaricides (19 tons) and rodenticides (2 tons). The rate of increase in the sales of mineral oils and additives between 1985 and 1992 was even more than 70%. It increased from 225 tons in 1985 to a level of 400 tons in 1992. The number of active ingredients increased over the past decades from about 30 in 1950 until 428 in 1989.

Sales of herbicides for use outside agriculture - about half of the amount in table 3.1 - will not be included in the subsequent part of the report.

Table 3.1 Annual sales of pesticides for use in agriculture in Belgium by product group (in 1,000 kg of active ingredients)

Product group	1985	1988	1989	1990	1991	1992
Herbicides a)	4,617	5,145	5,264	5,213	5,091	5,120
Fungicides	2,123	2,583	2,637	2,743	2,837	3,292
Insecticides	516	430	506	459	365	387
Nematicides	1,133	927	842	808	778	857
Growth regulators	170	267	394	503	373	276
Other	414	466	443	538	524	494
Total	8,973	9,818	10,086	10,264	9,969	10,426

a) Including sales of herbicides for use outside agriculture.
Source: Dienst Inspektie van de Grondstoffen (Inspectorate of raw materials), Ministry of Agriculture.

3.3 Denmark

Statistics on the sales of pesticides in Denmark for use in arable and livestock farming, horticulture, forestry and household are published by Miljøstyrelsen (the National Agency of Environmental Protection), which is part of the Ministry of the Environment (table 3.2). The sales of pesticides for use in arable crops are also specified. These statistics allow to quantify the number of standard treatments of arable crops. Sales of pesticides for use in arable crops increased until 1984 and then showed a decrease (table 3.3).

Sales of nematicides are of limited importance in Denmark and these products are primarily used in horticulture (table 3.2). Sales of herbicides decreased mainly due to the lower dosages required to treat the land. Sales of pesticides in Denmark may fluctuate largely in response to national policy by banning certain products. The sales of pesticides were high in 1984 because several products were announced to become forbidden in the near future. Farmers therefore bought more pesticides than actually would be required for that growing period. Extra amounts were bought for use in later years. Likewise there were very high sales of growth regulators in 1990. Sales of chlormequat-chloride (growth regulator) to grow cereals in 1990 was almost 0.8 million kg, which is some 0.6 million kg higher than sales in previous years. Sales of that product were small in 1991. It is allowed to use banned products in Denmark that are in the intermediate stages between manufacturers, importers and farmers. The number of active ingredients for use in pesticides decreased from 293 in 1988 to 264 in 1991.

Since the early 1980s the reduction of annual sales of pesticides for use in arable crops has been largest on the group of herbicides (table 3.3). The sales of some eight herbicides that are primarily used to grow cereals already decreased from 1.6 million kg in 1988 to 1.1 million

Table 3.2 Annual sales of pesticides for use in agriculture in Denmark by product group (in 1,000 kg of active ingredients) a)

Product group	1988	1989	1990	1991
Herbicides	3,962	4,276	3,488	3,429
Fungicides b)	1,310	1,516	1,660	1,678
Insecticides c)	223	306	313	241
Nematicides	73	86	85	65
Growth regulators	262	335	871	196
Other d)	18	12	10	9
Total	5,847	6,531	6,428	5,620

a) Excluding algicides, slimicides, products for the protection of wood and woodwork, repellants. Such products are used outside agriculture; b) Including combined fungicides and insecticides; c) Insecticides against pests on plants, against flies, moths, ants and grain pests, etc; d) Products against pests on farm animals and pets, rodenticides.
Source: Ministry of the Environment, 1992.

Table 3.3 Annual sales of pesticides for use in arable crops in Denmark by product group (in 1,000 kg of active ingredients)

Product group	1981/85	1986	1987	1988	1989	1990	1991
Herbicides	4,636	3,810	3,900	3,762	3,969	3,128	2,867
Fungicides	1,779	1,682	1,124	1,082	1,270	1,398	1,426
Insecticides	319	233	158	150	226	259	146
Growth regulators	238	360	303	259	330	867	189
Total	6,972	6,085	5,485	5,253	5,795	5,652	4,628

Source: Ministry of the Environment, 1992.

Table 3.4 Annual sales of 8 types of herbicides for use in agriculture between 1988 and 1991 in Denmark (in 1,000 kg of active ingredients)

Pesticide	1988	1989	1990	1991
Glyphosate	622	501	314	448
Dichlorprop	523	460	277	238
2,4-D	130	140	92	74
Dinoseb	106	210	-	-
Bentazone	71	50	42	47
Isoproturon	65	107	130	241
Difenzoquat	56	53	21	18
Bromoxynil	35	32	23	15
Total	1,607	1,553	899	1,081

Source: Ministry of the Environment, 1992.

kg active ingredients in 1991 (table 3.4). Sales of herbicides mainly reduced because of the substitution among products. This substitution of chemicals allows that lower dosages are used per hectare. A much smaller amount of active ingredients per hectare now suffices to treat plants compared to what was used in the past.

3.4 Germany

Since 1987, the Biologischen Bundesanstalt für Land- und Forstwirtschaft (BBA) has been assigned to produce annual statistics on the sales of pesticides for use in German agriculture. All firms producing or importing pesticides for agricultural use in Germany need to report the BBA about their sales. The total amount marketed for this use was rather stable in 1987 and 1988, but showed a decrease between 1988 and 1990 (table 3.5). Sales increased in 1991, which is due to the reunification of the country. Annual sales in 1992 were around the same level as in 1990, although the statistics also include sales in the new Bundesländer. The sales of nematicides reduced after 1987 in response to the restrictions from the Water Protection Act (Wasserschutzgesetz). These sales are presently very small. The total number of products for use in agriculture decreased from some 1800 in 1986 to 950 in 1992. The availability of pesticides also affects sales.

Data on the annual use of pesticides, as produced by BBA, are assessed higher than data published by the national association of producers of agrochemicals Industrieverband Agrar (IVA) (table 3.6). Total sales of pesticides in Germany from the industrial firms that belong to the IVA show a steady decrease over the past couple of years. Differences between the data given in tables 3.5 and 3.6 are caused by firms that produce or import pesticides for sale in Germany, but who are not affiliated to the IVA 1). It must be mentioned that the data given in table 3.6 also include the sales for use in the new Länder from mid 1991 onwards. The sales of pesticides to the new Länder already amounted to 330 million DM in 1991. Total sales decreased by some 13% in 1992 com-

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1) A task force of the Industrieverband Agrar recently assessed the import of pesticides by farmers to be around 140 million DM. These imports are not in the official statistics and part of it is likely to be illegal because the products are banned in Germany. Some 100 million DM is considered to originate from countries, bordering Germany by the western part, and some 40 million DM is considered to come from the eastern part of Europe. There are three reasons that might explain the illegal import. The first reason is the fact that prices are rather high in Germany compared to surrounding countries. The second reason are the VAT-rates which also are rather high in Germany. A third reason is the fact that several agrochemical products (like for example atrazin) are forbidden in Germany but allowed in some of the surrounding countries (Efken, 1993).

Table 3.5 Annual sales of pesticides for use in agriculture in Germany by product group, estimated by BBA (in 1,000 kg of active ingredients)

Product group	1987	1988	1989	1990	1991	1992
Herbicides	21,529	21,770	18,905	16,970	18,999	15,707
Fungicides	10,219	10,297	10,803	10,984	9,760	9,368
Insecticides	1,273	1,177	1,350	1,525	3,901	4,094
Growth regulators	1,346	1,434	1,627	1,916	2,411	2,931
Other	2,000	2,096	1,939	1,751	1,873	1,470
Total	36,367	36,774	34,625	33,146	36,944	33,570

Source: Holzman, 1993.

Table 3.6 Annual sales of pesticides for use in agriculture in Germany by product group, estimated by IVA (in 1,000 kg of active ingredients)

Product group	1989	1990	1991	1992
Herbicides	16,539	15,443	17,633	14,552
Fungicides	10,241	9,956	8,483	8,193
Insecticides	1,575	1,965	1,264	908
Other	2,329	2,519	2,300	2,080
Total	30,684	29,883	29,680	25,733

Source: Industrieverband Agrar e.V.

Table 3.7 Annual use of pesticides in the former German Democratic Republic in 1980, 1985 and 1989 (in 1,000 kg of active ingredients)

Product group	1980	1985	1989
Herbicides	16,454	18,582	21,458
Fungicides	4,494	4,335	5,373
Insecticides a)	2,080	1,880	1,500
Other	937	1,546	2,774
Total	23,965	26,343	31,105

a) Including acaricides.
Source: Beitz et al., 1991.

pared to the previous year (IVA, 1993). Sales increased in the new Bundesländer and decreased more than proportionally in the old Bundesländer. Industry considers this to be mainly due to the set-aside programme and extensification programmes in the old Bundesländer (IVA, 1993).

In 1989 the use of pesticides in the former German Democratic Republic was about at the same level as in the Federal Republic of Ger-

many (table 3.7). The average amount of active ingredients applied per hectare of agricultural area (exclusive of grassland) in 1989 was some 6 kg.

The price of pesticides in Germany is generally higher than in a country like France. This might be due to the relatively long distribution network in Germany from the producers and importers of pesticides to the farmers (see also Section 7.4 of the report). Price differences among countries diminished in the past couple of years due to the occurrence of so-called parallel imports. In such a case traders of pesticides buy pesticides abroad in a country with lower prices, add a new label to the products and sell them at a small discount in countries with relative high prices. The relative importance of parallel import was rather small, but it did have a major impact on the market of pesticides. Exchange rates also are considered to be an important aspect on price differences among countries. Price differences among countries have been reduced during the past couple of years. The risk of parallel imports still remains and may increase with only marginal differences on the price of pesticides.

3.5 Greece

All pesticides used in Greece are imported. Until 1992 all importers of active ingredients and formulated products had to inform the Ministry of Agriculture (Crop Protection Service) on the amount they planned to import for local use. This was required in order to get the necessary license from the customs office. It is estimated that the actual imported amounts are about 20-25% smaller than the planned import levels (Balayannis, personal comment).

Table 3.8 shows the import levels of pesticides (in 1,000 kg of active ingredients). It includes the total import of active ingredients and of formulated products for the period 1980-1989.

Table 3.8 Import of pesticides for agricultural use in Greece (in 1,000 kg of active ingredients)

Product group	1980	1984	1985	1987	1989
Herbicides	1,689	2,611	3,684	2,034	3,440
Fungicides	25,364	27,343	18,195	4,188	10,280
Insecticides a)	2,698	3,248	6,150	2,571	3,498
Other b)	6,137	8,944	9,320	7,586	6,259
Total	35,888	42,146	37,349	16,379	23,477

a) Also including acaricides and nematicides; b) Also including fumigantia.
Source: Panhellenic Association of Importers and Manufacturers of Agrochemicals.

The statistics that are available on the import of insecticides also include the import of acaricides and nematicides. An assessment was made on the sales of nematicides. These are estimated to be around 200-250 tons per year. Sales of nematicides are rather stable over time (Balayannis, personal comment).

Sales of fungicides mainly include elementary sulphur in the form of dust base (96-98%) and copper sulphate. Both products are mainly used to grow grapes for wine. Annual sales of sulphur might reach levels of over 20,000 tons. Sales of copper sulphate are around 1,500 to 3,000 tons. Sales of sulphur and copper sulphate show a decreasing trend after the mid 1980s because they are replaced by synthetic organic fungicides.

3.6 Spain

The total number of active ingredients that are available at the market in Spain amounts to some 420. Such a wide variety is required to make a total production of circa ninety crops possible. Total sales of pesticides are only published in kilogramme of formulated products (table 3.9). An estimation was made by the Ministry of Agriculture on the sales of pesticides in kilogramme of active ingredients (table 3.10).

Climatic conditions in Spain are rather dry and hot. Treatment of crops against insects is therefore more important than treatment against fungi. Copper sulphate to prevent the occurrence of mildew is mainly used in the northern part of the country (Galicia). The use of copper sulphate in the region of Castilla-La Mancha - an important region to grow grapes for wine - is small due to the dry climate. Mildew is observed rather rarely in that region, on average about once every ten to fifteen years.

Table 3.9 Annual sales of pesticides for use in agriculture in Spain in 1991 by product group (in 1,000 kg of formulated products)

Product group	Sales
Herbicides	22,459
Fungicides	24,695
Insecticides a)	34,243
Nematicides	12,948
Growth regulators	13,024
Other	4,163
Total	111,532

a) Including acaricides.
Source: Asociación Española de Fabricantes de Agroquimos Para la Protección de las Plantes (AEPLA).

Table 3.10 Sales of pesticides of nine products with highest weight in Spain (in 1,000 kg active ingredients, average of 1990-1992)

Product	Sales	Product group
Sulphur	30,000	Fungicides
Mineral oil	5,000	Other
Methyl bromide	4,000	Nematicides
Metam-Na	4,000	Nematicides
Carbamates	2,800	Insecticides
Copper	2,700	Fungicides
Dichloropropene	2,000	Nematicides
Simazine	1,000	Herbicides
Glyphosate	750	Herbicides
Total	52,250	

Source: Ministry of Agriculture (personal communication, Sub-directorate General of Plant Health).

3.7 France

The sales of pesticides in France strongly increased during the past thirty years. The monetary value of sales doubled during the sixties as well as the seventies and further increased by another 75% in the eighties.

Exact data of the sales of pesticides for use in agriculture in France are not available. The only available data concern the total sales of pesticides inclusive of the sales for consumption outside agriculture. Sales recently show a decreasing trend. Sales in kilogramme of active ingredients decreased by about 18% in 1992 (table 3.11). Sales of fungicides were high in 1991, compared to other years. Decline during the past couple of years has been largest on the sales of herbicides. The industry expects a further decline in the next years. Industry considers the set-

Table 3.11 Annual sales of pesticides in France by product group (in 1,000 kg of active ingredients)

Product group	1988	1989	1990	1991	1992
Herbicides	36,073	36,189	37,429	33,713	27,281
Fungicides	49,774	46,193	41,514	55,565	44,786
Insecticides	6,656	7,142	7,718	7,096	6,110
Nematicides	3,002	3,584	3,321	3,230	1,835
Growth regulators	1,944	5,019	3,243	3,036	3,394
Others	1,718	2,306	4,476	794	1,303
Total	99,167	100,433	97,701	103,434	84,709

Source: Union des Industries de la Protection des Plantes (UIPP).

aside obligations of the Common Agricultural Policy (CAP), lower product prices due to CAP, GATT negotiations and chemical substitution of pesticides as main reasons of the reduction of the sales of pesticides.

3.8 Ireland

All plant protection products used in Ireland are imported; there is no Irish production of active ingredients (table 3.12). It is therefore considered that the sales of pesticides in Ireland are equal to imports.

The sales of ferrous sulphate for use on golf greens will not be included in the subsequent part of the report.

Table 3.12 Imports of pesticides in Ireland (in 1,000 kg of active ingredients)

Product group	1991	1992
Herbicides	1,097	1,251 a)
Fungicides	535	663
Insecticides	102	63
Nematicides	61	81
Growth regulators	121	134
Other	90	130
Total	2,006	2,322

a) Increase in herbicide imports due to imports of 250 tons of ferrous sulphate (for use on golf greens) which was not reported in previous years.
Source: Pesticide Control Service, Department of Agriculture, Food and Forestry.

3.9 Italy

Statistics on the sales of pesticides in Italy are mainly reported in kilogramme of formulated products rather than in kilogramme of active ingredients.

Information on the sales of pesticides is provided by:

- Agrofarma, the national association of agrochemicals. These statistics are based on the sales by the firms that produce or import pesticides for use in agriculture. The statistic is limited to the firms that are affiliated with Agrofarma. These firms cover more than 95% of the market of pesticides in Italy.
- Istat, the statistical office of Italy. Istat data are based on a questionnaire with the seventy firms that either produce or import pesticides in the country. These firms are obliged to provide the information according to a national law of statistics. The provided information is based on 110 groups of main active ingredients. Statistics are primarily published in kilogramme of product, rather than in

kilogramme of active ingredients. Data on sales in kilogramme of active ingredients are also available.

- Ministry of Agriculture and Forestry. According to a law of the Ministry of Health from November 12, 1991, the Ministry of Agriculture is assigned to provide information regarding the sales of pesticides by salesmen. This survey is referred to as the Sistemo Informativo Agricolo Nazionale (S.I.A.N.) 1). The data base includes the 6,000 products that have been registered since 1975 and about 300 types of active ingredients. The survey is based on a questionnaire, organized every six months with the 6,000-8,000 salesmen of pesticides. Information is provided in kilogramme of product, rather than kilogramme of active ingredients. It is likely that the data will be given in kilogramme of active ingredients in the near future.
  According to the same law, farmers are also assigned to develop a bookkeeping system regarding the pesticides they bought. Resistance by farmers' organizations against the system has been strong so far. This delayed the introduction of the system, but it is foreseen to be introduced in 1994.

The statistics from Istat and Agrofarma do not only differ because some firms are not affiliated to Agrofarma. There are also differences regarding the products included in the statistics. Agrofarma has a more strict definition of the products included in their statistics relative to Istat. Agrofarma data are limited to the definition of pesticides mentioned in national law on pesticides (Agrofarma, 1991). The definition of pesticide products excludes the use of copper, copper sulphate and ferrous sulphate if they are sold under the original names of the products. They are however identified to be pesticides if these products are sold under a product name or mixed with other products. The statistics of Agrofarma do not include the sales of such products, while Istat does.

Total sales of pesticides for use in agriculture in Italy, according to the Agrofarma data have been showing a steady decrease since 1987 (table 3.13). Differences with the Istat data (table 3.14) are mainly due to the inclusion of larger amounts of products used as fungicides.

Sales of pesticides marketed for use in agriculture, given in active ingredients, decreased in 1989 by some ten percent compared to the previous year (table 3.15).

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1) The new survey will replace the statistics on the sales of herbicides provided so far by the Unitá Sanitarie Locali (USL). The collection of data on the sales of herbicides was initiated by the Ministry of Health and organized by the USL, because of problems on the quality of water in the northern part of Italy, i.e. in regions like Veneto, Piemonte, Emilia-Romagna and Lombardia.

Table 3.13 Annual sales of pesticides for use in agriculture in Italy by product group, estimated by Agrofarma (in 1,000 tons of formulated products)

Product group	1984	1985	1986	1987	1988	1989	1990	1991	1992
Herbicides	29.9	30.5	32.2	33.3	32.7	29.9	27.8	26.4	25.1
Fungicides	62.9	59.3	66.7	74.5	71.8	67.1	65.8	56.1	57.3
Insecticides a)	37.5	36.7	38.6	37.6	39.4	39.1	36.5	34.8	36.0
Nematicides and fumigants	10.7	9.1	8.5	8.6	7.9	8.3	6.7	4.8	5.1
Other	6.0	4.5	5.3	5.1	4.7	4.4	4.5	4.2	3.9
Total	147.0	140.1	151.3	159.1	156.5	148.8	141.3	126.3	127.4

a) Including acaricides.
Source: Agrofarma, 1992.

Table 3.14 Annual sales of pesticides for use in agriculture in Italy by product group, estimated by Istat (in 1,000 tons of formulated products)

Product group	1984	1985	1986	1987	1988
Herbicides	28.2	28.5	29.5	31.8	31.1
Fungicides	81.5	85.0	93.7	109.7	109.7
Insecticides a)	38.0	36.3	35.8	35.5	37.8
Nematicides and fumigants	12.5	9.5	10.3	10.7	12.7
Other	5.2	3.2	2.5	2.4	1.7
Total	165.4	162.5	171.8	190.1	193.0

a) Including acaricides.
Source: Istat.

Table 3.15 Annual sales of pesticides for use in agriculture in Italy by product group, estimated by Istat (in 1,000 kg of active ingredients)

Product group	1988	1989
Herbicides	10,800	10,600
Fungicides	65,600	57,100
Insecticides a)	11,800	11,100
Nematicides and fumigants	10,000	9,500
Other	2,400	2,800
Total	100,600	91,100

a) Including acaricides.
Source: Istat.

3.10 Luxembourg

Information about the sales of pesticides for use in agriculture is provided by the Commission d'Agrement de Produits Phytopharmaceutiques (table 3.16). Herbicides and fungicides both cover about half of the annual sales.

Table 3.16 Annual sales of pesticides in 1991 for use in agriculture in Luxembourg by product group (in 1,000 kg of active ingredients)

Group	Amount
Herbicides	121
Fungicides	113
Insecticides	10
Other	9
Total	253

Source: Administration des Services Techniques de l'Agriculture, Commission d'Agrement de Produits Phytopharmaceutiques, Grand-Duche de Luxembourg.

3.11 Netherlands

The available data on the sales of pesticides are limited to the sales from firms that are affiliated with the Dutch Foundation for Phytopharmacy (Nefyto). It is assessed that total sales are around 7% higher, but of course this may vary among years. Annual sales of pesticides decreased by some 20% during the period between 1984-1988 and 1992. Sales of pesticides during the four annual averages of the period 1984-1988 are the reference period in the Multi Year Crop Protection Plan from the Dutch Government (table 3.17). This plan includes targets for the year 2000, viz. to reduce the use of pesticides, to reduce their

Table 3.17 Annual sales of pesticides for use in agriculture in the Netherlands by product group (in 1,000 kg of active ingredients)

Product group	1984-1988	1989	1990	1991	1992	1993 b)
Herbicides	3,854	3,330	3,468	3,312	2,987	2,800
Fungicides	4,029	4,052	4,140	4,281	4,192	4,000
Insecticides a)	603	745	731	594	557	465
Nematicides	10,247	9,830	8,937	7,679	6,762	2,420
Other	1,218	1,189	1,559	1,440	1,423	1,900
Total	19,951	19,146	18,835	17,306	15,921	11,585

a) Including acaricides; b) Tentative figures.
Source: Nefyto, 1993.

emissions to the environment and to diminish the dependence of agriculture on chemical pesticides. Sales in 1992 reduced by some nine percent compared to the previous year. A tentative estimation on the sales of pesticides in 1993 shows a reduction of about 25% compared to the previous year. Sales of nematicides decreased by more than 60%. One of the most important factors contributing to the reduction between 1992 and 1993 was the bad weather for soil disinfection in autumn 1993. Annual sales of nematicides of about 6-7 million kg of active ingredients are considered to be more realistic according to the Nefyto.

The group of other pesticides in the Netherlands mainly includes mineral oils (1,173 tons in 1992) and other additives (78 tons), to be followed by growth regulators (120 tons), and other pesticides (52 tons).

All firms need to report on their sales as of 1993 in response to the Regulation for Administration Requirements for Pesticides (Regeling Administratievoorschriften Bestrijdingsmiddelen). Statistics on the sales of pesticides for agricultural use from all firms producing or importing pesticides will therefore become available in the near future. So sales from firms that are not affiliated with Nefyto, are also incorporated in the statistics.

3.12 Portugal

Total sales of pesticides for agricultural use are rather low in Portugal, due to climatic conditions (dry and hot from mid spring until the end of the summer period) and the small income levels. Sales of pesticides showed a decreasing trend during the past couple of years which was mainly due to climatic conditions (extraordinarily dry and hot) (table 3.18). The smaller number of treatments of grapes against mildew largely contributed to a major reduction on the sales of fungicides. In total there are about 200 types of active ingredients used in the market of pesticides in Portugal.

Table 3.18 Annual sales of pesticides for use in agriculture in Portugal by product group (in 1,000 kg of active ingredients)

Product group	1991	1992
Herbicides	1,801	1,192
Fungicides	6,511	3,932
Insecticides a)	831	754
Other	212	239
Total	9,355	6,117

a) Including acaricides.
Source: ANIPLA.

3.13 United Kingdom

Total sales of pesticides for use in agriculture and horticulture in 1992 amount to 23.8 million kg of active ingredients (BAA, 1993). They account for 96% of the total sales in kg of active ingredients. These statistics are limited to the sales of firms that are associated with the British Agrochemicals Association (BAA). Sales of pesticides for use in agriculture and horticulture showed a decline of some three percent in 1992 compared with 1991 (table 3.19). Total sales of active ingredients in 1992 showed a decline of some 25% as compared with 1983 (BAA, 1993).

Table 3.19 Annual sales of pesticides for use in agriculture in the United Kingdom by product group (in 1,000 kg of active ingredients)

Product group	1990	1991	1992
Herbicides	11,814	14,313	13,039
Fungicides	6,757	6,510	6,708
Insecticides	1,467	1,121	1,043
Growth regulators	2,840	1,915	1,782
Other	714	803	1,228
Total	23,592	24,662	23,800

Source: BAA, 1992; 1993.

3.14 Concluding remarks

1. Data in this chapter about the sales of pesticides in the Member States allows to assess total sales in EUR 12. The most recent assessment on the annual sales of pesticides for use in agriculture in EUR 12 adds to some 346 million kg of active ingredients (table 3.20). This is considered to be the best available guess on the actual use of pesticides for agriculture in the EC. Italy and France already account for 50% of the total sales of pesticides in the EC. Fungicides cover about half of the sales of pesticides.
2. The amount of pesticides sold per hectare of land to grow arable crops and permanent crops is less than 3 kg in Denmark, Spain, Ireland and Portugal. It is highest in Belgium (11 kg of active ingredients per hectare) and the Netherlands (17 kg of active ingredients per hectare) (table 3.21). Differences among countries are large, both in terms of (i) the total sales of pesticides per hectare and (ii) the composition of the type of pesticides used.
3. The use of pesticides is high in the Netherlands because of its position as an exporting country of agricultural products and the strict international phytosanitary regulations that have to be met. This holds especially in horticulture, seed potatoes and other seeds and

Table 3.20 Annual sales of pesticides for use in agriculture by product group and country (in 1,000 kg of active ingredients)

Country	Year	Herbi-cides	Fungi-cides	Insect-icides	Nemati-cides	Other	Total
Belgium a)	1992	2,560	3,292	387	857	770	7,866
Denmark	1991	3,429	1,678	241	65	206	5,619
Germany	1990	16,970	10,984	1,525	-	3,667	33,146
Greece	1989	3,440	10,280	3,248	250	6,259	23,477
Spain	1990-92	1,750	32,700	2,800	10,000	5,000	52,250
France	1992	27,281	44,786	6,110	1,835	4,697	84,709
Ireland	1992	1,001	663	63	81	264	2,072
Italy	1989	10,600	57,100	11,100	9,500	2,800	91,100
Luxembourg	1991	121	113	10	-	9	253
Netherlands	1992	2,987	4,192	557	6,762	1,423	15,921
Portugal	1992	1,192	3,932	754	-	239	6,117
United Kingdom	1992	13,039	6,708	1,043	-	3,010	23,800
EUR 12		84,370	176,428	27,838	29,350	28,344	346,330

a) It is considered that half of the sales of herbicides are used outside agriculture.
Sources: see tables 3.1-3.19.

Table 3.21 Annual sales of pesticides in agriculture by product group (in kilogramme of active ingredients per hectare of arable land and land under permanent crops) and output from crop production by Member State

Country	Arable/ permanent crops (1,000 ha) a)	Sales of pesticides by group (kg/ha)						Output b) (ECU/ha)
		herbi-cides	fungi-cides	insect-icides	nemati-cides	other	total	
Belgium c)	737	3.5	4.5	0.5	1.2	1.0	10.7	3,069
Denmark	2,558	1.3	0.7	0.1	<0.1	0.1	2.2	1,234
Germany	7,492	2.3	1.5	0.2	-	0.5	4.4	1,623
Greece	3,912	0.9	2.7	0.8	0.1	1.6	6.0	1,842
Spain	20,089	0.1	1.6	0.1	0.5	0.2	2.6	844
France	19,234	1.4	2.3	0.3	0.1	0.2	4.4	1,709
Ireland	933	1.1	0.7	0.1	0.1	0.3	2.2	1,174
Italy	11,975	0.9	4.8	0.9	0.8	0.2	7.6	2,400
Luxembourg	81	1.5	1.4	0.1	-	0.1	3.1	1,371
Netherlands	911	3.3	4.6	0.6	7.4	1.6	17.5	8,423
Portugal	3,173	0.4	1.2	0.2	-	0.1	1.9	1,036
United Kingdom	6,600	2.0	1.0	0.2	-	0.5	3.6	1,441
EUR 12	77,695	1.1	2.3	0.4	0.4	0.4	4.5	1,666

a) Arable land also includes voluntary set-aside; b) Exclusive of forage crops. Average of the accounting years 1988/89-1990/91; c) It is considered that half of the sales of herbicides are used outside agriculture.
Source: Sales of pesticides see table 3.20; arable land and land under permanent crops from FAO; output from FADN/LEI-DLO.

seedlings. The same is the case for Spain and Italy with a strong position to the export of fruits. Limited possibilities to rotate crops increase the risk of soil-borne diseases. This also explains high usage of pesticides in the Netherlands. The possibilities for crop rotation are limited in the Netherlands because intensive crops are concentrated in the country. The relatively small size of farms in the Netherlands also limits the possibilities for crop rotation. Intensive cropping systems increase the risks of pests and diseases. Farmers might avert such risks by high usage of pesticides.

4. Sales of herbicides per hectare of land are relatively high in northwestern Europe (figure 3.1). They are highest in Belgium, Germany, the Netherlands and the United Kingdom (table 3.21). Sales of fungicides per hectare of land are highest in Italy, Belgium and the Netherlands. Sales of nematicides per hectare of land are by far highest in the Netherlands. Crops in the Netherlands are usually grown intensively in narrow rotation, which is likely to encourage soil-borne diseases. The use of 'other' pesticides in Belgium, Spain and the Netherlands is to a large extent due to the sales of mineral oils. These sales amount to some 5 million kg in Spain, 1.2 million kg in the Netherlands and 0.4 million kg in Belgium (all in active ingredients).

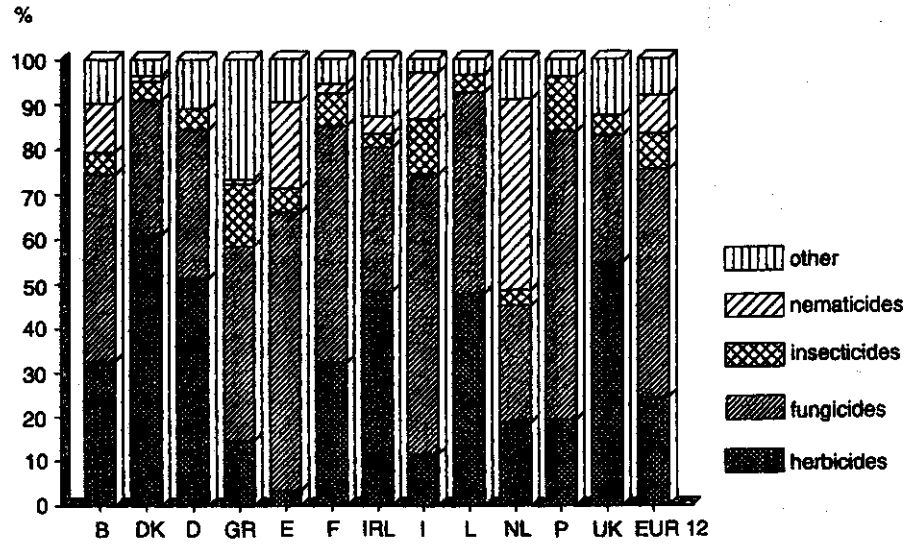

Figure 3.1 Share of pesticide groups (herbicides, fungicides, insecticides, nematicides and others) in national sales of pesticides by country

5. The countries with high sales of pesticides also have a high level of output per hectare of land (table 3.21 and figure 3.2). Annual sales of pesticides per hectare of arable land and land under permanent crops are around 17 kg in the Netherlands, which is about four times higher than the average of EUR 12, but the output from crops per hectare of utilized agricultural area (excluding forage crops) in that country is about five times higher than the average of EUR 12. Output per kilogramme of active ingredients is highest in Denmark and lowest in Belgium (successively 560 and 287 ECU/kg of active ingredients). It is high (around 500 ECU/kg) in Ireland, the Netherlands and Portugal and small (around 300 ECU/kg) in Greece, Spain and Italy. Germany, France, Luxembourg and the United Kingdom take a medium position (around 400 ECU/kg) in this respect.

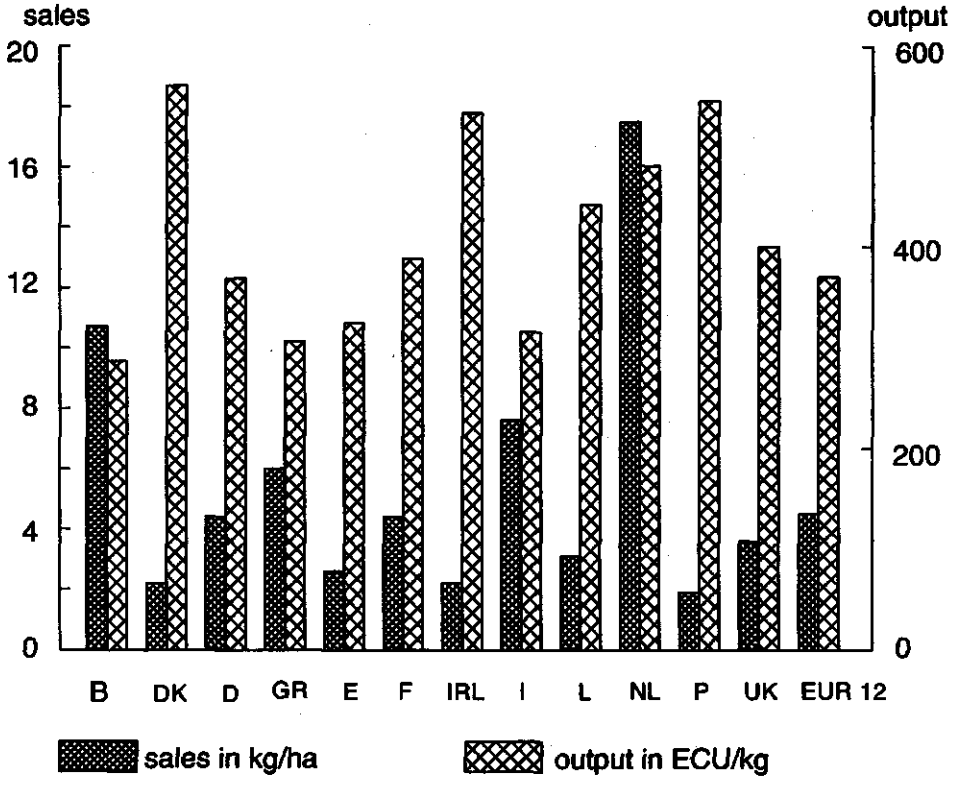

Figure 3.2 Sales of pesticides per hectare of arable land and land under permanent crops (kg/ha) and output from crops (exclusive of forage crops) per kg of active ingredients (output in ECU/kg)

Table 3.22 *Annual sales of pesticides for use in agriculture in the 1980s by product group (1,000 kg of active ingredients) and (between brackets) percentage change of sales for six Member States with regard to table 3.20*

Country	Year	Herbicides	Fungicides	Insecticides	Nematicides	Other	Total
Belgium a)	1985	2309 (+11)	2123 (+55)	516 (-25)	1133 (-24)	584 (+32)	6665 (+18)
Denmark	1988	3962 (-13)	1310 (+28)	223 (+8)	73 (-11)	280 (-26)	5847 (-4)
Germany	1987	21529 (-21)	10219 (+7)	1273 (+20)	- (0)	3346 (+10)	36367 (-9)
Greece	1985 b)	3684 (-7)	18195 (-44)	5900 (-45)	250 (0)	9320 (-33)	37349 (-37)
France	1988	36073 (-24)	49774 (-10)	6656 (-8)	3002 (-39)	3662 (+28)	99167 (-15)
Netherlands	1984/88	3854 (-22)	4029 (+4)	603 (-8)	10247 (-34)	1218 (+17)	19951 (-20)
Total		71411 (-21)	85650 (-12)	15171 (-20)	14705 (-34)	18410 (-8)	205346 (-17)

a) It is considered that half of the sales of herbicides are used outside agriculture; b) Sales of nematicides in 1985 are considered to be equal to the 1989 level.

6. Annual sales of pesticides (in kilogramme of active ingredients) in EUR 12 showed a decreasing trend over the past few years. Data on sales are available since the mid 1980s from Belgium, Denmark, Germany, Greece, France and the Netherlands. Total reduction in these countries amounted to approximately 17% (table 3.22). The reduction on the sales of nematicides (-34%), herbicides (-21%) and insecticides (-20%) was above the average of total reduction. The reduction of fungicides (-12%) and 'other' pesticides (-8%) was below average.

   There are several plausible reasons for the reduction of the sales of pesticides in the EC during the past couple of years. Important elements to be considered in this respect are:

   - Substitution by dosages requiring smaller amounts of chemicals to prevent or treat diseases. For example, sales of herbicides to grow cereals decreased due to this chemical substitution process.
   - Autonomous development of a decrease of utilized agricultural area. Total of arable crops and permanent crops decreased by 880 thousand hectares (roughly a decrease of 1%) between 1985 and 1990. However, the impact of this reduction on the use of pesticides is likely to be rather limited.
   - Climate and weather conditions could largely affect the use of chemicals to prevent pests and diseases. Consider for example the use of fungicides in the Mediterranean part of Europe. The use of fungicides is high in the northern part of Italy, compared to countries like Spain and Portugal. This is among other things due to the relatively high precipitation levels in that part of Italy. The relatively dry and hot summers affected the use of fungicides in Portugal and Spain. Variation of weather conditions might therefore also cause fluctuations in the use of pesticides with the lapse of time.

7. The use of pesticides may further reduce in the years to come due to:
   - Agro-environmental policies. CAP reforms are already considered to have adverse effects on the sales of pesticides during the first part of 1993. Reduction is considered to be largest in France and Germany (Agrow, September 17th, 1993, volume 192, p. 6). An important aspect to be considered is the amount of land that is set aside. Besides, the impact of changing market and price policies on cropping pattern and on the use of inputs like pesticides, is important as well. Set-aside was introduced into the CAP in 1988 as a voluntary scheme for arable crops. Under the CAP reform from 1992, production-oriented support is being replaced by direct producer payments coupled with set-aside requirements. Provisional estimates from the EC Commission suggest that the total amount of land set-aside in 1993 will be 6.4 million ha (Agra Europe, January 21, 1994). The five-year voluntary set-aside scheme accounts for approximately 1.5-1.6 million ha, putting the compulsory set-aside at around 4.7-4.8 million ha. The main areas are in France (1.5 million ha), Germany (1.0 million ha) and Spain (0.7 million ha). A reduction of price support for agricultural products under the MacSharry reform (CAP reform from 1992) may require a further reduction of the costs for using inputs in future years. The decline in the use of pesticides by set-aside is projected to be largest in Germany, Spain, France and the UK. These countries have the biggest farms and/or largest areas of cereals (Agrow, October 8th, volume 193, 1993, p. 11).
   - The Council Directive 91/414 concerning placing plant protection products on the market. Its purpose is to introduce high standards of protection for man and the environment throughout the Community. This directive will most likely also contribute to a reduction of sales. Various relatively old products might not be registered under this directive.

4. USE OF PESTICIDES AT CROP AND REGIONAL LEVEL

4.1 Introduction

The main objective of this chapter is to focus on the use of pesticides at crop and regional level. This is to identify crops and regions in the EC with a high use of pesticides. A distinction is made between the use of pesticides at regional and at crop level, wherever this kind of information is available. The product categories distinguished are herbicides, fungicides, insecticides, nematicides and other pesticides.

4.2 Belgium

There is only limited information on the use of pesticides in Belgium at crop level. The available information is aimed to examine the use of the most important active ingredients to grow maize and potatoes (table 4.1). The focus is on those agrochemical products that were identified to be toxic in draft EC Directives, among others atrazine, lindane and fentin products.

4.3 Denmark

Sales of pesticides to grow arable crops are published in Denmark by the Ministry of the Environment in order to prepare an assessment on the number of applications. Sales of pesticides to grow arable crops have shown a steady decreasing trend during the past decade (see section 3.3). This might be partly due to the substitution of pesticides that require smaller dosages to treat plants. The reduction of the sales of pesticides therefore does not necessarily reflect a decrease in the number of times the land is being treated. The number of times the land is applied with a pesticide might be reduced much less, because of the chemical substitution requiring smaller dosages. This trend has been observed in Denmark for arable crops during the past decade. The frequency of using pesticides, in terms of the number of treatments per hectare per year, rather shows a steady increase. It increased from 1.6 in 1981 to 2.9 treatments per hectare in 1991. The application frequency is based on total sales of a chemical pesticide for a specific crop, the recommended dosage per hectare per application and the acreage of that crop. One of the important factors determining the intensity of pesticide

Table 4.1 Use of pesticides in Belgium to grow maize and potatoes

Product used	Share of farms using active ingredient (in %)	Average dosage (kilogramme or liter per hectare)
Maize:		
Herbicides		
Atrazine	73	2.0
Lentagran	43	1.7
Atrazine and bentazon	29	4.1
Rasamais	15	1.5
Insecticides		
Lindane	10	1.5
Potatoes:		
Fungicides		
Fentin acetate	78	3.3
Maneb	71	15.0
Mancozeb	43	13.4
Herbicides		
Metribuzin	76	0.5
Aclonifen	35	3.1
Metobromuron	38	3.2
Diquat	62	3.2
Insecticides		
Pirimicarb	25	3.4
Ethiofencarb	10	1.0

Source: LEI (1991) and CHPTE (1992).

Table 4.2 Number of standard treatments in Denmark to grow arable crops in 1991 by product group and crop

Crop	Herbi-cides	Fungi-cides	Insect-icides	Growth regulators	Total
Winter cereals	1.5	1.7	0.6	0.3	4.1
Spring cereals	0.9	0.6	0.4	<0.1	1.9
Winter rape	0.7	0.2	1.3	-	2.2
Spring rape	1.1	0.1	1.8	-	3.0
Potatoes	1.6	4.5	0.3	-	6.3
Beet	2.7	0.1	2.4	-	5.2
Peas	2.0	0.7	1.3	-	4.0
Vegetables a)	2.2	3.3	2.1	0.1	7.7
Arable crops	1.3	0.8	0.7	0.1	2.9

a) Vegetables grown by arable farmers.
Source: Ministry of the Environment, 1992.

use is the type of crop grown. It is high on winter cereals, potatoes, beet, peas and vegetables (table 4.2). The share of the acreage of these crops in total utilized agricultural area increased from 17% in 1981 to 41% in 1991.

The application frequency in table 4.2 is based on national averages. Differences however may be large, depending among others on local conditions, farm management and farm structure. A survey of some 800 farmers provided information on the variation among farms of the number of treatments per hectare per year. The survey showed that the range indeed is rather broad (Landskontoret for Planteavl, 1993). The average application frequency to winter wheat is between three and four. The range is between less than one (1% of the cases) and over six treatments per hectare per year (2% of the cases). The annual application frequency is less than three on slightly over a third of the fields examined.

The use of pesticides in the western part of Denmark is smaller than in the eastern part of the country. This is mainly due to smaller needs to treat plants against fungi and insects.

4.4 Germany

The Biologischen Bundesanstalt für Land- und Forstwirtschaft organized annual surveys on the use of pesticides in agriculture during the years 1977 to 1979. The sample included 1,600 arable farms, and was stratified according to cropping plan, region and farm size. The survey

Table 4.3 Use of pesticides to grow arable crops in Germany, average of period 1977-1979 and 1987 (in kilogramme of active ingredients per hectare)

Crop	Herbicides		Fungicides		Insecticides		Others		Total	
	77-79	87	77-79	87	77-79	87	77-79	87	77-79	87
Cereals	2.1	2.2	0.2	0.9	<0.1	<0.1	0.2	0.2	2.6	3.4
of which:										
winter wheat	2.4	2.5	0.5	2.2	<0.1	<0.1	0.5	0.5	3.4	5.2
winter barley	2.6	2.7	0.2	1.6	<0.1	<0.1	0.1	0.1	2.9	3.3
rye	1.7	1.6	<0.1	0.3	<0.1	<0.1	0.3	0.3	2.1	2.2
coats	1.7	1.5	<0.1	<0.1	<0.1	<0.1	0.1	0.1	1.8	1.7
Rape seed	3.1	2.3	<0.1	0.3	0.4	0.2	0.1	<0.1	3.6	2.6
Potatoes	0.8	1.5	1.5	3.7	0.3	0.3	<0.1	<0.1	2.7	5.4
Sugar beet	3.7	3.7	<0.1	<0.1	0.7	0.7	0.1	n.a. a)	4.6	4.5
Fodder beet	2.5	2.9	<0.1	<0.1	0.2	0.3	<0.1	n.a. a)	2.7	3.2
Average	2.0	2.1	0.2	0.8	0.1	0.1	0.2	0.2	2.5	3.1

a) Data not available.
Sources: Hildebrandt, 1991; Hildebrandt et al., 1990.

was once more repeated in 1987. The use of pesticides is given for a limited number of arable crops (table 4.3).

Nematicides were still used until the mid 1980s, among others to grow potatoes. The application level of this type of pesticides is however presently negligible due to the strict regulation on the protection of water since 1987 (Grundwasserschutz). Farm size and the number of field crops per farm have an equally important effect on the number of treatment days per year (Hildebrandt et al., 1992).

Table 4.4 Use of pesticides to grow horticultural crops in Germany (in kilogramme of active ingredients per hectare)

Product group	Vegetables/ fruit 1987	Perennial crops 1987	Grapes 1982	Grapes 1992
Insecticides	0.8	2.2	5	3
Fungicides	4.8	14.0	32	15
Herbicides	1.7	4.2	10	3
Other	1.2	5.6	4	0.1
Total	8.5	26.0	51	21

Sources: Grapes from BBA, 1993; other crops from Hildebrandt, 1991.

More than half of the use of pesticides to grow horticulture crops (table 4.4) includes fungicides. The use of pesticides to grow fruit and vegetables during the 1987 survey was assessed to be some 8.5 kg per hectare. These crops are grown on some 59,000 ha of land in Germany. Annual use of pesticides to grow these fruits and vegetables is around 500 ton. Pesticide usage to grow perennial crops is about 26 kg per hectare. The use of pesticides to grow grapes in Germany decreased from 51 kg of active ingredients per hectare in 1982 until some 21 kg per hectare in 1992. The reduction was particularly high in the use of fungicides and herbicides.

4.5 Greece

The share of pesticide consumption per crop, expressed as percentage of total sales, is given in table 4.5. Grapes have the highest share (16%), followed by fruit trees (13%), cotton and vegetables (10%).

The average use of fungicides and insecticides was about 4 kg of formulated product per treated hectare in 1992 (see table 4.6). Compared to the previous years, these amounts are rather low, because 1992 was a typical non-epidemic year. The average use of herbicides was about 3 kg of formulated product per treated hectare, which was more

Table 4.5 Use of pesticides by crop in Greece in 1992 (expressed as percentage of total sales in drachmas)

Crop	Percentage
Citrus	3.1
Fruit trees	13.2
Olive trees	6.3
Grapes	16.0
Vegetables	9.5
Cereals	6.5
Maize	6.0
Rice	1.0
Sugar beet	6.5
Potatoes	3.8
Cotton	10.3
Tobacco	5.8
Other crops	11.0

Source: Laboratory of Pesticide Science, Agricultural University of Athens.

or less at the same level as the years before. For some crops the use of formulated product per hectare is considerably above the average. The use of fungicides per treated hectare is 10 kg for citrus fruit, 9 kg for cucumbers and olives and 6 kg for peaches and tobacco. About 30% of the cultivated area with grapes is treated with sulphur dust. On this area about 30-50 kg per hectare is used. The use of herbicides per treated hectare for rice (13 kg) and fruit trees, maize and tobacco (4-6 kg) is above average. The same applies for the use of insecticides per treated hectare for cucumbers (20 kg) and citrus, maize, sugar beet and potatoes (7-9 kg). It should be noted that differences in the use of formulated product per crop do not exactly reflect differences in the use of active ingredients per crop, since the percentage of active ingredients varies per formulated product. The average use of active ingredients in herbicides and insecticides was about 2 kg per treated hectare in 1992; in fungicides

Table 4.6 Average use of pesticides per hectare of treated area in Greece in 1992

	Fungicides a)	Herbicides	Insecticides
Treated area (* 1,000 ha)	1,109.1	1,765.0	1,562.1
Total used formulated product (in tons)	4,513.6	5,186.6	6,093.2
Total used active ingredients (in tons)	3,500.0	2,945.0	2,953.0
Formulated product in kg per hectare	4.1	2.9	3.9
Active ingredients in kg per hectare	3.2	1.7	1.9

a) Exclusive of sulphur dust.
Source: Laboratory of Pesticide Science, Agricultural University of Athens.

about 3 kg (see table 4.6). Relating the use of pesticides to the treated area implies that figures tend to be higher than when the use is related to the total cultivated area.

Differences in the use of pesticides among Greek regions are considerable. The regions with a relatively high use of pesticides are the northern and northwestern part of the Peloponissos, Thessalia, West Macedonia and the island of Crete.

4.6 Spain

The use of pesticides in Spain is on average less than 3 kg of active ingredients per hectare of land (table 3.21). Differences among regions are rather large. The regions with the highest use of pesticides are located along the southeastern coast of Spain: Murcia, Comunidad Valenciana and Andalucia. In the other Spanish regions the use is very small, mainly because the nature of agricultural practice is rather traditional and extensive. Farmers in those regions primarily produce for local markets. Agriculture of Valencia and Aragon is well advanced, while intensive agriculture in the province of Almeria started only some ten years ago. About two thirds of the total greenhouse area in Spain (24,000 ha in 1990) is located in Almeria.

The use of active ingredients for fruit and rice in Valencia is given in table 4.7. For stonefruits a winter treatment and a spring/summer treatment is distinguished. The amount of active ingredients in the winter treatment varies from 6 to 24 kg per hectare, depending on the mix of mineral oils with other ingredients. Total use of active ingredients for stonefruits is 30 or 50 kg per hectare, except for plums. The use of active ingredients for plums is lower (9 or 28 kg), mainly due to the small amount of fungicides. Once every three years oranges and mandarins are treated with an additional dosis. On average the annual use of active ingredients per hectare is 2 kg for oranges and 4 kg for mandarins. The use of active ingredients per hectare of grapes is about 32 kg. A considerable part of these active ingredients consists of fungicides, which are applied to prevent mildew. The occurrence of mildew depends on weather conditions. In table 4.7 it is assumed that grapes are treated two times a year; sometimes it is less, sometimes it is more. The use of pesticides in Valencia might be somewhat lower than in surrounding regions of the south-east coast of the country. This is partly due to climatic conditions and partly to the quite early harvest of crops. Especially the use of fungicides in Catalonia and the use of insecticides in Almeria tends to be higher than that in Valencia.

Horticultural production under plastic in Almeria is a relatively recent business, which started about ten years ago. Total area of horticulture under plastic is about 15,000 ha in Almeria, of which 40% is used for the production of green peppers. In the period 1985-87 the University of Madrid monitored the use of pesticides in the cultivation of green

Table 4.7 Use of pesticides in fruit and rice in Valencia (in kilogramme of active ingredients per hectare per year)

Crop	Insect-icides	Fungi-cides	Herbi-cides	Other	Treatment once in 3 years with insecticides	Total
Peaches	0.4	26.4				51.1 or 32.7 b)
Nectarines	0.4	26.5				51.2 or 32.7 b)
Apricots	1.0	24.4				49.7 or 31.3 b)
Plums	1.2	2.5				27.9 or 9.4 b)
Winter treatment of stonefruits above: a)						
treatment A	1.3	2.5		20.5		24.3
treatment B	<0.1	2.5		3.3		5.8
Oranges	0.2			0.2	4.7	1.9 c)
Mandarins	0.2			0.2	10.2	3.7 c)
Grapes	2.6	29.3				31.9 d)
Rice	2.3		5.4			7.8

a) Winter treatment consists either of treatment A or treatment B; In treatment A DNOC, oxicloruro de cobre and mineral oils are used; in treatment B metil tiofanato, oxicloruro de cobre and mineral oils are used; b) First figure includes treatment A; second figure includes treatment B; c) Total is calculated as the sum of insecticides, other and one third of the treatment which is applied once in three years; d) It is supposed that two treatments against mildew are applied.
Source: Expert judgement, Generalitat Valenciana, Conselleria d'Agricultura, i Pesca, Cap de Servei de Sanitat Vegetal.

Table 4.8 Use of pesticides in green peppers in Almeria (in kilogramme of active ingredients per hectare)

Product group	1985/86	1986/87	1987/88
Herbicides	-	0.7	0.7
Fungicides	129.5	124.2	86.8
of which:			
Azufre micronizado	124.3	119.6	75.6
Insecticides a)	5.3	10.9	8.8
of which:			
Endosulfan	1.6	1.8	5.3
Dicofol	1.6	1.6	0.8
Malathion	-	4.4	-
Nematicides	153.8	130.7	3.2
of which:			
Metam-Na	153.8	89.3	-
Other	2.7	1.8	2.5
Total	291.3	268.3	102.0

a) Including acaricides.
Source: Escuela Técnica Superior de Ingenieros (ETSI) Agrónomos.

peppers under plastic on a horticultural farm of 6,500 m^2. This farm can be considered as representative for other farms in Almeria. The total use of active ingredients per hectare of green peppers was almost 300 kg in 1985/86 (table 4.8). Although the use of pesticides has considerably declined to about 100 kg in 1987/88, it is nevertheless high. The decrease between 1985/86 and 1987/88 was due to the disappearance of nematicides and a reduction of about one third in the use of fungicides. It is expected that at this moment the use is below the level of 1987/88, as during the monitoring period a large number of old-fashioned products were applied, which are now used to a lesser extent.

4.7 France

More or less incidentally the Service Central des Enquêtes et Etudes Statistiques (SCEES) of the Ministère de l'Agriculture et de la Pêche conducts an inquiry with respect to the use of pesticides at product level. In 1986 a research project was carried out in sixty departments concerning the use of pesticides in cereals, oil-seeds and protein crops. These departments represent 90% of the production concerned. In each department information was collected at crop level on the use of pesticides and the number of treatments. This project is repeated in 1993 and results will become available in 1995. In the 1993 project the use of pesticides on set-aside land is also included. A similar project has been carried out in 1992 for fruits. In total six kinds of fruit are distinguished.

The available information is limited to the share of different pesticides in total sales (in monetary terms). Ten crops already account for over 90% of the market of pesticides in France (table 4.9). More than 40% of the sales of pesticides is used to grow cereals. Fungicides cover about a third of the market of pesticides. Nematicides are of marginal importance with a market share of 0.3%.

Table 4.9 Market share of pesticides by crop in France (in %)

Crop	Herbicides	Fungicides	Insecticides	Other	Total
Cereals	11.0	21.0	2.6	9.4	44.0
Maize	6.0	0.6	3.1	-	9.7
Grapes	2.8	5.2	1.4	3.0	12.4
Sugar beet	3.3	0.7	1.7	-	5.7
Sunflower	3.0	-	1.0	0.2	4.2
Pulses	1.5	2.6	-	-	4.1
Rape seed	2.4	1.2	0.7	0.2	4.5
Peas	1.6	1.4	0.5	0.8	4.3
Orchards	0.4	1.2	1.3	0.2	3.1
Potatoes	0.3	0.9	0.2	0.6	2.0
Total above crops	32.3	34.8	12.5	14.4	94.0

Source: UIPP.

4.8 Ireland

For a number of crops estimates of the use of active ingredients per hectare are given in table 4.10. The use of active ingredients per hectare amounts to about 2-4 kg for cereals, pulses, oil-seeds and beet. The use of active ingredients per hectare of potatoes (13 kg) and fruit and vegetables (28 kg) lies at a considerably higher level. The used active ingredients in Ireland mainly consist of herbicides and fungicides.

Table 4.10 Estimated use of pesticides (in kilogramme of active ingredients) per hectare for main crops in Ireland in 1991

	Herbi-cides	Fungi-cides	Insecti-cides	Nemati-cides	Other	Total
Cereals	1.1	0.8	0.2	-	0.5 a)	2.5
Sugar/fodder beet	3.8	-	0.1	-	0.2	4.0
Potatoes	1.4	10.0	0.1	-	1.4	12.9
Fruit and vegetables	6.7	5.0	5.0	10.2	1.3	28.2
Pulses and oil-seeds	2.1	0.4	0.4	-	0.4	3.4
Average	1.4	1.3	0.2	0.2	0.5	3.6

a) Of which 0.4 kg growth regulators.
Source: Active ingredients from Department of Agriculture, Food and Forestry in Ireland; area from CEC, The agricultural situation in the Community, 1992 report, Brussels/Luxembourg, 1993, T/110.

4.9 Italy

Agrofarma, the Italian producers' association estimates the use of active ingredients per crop (table 4.11). These estimates should be interpreted carefully since some products can be used for several crops. More than two thirds of the total amount of active ingredients used in Italy are applied in the cultivation of fruit, citrus fruit and grapes. These crops also show the highest use per hectare: 26.5 kg for (citrus) fruit and 44 kg for grapes. The use of pesticides to grow rice is 12 kg per hectare. For the other crops the use of active ingredients per hectare varies between 1 and 5 kg. The use of pesticides to grow wheat and barley are lower than the estimates from other countries. In this respect it must be considered that these estimates are based on incidental surveys, while in some countries (e.g. Germany) they are based on regular monitoring programmes.

Sales of pesticides in Italy are mainly concentrated in eight regions (see table 4.12). More than 40% of all sales occurs in Emilia-Romagna, Veneto, Piemonte and Lombardia, regions which are located in the northern part of Italy. On the other hand, Lazio, Campania, Puglia and

Table 4.11 Estimated use of pesticides (in active ingredients) a) and utilized agricultural area by crop in Italy in 1990

Crop	Used pesticides (1,000 kg)	Area (1,000 ha)	Use per hectare (kg)
Wheat and barley	2,500	3,250	0.8
Maize	2,300	1,050	2.2
Rice	2,600	215	12.1
Oil-seeds and tobacco	3,400	1,005	3.4
Olives	1,600	1,000	1.6
Fruit and citrus fruit	11,400	430	26.5
Grapes	42,000	950	44.2
Other crops	9,700	2,200	4.4
Total	75,500	10,100	7.5

a) Based on sales.
Source: Annual report of Agrofarma, 1992, p. 25.

Table 4.12 Sales of pesticides used for agricultural purposes in the Italian regions in 1990 (in 1,000 kg of formulated product)

Region	Sales		Sales by product group			Arable/ permanent crops (1,000 ha)	Average use (kg/ha)
	total	% of total	fungicides	herbicides	insecticides		
Piemonte	16,270	8	7,552	5,996	2,236	757.2	21.5
Valle d'Aosta	75	<1	46	4	21	2.1	35.7
Lombardia	13,904	7	4,248	6,520	2,572	820.1	17.0
Trentino-Alto Adige	5,215	3	2,675	148	1,713	58.6	89.0
Veneto	22,844	12	13,952	3,236	3,558	738.1	30.9
Friuli-Venezia Giulia	3,639	2	2,075	879	442	217.2	16.8
Liguria	3,101	2	1,809	46	185	53.6	57.9
Emilia-Romagna	30,943	16	18,264	3,356	6,238	1,083.5	28.6
Toscana	7,589	4	5,140	864	879	807.1	9.4
Umbria	3,538	2	2,388	402	507	300.1	11.8
Marche	5,976	3	3,545	1,053	1,051	473.5	12.6
Lazio	14,162	7	8,401	1,073	1,567	634.6	22.3
Abruzzi	5,282	3	4,088	230	642	352.1	15.0
Molise	957	<1	533	116	276	211.4	4.5
Campania	14,433	7	7,356	582	2,945	569.1	25.4
Puglia	15,795	8	9,594	837	3,506	1,358.1	11.6
Basilicata	2,339	1	1,512	184	453	444.1	5.3
Calabria	4,515	2	2,102	196	1,734	563.0	8.0
Sicilia	17,723	9	7,803	722	3,542	1,346.2	13.2
Sardegna	4,210	2	3,037	227	550	519.3	8.1
Total	192,509	100	106,121	26,671	34,619	11,308.7	17.0

Source: Istat/Eurostat (1991).

Sicilia in the southern part of the country have a share of about one third in total sales. Regional variations in the use of pesticides are among others due to the intensity of agricultural practice and cropping plan, soil conditions and climatological differences.

Sales of pesticides per hectare of arable crops and permanent crops differ largely among the regions. Sales per hectare (in kilogramme of formulated products) exceed 25 kg in Valle d'Aosta, Trentino-Alto Adige, Veneto, Liguria, Emilia-Romagna and Campania.

4.10 Luxembourg

For Luxembourg no information is available on the use of active ingredients per crop. According to the Commission d'Agrement de Produits Phytopharmaceutiques about 81,000 ha were treated with 253,000 kg of active ingredients in 1991, which implies that the average dosage applied in that year was about 3 kg per hectare. The treated area consists mainly of cereals (68%) and forage crops (25%).

4.11 Netherlands

The farm accountancy data network of the Agricultural Economics Research Institute (LEI-DLO) allows to assess the use of pesticides by arable farms. The use of pesticides is classified according to crop and product group. On average it amounted to some 21 kg/ha during the year 1989/90 and increased to 24 kg/ha during the year 1990/91 (Kavelaars and Poppe, 1993). It reduced to 21.5 kg per hectare in 1991/92 (table 4.13).

The reduction which was achieved during that year was mainly due to lower application levels of nematicides. The available data also allow to assess use of pesticides for different regions, cropping plan and farm size.

Differences among provinces on the use of pesticides at arable farms (table 4.14) are largely due to cropping pattern. Differences among provinces on the use of pesticides are largest for nematicides. They are much smaller for the other product groups. The use of nematicides is highest in the provinces with a high share of starch potatoes in cropping pattern (e.g. Drenthe and Groningen). The use of pesticides may also vary within the regions (table 4.15).

The use of pesticides for arable crops was some 22 kg of active ingredients. For 20% of the farms with lowest use, it was even less than 6 kg per hectare, and for 20% of the farms with highest use, it was slightly over 60 kg. Differences in the use of pesticides at arable farms are mainly due to the use of nematicides.

The use of pesticides to grow horticultural crops also shows a wide variation. Research indicates that differences among farms with lowest

Table 4.13 Use of pesticides in the Netherlands in 1991/92 by crop (kilogramme of active ingredients per hectare)

Crop	Herbi-cides	Fungi-cides	Insec-ticides	Nemati-cides	Growth regul.	Other	Total
Arable crops	3.3	4.9	0.4	11.6	0.2	1.2	21.5
of which:							
Winter wheat	3.3	2.5	0.2	0.0	0.7	0.2	6.9
Ware potatoes							
Sandy soils	1.2	11.0	0.0	38.0	0.0	0.5	50.7
Clay soils	2.9	17.8	0.6	12.5	0.0	2.9	36.7
Seed potatoes							
Sandy soils	7.8	6.9	0.2	44.3	0.0	5.7	64.9
Clay soils	5.6	12.3	0.9	15.4	0.0	2.2	36.5
Starch potatoes	1.5	10.9	0.1	91.9	0.0	0.6	104.9
Sugar beet	3.5	0.1	0.4	5.2	0.0	1.8	10.9
Flowers from bulbs and bulb growing	6.3	40.4	2.7	64.7	0	12.7 a)	126.8
of which:							
Tulip: Sandy soils	4.4	42.0	3.4	60.1	0	0	109.9
Clay soils	5.1	42.0	3.4	0	0	0	50.5
Iris: Sandy soils	5.5	55.1	0.4	221.6	0	0	282.6
Clay soils	7.1	55.1	0.3	0	0	0	62.5
Lily: Sandy soils	13.1	42.9	6.6	78.8	0	86.4	227.8
Clay soils	15.9	42.9	6.6	0	0	86.4	151.8

a) Additives to grow lilies.
Source: Poppe et al. (1993) for arable crops; Multi Year Crop Protection Plan for flowers from bulbs and bulb growing.

Table 4.14 Use of pesticides at arable farms in the Netherlands in 1991/92 by province (kilogramme of active ingredients per hectare) a)

Province	Herbi-cides	Fungi-cides	Insecti-cides	Nemati-cides	Other	Total
Groningen	3.0	3.8	0.3	15.4	0.8	23.3
Friesland	4.7	3.7	0.3	3.3	0.9	12.9
Drenthe	2.9	4.8	0.1	37.1	1.8	46.7
Flevoland	3.4	7.9	0.7	9.4	1.2	22.4
Noord-Holland	3.0	4.0	0.4	3.7	0.9	12.0
Zuid-Holland	3.6	5.5	0.6	13.0	1.5	24.1
Zeeland	3.7	4.1	0.3	2.8	1.4	12.2
Noord-Brabant	2.5	4.1	0.3	0.0	1.9	8.9
Netherlands b)	3.3	4.9	0.4	11.5	1.4	21.5

a) Not all provinces are identified due to the small sample size; b) Including all provinces.
Source: Poppe et al. (1994)

Table 4.15 Use of pesticides at arable farms in the Netherlands in 1991/92 by region

Region	North (clay)	Centre (clay)	South-west (clay)	North (sand)	Veen-kolo-niën (peat)	Average	
						total	nema-ticides
Average	12.2	18.6	16.2	34.0	59.6	21.5	11.5
Quintal:							
Highest	29.3	46.2	42.6	63.0	95.6	61.5	50.8
Lowest	4.1	5.0	6.0	9.1	12.8	5.7	0.0

Source: Poppe et al., 1993.

use of pesticides and those with highest application levels might be up to a factor of 3 to 6. The use of pesticides (excluding growth regulators) on 20% of the farms with lowest use was 31 kg and on 20% of the farms with highest use it was 98 kg (Vernooy, 1992). The same report assessed the range at chrysanthemum holdings, which varied between 23 and 71 kg per hectare. The use of pesticides was lowest on the farms using modern spraying equipment. Farmers also indicated that they considered a further reduction to be achievable in case sufficient information was available on the chemicals they apply.

4.12 Portugal

There are no statistics available on the use of pesticides at crop level. The only information available originates from the Associa Nacional da Industrie Para e Proteccao des Plantes (Anipla) and accounts for the share of different crops in total sales of pesticides (in values). Grapes cover about 30% of the market of pesticides, the other crops with a high market share being fruits (12-15%), cereals, rice and maize (all 6-8%), potatoes (8-10%) and vegetables (5-7%).

The use of pesticides is identified to be highest in the regions with fertile soils and intensive production of horticultural crops. This includes the regions around Lisboa (growth of apples, pears, tomatoes and vegetables) and the southern part of the Algarve region. The agricultural sector around Lisboa is more advanced than elsewhere in the country and farmers also use more of the modern pesticides than in the north. The use of pesticides is also high around the coastal area in the north-western and northern part of the country. This is the region to grow grapes for wine. Copper products are mainly used in that part of the country.

4.13 United Kingdom

A number of agricultural holdings was selected using data from the Agricultural Census Returns. Samples were drawn so as to represent the area of the respective sector in the six regions of England and Wales, which are identified by the Ministry of Agriculture, Fisheries and Food (MAFF).

Table 4.16 Use of pesticides in England and Wales for major crop groups by product group (in 1,000 kg of active ingredients) and utilized agricultural area (UAA)

Crop group	Year	UAA (x 1,000 ha)	Fungicides	Herbicides	Insecticides	Other	Total
Arable crops	1990	4,045	5,151	16,262	723	9,323 a)	31,459
Protected crops							
Edible	1991	2	17	1	3	138	158
Ornamental	1991	2	37	1	34	808	881
Soft fruit	1990	12	97	49	16	52	215
Vegetables	1991	140	181	450	172	14	818
Total	-	4,201	5,483	16,764	949	10,335	33,531

a) Including 6,759 tons of sulphuric acid, used as desiccant to grow potatoes and 2,147 tons of chlormequat, mainly used to grow wheat.
Source: Davis et al., 1991; Davis et al., 1992; Thomas et al., 1992; Thomas et al., 1993.

Table 4.17 Use of pesticides in England and Wales for major crops in 1990 (arable crops) and glasshouse crops (1991) (in kilogramme of active ingredients per hectare) and utilized agricultural area (UAA)

Crop	UAA (x 1,000 ha)	Fungicides	Herbicides	Insecticides	Other	Total
Wheat	1,894.8	1.4	2.8	0.1	0.9	5.2
Winter barley	809.8	0.9	2.4	0.1	0.7	4.0
Spring barley	329.2	0.5	1.3	0.1	<0.1	2.0
Oil-seed rape	343.2	0.8	1.4	0.1	0.2	2.4
Potatoes	138.7	7.1	1.4	1.7	48.9	59.1
Sugar beet	194.1	1.3	3.5	0.1	<0.1	4.8
Tomatoes	0.4	8.3	<0.1	3.2	126.3	138.2
Cucumbers	0.2	8.9	-	8.6	12.5	30.0
Lettuce	1.0	9.3	0.4	0.5	2.2	12.3
Chrysanthemums	0.3	7.6	0.7	37.3	106.4	152.1
Roses	<0.1	56.3	3.3	22.0	21.7	103.3

Source: Davis et al., 1992; Thomas et al., 1992.

Table 4.18 Average annual usage of pesticides in England and Wales by region in 1992 (kilogramme of active ingredients per hectare)

Region	Herbi-cides	Fungi-cides	Insec-ticides	Other	Total
Northern	0.6	0.5	0.1	0.4	1.6
Midlands and Western	1.7	0.6	0.2	0.2	2.6
Eastern	3.5	1.3	0.2	0.6	5.6
South-Eastern	1.4	0.8	0.3	0.4	2.9
South-Western	0.6	0.3	0.1	0.1	1.1
Wales	0.1	0.1	<0.1	<0.1	0.2
England and Wales	2.2	0.7	0.1	0.3	3.4

Source: Pesticide Usage Survey Group.

Arable crops cover about 94% of the total use of pesticides in England and Wales, about half of them are herbicides (table 4.16). The total use of pesticides to grow wheat and potatoes is some 18 million kg of active ingredients, which is mainly due to the large area of wheat (1.9 million ha) and the high usage level to grow potatoes (60 kg/ha) (table 4.17).

The use of pesticides ranges from 0.2 (Wales) to 5.6 kg of active ingredients per hectare (Eastern England) (table 4.18). Census area for all crops for June 1992 include cereals, potatoes, all horticultural crops, oilseeds, sugar beet and other crops, bare fallow and all grassland (except for rough grazing and woodland on agricultural holdings). Pesticide usage is taken from surveys on arable crops, grassland and fodder crops, hops, top fruit, soft fruit, outdoor vegetables and glasshouse crops (edible and ornamental).

4.14 Concluding remarks

1. The use of pesticides at crop level (in kilogramme of active ingredients) is monitored periodically in a limited number of countries (the Netherlands and the United Kingdom). Surveys also have been organized in Germany, Spain, France and Italy. Statistics on the use of pesticides at crop level in Denmark focus on the application frequency. Data on the use of pesticides are available at crop level for Germany, Spain, France, the Netherlands and the United Kingdom. Assessments are available for several other countries as well.
2. Estimates on the use of pesticides at crop level are based on different approaches: registration at farm level or sales from industry. Such different approaches may affect the outcome.
3. The use of pesticides to grow cereals does not differ very much across northwestern Europe. The use of pesticides to grow winter

wheat is 5.2 (Germany and the United Kingdom) and 6.9 (the Netherlands) kilogramme per hectare. This also holds for the other arable crops in these three countries, if nematicides are excluded. The use of pesticides in arable crops is high in the Netherlands and the United Kingdom, mainly because of the use of nematicides to grow potatoes and sugar beet. A narrow crop rotation and the subsequent occurrence of soil-borne diseases is an important phenomenon in this respect. The use of nematicides is very limited in several other countries. It is very low in Germany due to regulations to protect water resources. The use of pesticides to grow cereals is rather low in Italy. Estimates on the use of pesticides in Italy originate from industry and are based on sales; estimates in Germany, the Netherlands and England and Wales are based on registration at farm level.

4. Differences among regions and countries are large in their use of pesticides to grow arable crops. They range from 3 kg (Germany) to 22 kg of active ingredients per hectare (the Netherlands). The use of pesticides to grow cereals is lower than the use of pesticides to grow other field crops (e.g. sugar beet and potatoes). The high share of other field crops in the Netherlands is important in this respect. The use of pesticides to grow potatoes may exceed 100 kg per hectare (starch potatoes). This is mainly due to the usage of nematicides (92 kg of active ingredients per hectare).
5. Data are available on the use of pesticides to grow grapes in Germany (around 20 kg), Spain (around 30 kg) and Italy (around 45 kg per hectare). The use of cupric products is high in regions that are vulnerable to fungi and fungicides are therefore used in high quantities in the northern part of Italy (e.g. Veneto and Emilia-Romagna) and Spain (Galicia). These are the regions to grow grapes for wine. The use of cupric products in the region of Castilla-la Mancha - an important region to grow grapes for wine - is rather small because of the dry climate.
6. The use of pesticides to grow vegetables and fruit is high in the regions along the south-east coast of Spain: Murcia, Comunidad Valenciana and Andalucia. It is also high in northern Italy: Valle d'Aosta, Trentino-Alto Adige, Veneto, Liguria and Emilia-Romagna. Horticulture and fruit culture are mainly concentrated in these regions. The use of pesticides in such regions with specialist horticulture is higher than the use to grow vegetables under glass in north-western Europe.
7. The use of pesticides to grow bulbs and flowers from bulbs in the Netherlands is very high. More than 10% of national sales are used to grow these crops whereas they cover only about 2% of the utilized agricultural area (exclusive of grassland). This high usage level is largely due to the use of nematicides to grow bulbs on the sandy soil with a narrow rotation and to a lesser extent to the use of additives to grow lilies.

5. COSTS OF PESTICIDES FOR MAJOR CROPS

5.1 Introduction

The main objective of this chapter is to assess differences in the costs of pesticides for major crops among Member States in order to get an impression of variations in use patterns. The analysis of costs of pesticides in this chapter is based on data of the SPEL/EC model. The Sectoral Production and Income Model for Agriculture (Sektorales Produktions- und Einkommensmodell der Landwirtschaft, SPEL/EC model) was developed in response to the demand for up-to-date information on the trend of agricultural income in the EC. It is aimed to constitute the basis for (i) checking the consistency of the agricultural statistics of Eurostat, (ii) monitoring the present situation in the agricultural sector, (iii) ex-post analyses of sectoral developments and (iv) forecasts and policy simulations of the effects of alternative agricultural policies from short-term and medium-term viewpoints (Eurostat, 1992). The SPEL System was developed at the Institut für Agrarpolitik, Marktforschung und Wirtschaftssoziologie of the University of Bonn by a research group of W. Henrichsmeyer and W. Wolf.

The Base Model of the SPEL/EC System was originally developed during the early 1980s to focus on EUR 9. Several improvements were also made during the past decade. It is likely that present estimates from SPEL on the main crops in the northern Member States are more reliable than those regarding typical Mediterranean crops. In this respect it should be mentioned that a revised version of SPEL is foreseen to become available in the near future and improvements are to be expected in Greece, Spain and Italy.

Data in this chapter refer to the three annual averages of the period 1989, 1990 and 1991. Costs of pesticides are identified at crop level. Two approaches are used in SPEL to assess these costs, depending on the availability of information. First, standard cost margins on the costs of intermediate consumption (including pesticides) are available for all crops in Belgium, Germany, the Netherlands and the United Kingdom. Costs of intermediate consumption are based on FADN in the other countries. Standard cost margins allow for more precise estimates at crop level than the FADN supplies. The reason for it being that FADN provides costs of pesticides at farm level. In the interpretation of the results of SPEL data it should therefore be kept in mind that SPEL data can deviate from observations in other sources. This is especially the case for national total costs of pesticides in Portugal, which are too high, whereas costs of pesti-

cides in the Netherlands according to SPEL data base are too low (see also section 2.1).

Costs of pesticides are an imperfect indicator of the volume of used active ingredients. However, the SPEL database does not provide information on active ingredients. Costs as such are a multiplication of prices and quantities. High costs can for instance be the result of the use of a product with a low dosage of active ingredients but a high price, or of the use of a large volume of a low-priced product. Nevertheless, costs of pesticides related to other key indicators can provide useful information on its role in the agricultural production process, on costs efficiency and on any scope for policy intervention. Besides, an international comparison of costs of pesticides can reveal striking differences and similarities in the production process among countries. In this chapter the costs of pesticides for thirteen (groups of) crops in the EC are examined. These crops are selected as they have a high share in the total costs of pesticides in EC agriculture (table 2.5). In the analysis the focus is on the next indicators:

(a) Agricultural area used for each crop.
This indicator shows the relative importance of a crop in land use.

(b) Yields in ton per hectare.
This indicator provides information on the intensity of production.

(c) Total costs of pesticides.
This indicator gives information on the amount of money involved in the use of pesticides.

(d) Costs of pesticides per hectare.
This indicator shows how much money is spent on pesticides per hectare and gives indirectly an idea of the intensity of production.

(e) Costs of pesticides per ton of product.
This indicator illustrates the amount of money spent on pesticides for each ton of product. This indicator can be considered as a yardstick for cost efficiency. However, such a cost efficiency should be assessed in relation with other costs.

(f) Costs of pesticides as percentage of the total value of output.
This indicator presents the share of the costs of pesticides in the value of output. Comparisons of this indicator among countries give rise to an assessment of the level of costs of pesticides.

(g) Costs of pesticides as percentage of variable costs.
This indicator shows the share of costs of pesticides in the total intermediate consumption.

Unlike the previous chapters this chapter is not organized per Member State, but per crop. The thirteen crops are divided into arable and horticultural crops. A comparison of costs of pesticides for the group of arable crops in the EC Member States is carried out in section 5.2; a comparison of horticultural crops is given in section 5.3. In the last section some concluding remarks on differences and similarities in the costs of

pesticides among arable and horticultural crops in the EC Member States are made.

5.2 Arable crops

Soft wheat

France has the largest area of soft wheat (4.7 million ha), followed by the UK (2 million ha), Spain (1.9 million ha) and Germany (1.7 million ha) (see table 5.1). With regard to the yield per hectare a distinction can be made between high and low yielding countries. In Belgium, Denmark, Germany, France, the Netherlands and the UK the yield of soft wheat per hectare is about 6.5-7.5 tons, while in Greece, Spain and Portugal it is less than 3 tons. Within the group of high yielding countries costs of pesticides per hectare vary from about 70-100 ECU, but costs in the Netherlands (128 ECU) and Belgium (152 ECU) are considerably higher. As a consequence the percentage of costs of pesticides in output in the Netherlands (10%) and in Belgium (13%) lies above the percentage of other high yielding countries. Ireland performs above average with a yield of 8.2 tons per hectare, while costs of pesticides per hectare (14 ECU) are extremely low. In the three low yielding countries costs of pesticides per hectare are also at a lower level. Although differences in yield per hectare between Spain and Greece are small, costs of pesticides per hectare and per ton of product in Greece are over twice as high as in Spain.

Barley

Like in the case of soft wheat, the largest cultivated areas of barley are found in Spain (4.4 million ha), France (1.8 million ha), Germany (1.7 million ha) and the UK (1.5 million ha) (see table 5.2). Yields per hectare in the northern Member States vary in a narrow range between 5 and 6 tons, whereas yields per hectare in the southern Member States (Italy, Greece, Spain and Portugal) are less. Costs of pesticides per hectare in the high yielding countries are about 50-70 ECU per hectare, except for Ireland (11 ECU), France (84 ECU) and Belgium (156 ECU). The relatively low costs in Ireland and the high costs in Belgium also appeared in the production of soft wheat. Costs of pesticides as percentage of output is above the average of about 6% in Belgium (14%) and Luxembourg (12%). In the southern Member States costs of pesticides per hectare and as percentage of output in Spain are low compared with the other countries.

Table 5.1 Costs of pesticides to grow soft wheat (averages of the period 1989-1990-1991)

Country	UAA (1,000 ha)	Yield (ton/ ha)	Costs of pesticides				
			total (million ECU)	per ha (ECU)	per ton product (ECU)	percentage of	
						output	variable costs
Belgium	210.3	6.5	32.0	152.2	23.3	13	18
Denmark	500.6	7.2	33.8	67.6	9.4	6	19
Germany	1,689.7	6.7	150.1	88.8	13.2	8	13
Greece	334.5	2.7	7.8	23.3	8.6	4	12
Spain	1,922.6	2.3	16.0	8.3	3.6	1	4
France	4,708.3	6.6	478.3	101.6	15.3	8	25
Ireland	73.4	8.2	1.0	14.1	1.7	1	6
Italy	1,063.2	4.1	26.3	25.7	6.3	2	11
Luxembourg	8.3	5.4	0.4	45.1	8.3	8	14
Netherlands	134.5	7.6	17.2	128.2	16.9	10	23
Portugal	253.9	1.4	8.8	34.6	24.0	6	26
United Kingdom	2,024.5	7.0	165.3	81.6	11.6	6	26
EUR 12	12,910.8	5.7	944.7	73.2	12.8	7	19

Source: Eurostat/LEI-DLO.

Potatoes

The EC area cultivated with potatoes amounts to merely 1% of the total agricultural area. In most EC Member States the area is even less than 1%, except for the Netherlands (8%), Belgium (4%), Portugal (3%) and Germany (2%). Yields per hectare of potatoes are high in the Netherlands: 41 tons (see table 5.3). In Belgium and Germany yields are about 30 tons per hectare whereas they are only 9 tons in Portugal. Costs of pesticides per hectare are highest in Belgium (278 ECU) and the Netherlands (255 ECU); in Germany and Portugal costs per hectare lie at a considerably lower level of 65-85 ECU. It is remarkable that costs of pesticides per hectare in France and Denmark - countries with more or less the same yield per hectare as in Belgium - amount to only half or less the costs in Belgium. In this sense the differences between Belgium and Germany are even more striking. Costs of pesticides per ton of product amount to 8 ECU in Belgium and 6 ECU in the Netherlands. Expressed as percentage of output, costs in both countries are 6% of output; in Germany and Portugal this percentage is lower.

Table 5.2 Costs of pesticides to grow barley (averages of the period 1989-1990-1991)

Country	UAA (1,000 ha)	Yield (ton/ ha)	Costs of pesticides				
			total (million ECU)	per ha (ECU)	per ton product (ECU)	percentage of output	percentage of variable costs
Belgium	92.4	5.9	14.4	156.4	26.4	14	19
Denmark	950.3	5.3	51.0	53.7	10.2	6	17
Germany	1,690.6	5.6	117.1	69.3	12.4	7	13
Greece	193.9	2.6	8.1	41.5	16.0	6	20
Spain	4,360.8	2.1	24.3	5.6	2.6	1	3
France	1,780.6	5.7	149.9	84.2	14.6	8	22
Ireland	231.2	6.0	2.5	10.7	1.8	1	6
Italy	467.8	3.7	10.1	21.6	5.8	4	9
Luxembourg	15.7	5.0	0.7	45.0	9.1	12	15
Netherlands	44.2	5.4	2.5	55.5	10.3	6	13
Portugal	68.4	1.2	1.8	26.2	22.0	9	23
United Kingdom	1,521.2	5.2	87.8	57.7	11.1	6	23
EUR 12	11,405.5	4.1	467.2	41.0	10.1	6	14

Source: Eurostat/LEI-DLO.

Table 5.3 Costs of pesticides to grow potatoes (averages of the period 1989-1990-1991)

Country	UAA (1,000 ha)	Yield (ton/ ha)	Costs of pesticides				
			total (million ECU)	per ha (ECU)	per ton product (ECU)	percentage of output	percentage of variable costs
Belgium	52.2	33.2	14.5	277.8	8.4	6	13
Denmark	38.9	32.4	4.3	111.6	3.4	4	18
Germany	212.2	28.5	13.8	65.2	2.3	2	3
Greece	50.6	19.3	3.4	68.0	3.5	1	11
Spain	271.3	19.1	21.0	77.5	4.1	2	11
France	164.7	34.5	24.1	146.2	4.2	3	17
Ireland	24.3	25.3	0.6	24.2	1.0	0	10
Italy	111.2	21.0	2.7	24.2	1.2	0	10
Luxembourg	0.8	21.9	0.1	74.8	3.4	2	12
Netherlands	173.3	41.1	44.3	255.4	6.2	6	20
Portugal	122.1	8.8	10.3	84.0	9.5	4	30
United Kingdom	176.2	35.1	30.8	174.5	5.0	4	19
EUR 12	1,396.5	27.3	171.0	122.4	4.5	3	13

Source: Eurostat/LEI-DLO.

Sugar beet

Sugar beet is another arable crop that is cultivated on a small part of the EC agricultural area. However, in Belgium the share of area with sugar beet in total agricultural area amounts to 8%, in the Netherlands to 6%, in Germany to 3% and in Denmark to 2%. The remaining part of the agricultural area with sugar beet is mainly located in France, Italy, the UK and Spain. Yields of sugar beet in Belgium and the Netherlands are more than 60 tons per hectare; in Germany and Denmark over 50 tons per hectare (see table 5.4). Costs of pesticides per hectare are rather high in Belgium (386 ECU), which is twice as much as in Germany and the Netherlands and about four times the costs per hectare in Denmark. Costs of pesticides per ton sugar beet are 6 ECU in Belgium, 3 ECU in Germany and the Netherlands and 2 ECU in Denmark. From the other four major sugar beet producers yields in France are about 60 tons per hectare, in Italy 50 tons and in Spain and the UK 40 tons. Costs of pesticides per hectare amount to about 150 ECU in France and the UK, 90 ECU in Italy and 50 ECU in Spain. Considered the low yield per hectare in the UK, costs of pesticides per hectare are relatively high.

Table 5.4 Costs of pesticides to grow sugar beet (averages of the period 1989-1990-1991)

Country	UAA (1,000 ha)	Yield (ton/ ha)	Costs of pesticides				
			total (million ECU)	per ha (ECU)	per ton product (ECU)	percentage of output	percentage of variable costs
Belgium	105.4	61.5	40.7	386.2	6.3	10	26
Denmark	65.9	51.1	7.0	106.8	2.1	3	18
Germany	392.1	54.3	66.2	168.9	3.1	5	16
Greece	46.1	63.9	0.1	1.5	0.0	0	0
Spain	168.7	42.5	7.8	46.3	1.1	1	7
France	455.0	58.4	63.1	138.6	2.4	5	17
Ireland	32.6	45.8	0.8	23.8	0.5	1	10
Italy	279.0	48.6	24.0	86.0	1.8	3	13
Netherlands	124.0	63.4	24.3	196.0	3.1	6	25
Portugal	1.0	21.6	0.0	1.9	0.1	10	0
United Kingdom	194.7	40.6	34.3	176.3	4.3	7	33
EUR 12	1,862.5	53.0	263.6	141.5	2.7	5	18

Source: Eurostat/LEI-DLO.

Table 5.5 Costs of pesticides to grow rape and turnip rape seed (averages of the period 1989-1990-1991)

Country	UAA (1,000 ha)	Yield (ton/ ha)	Costs of pesticides				
			total (million ECU)	per ha (ECU)	per ton product (ECU)	percentage of output	percentage of variable costs
Belgium	5.4	3.0	0.5	90.3	30.3	8	8
Denmark	260.7	2.8	16.6	63.8	22.5	2	18
Germany	538.8	3.2	68.7	127.5	39.6	11	20
Spain	15.6	1.6	0.2	10.9	6.9	1	4
France	695.0	2.9	55.2	79.5	27.2	8	19
Ireland	10.1	1.8	0.1	6.4	3.5	7	8
Italy	15.6	2.6	0.2	12.6	4.9	1	14
Luxembourg	1.9	2.5	0.0	22.5	8.9	2	6
Netherlands	7.3	3.2	0.7	99.5	31.0	7	15
United Kingdom	385.1	3.1	41.6	107.9	35.2	9	30
EUR 12	1,933.4	3.0	179.8	93.0	31.0	7	20

Source: Eurostat/LEI-DLO.

Rape and turnip rape seed

The agricultural area of rape and turnip rape seed is largely located in France, Germany, the UK and Denmark (see table 5.5). In France and the UK about 2% of the agricultural area is grown with (turnip) rape seed, in Germany 5% and in Denmark 9%. There are hardly any differences in yields per hectare among the four countries: yields fluctuate in a narrow range around 3 tons. On the other hand costs of pesticides per hectare do vary: they are relatively high in Germany (128 ECU) and in UK (108 ECU) and lower in France (80 ECU) and Denmark (64 ECU). Expressed as share of output costs of pesticides vary from 2% in Denmark to 11% in Germany.

Arable crops reconsidered

The cultivation of soft wheat and barley covers about 20% of the EC agricultural area, while the cultivations of potatoes, sugar beet and (turnip) rape seed use each about 1% of the EC agricultural area. The share of soft wheat and barley in total EC costs of pesticides is about one quarter, that of sugar beet about 5% and the shares of potatoes and rape seed each about 3% (see table 2.5). Costs of pesticides per hectare of sugar beet are on average 141 ECU in the EC. These average costs amount to 122 ECU for potatoes, to 93 ECU for rape seed, to 73 ECU for soft wheat and to 41 ECU for barley. On the whole costs per hectare in

the northern Member States exceed those in the southern Member States, which can partly be explained by the higher yields per hectare in the northern Member States. In the group of northern Member States Belgium has a relatively high level of costs per hectare, which is about two times or more the EC average. Costs per hectare in the Netherlands are high for soft wheat, potatoes and sugar beet. In Denmark the smallest amount of costs is spent per hectare. Ireland has a striking low level of costs per hectare, which can be due to the character of SPEL data. In the group of southern Member States costs of pesticides for cereal growing are relatively low in Spain, but costs per hectare for potato production in Spain are about at the same level as in Portugal and Greece. The relatively high costs per hectare in Portugal are probably overestimated by SPEL. Differences among countries in the costs of pesticides per ton product are smaller than differences in costs per hectare. The average costs per ton sugar beet in the EC are 3 ECU, per ton potatoes 5 ECU, per ton cereals about 11 ECU and per ton rape seed about 31 ECU. The average share of costs of pesticides in the value of output varies from 3% for potatoes, 5% for sugar beet and 6-7% for cereals and rape seed. Expressed as percentage of total variable costs, costs of pesticides range from 13% for potatoes to 20% for rape seed.

5.3 Horticultural crops

Tomatoes

Tomato producing countries in the EC can be divided into a group of northern Member States with high yields per hectare and a group of southern Member States with low yields. The first group consists of the Netherlands, Belgium and the UK, with production under glass and yields of successively about 400, 300 and 250 tons per hectare (see table 5.6). France, Italy, Greece, Spain and Portugal, with mainly production in the open air, belong to the second group. Yields of tomatoes in this group vary from 35 to 65 tons per hectare. Costs of pesticides per hectare in the high yielding countries are about 800 ECU in Belgium and 650 ECU in the Netherlands, but in the UK these costs lie at the much lower level of about 300 ECU. In the group of low yielding countries costs per hectare fluctuate between 100 ECU and 200 ECU, except for Spain. Costs of pesticides per hectare in Spain are about the same as in the UK, while yields in the UK are about seven times higher than in Spain. On the whole costs of pesticides per ton of tomatoes in the high yielding countries (between 1 and 3 ECU) are lower than those in the low yielding countries (between 3 and 8 ECU). In all countries the share of costs of pesticides in the value of output amounts only to a few percents. The share of costs of pesticides in variable costs varies from about 5% in Belgium and the Netherlands to 23% in Spain.

Table 5.6 Costs of pesticides to grow tomatoes (averages of the period 1989-1990-1991)

Country	UAA (1,000 ha)	Yield (ton/ ha)	Costs of pesticides				
			total (million ECU)	per ha (ECU)	per ton product (ECU)	percentage of output	percentage of variable costs
Belgium	0.9	288.6	0.7	796.7	2.8	0	4
Greece	40.8	44.4	7.4	180.2	4.1	1	17
Spain	65.7	36.1	19.4	295.9	8.2	1	23
France	12.7	63.5	2.3	181.9	2.9	0	8
Italy	133.2	42.2	28.9	217.3	5.2	3	16
Netherlands	1.6	387.6	1.1	644.5	1.7	0	5
Portugal	21.3	43.5	2.5	119.1	2.7	2	32
United Kingdom	0.6	259.0	0.2	281.2	1.1	0	12
EUR 12	276.7	45.5	60.7	219.5	4.8	1	16

Source: Eurostat/LEI-DLO.

Other vegetables

The group of other vegetables consists of all cabbages except for cauliflowers, leaf and stark vegetables, root and tuber crops, pod vegetables and mushrooms. The heterogeneity of products in this group with different yields, production processes and output values, hampers a comparison among countries. Remarks on differences in yields and costs of pesticides have to be interpreted with this heterogeneity in mind. Yields per hectare vary from 15 tons in Denmark to 46 tons in Germany and the Netherlands (see table 5.7). Yields in Ireland of 93 tons are rather high and can undoubtedly be explained by the composition of vegetables. With regard to the costs of pesticides per hectare three groups of countries can be distinguished. In Belgium (530 ECU), the Netherlands (480 ECU), Germany (355 ECU) and the UK (295 ECU) costs per hectare are relatively high. In Denmark, Spain, France, Italy and Portugal costs of pesticides per hectare fluctuate between 100 ECU and 200 ECU, whereas costs in Ireland and Greece are low (successively 54 and 32 ECU per hectare). Costs of pesticides per ton product also vary considerably. They range from 1 ECU in Greece to 14 ECU in Belgium. However, the share of the costs of pesticides in the value of output of 2% or less shows an uniform pattern among countries.

Table 5.7 Costs of pesticides to grow other vegetables (averages of the period 1989-1990-1991)

Country	UAA (1,000 ha)	Yield (ton/ ha)	Costs of pesticides				
			total (million ECU)	per ha (ECU)	per ton product (ECU)	percentage of output	percentage of variable costs
Belgium	25.5	36.8	13.4	527.7	14.3	2	5
Denmark	15.2	14.9	1.8	118.9	8.0	2	3
Germany	46.4	46.3	16.6	357.0	7.7	2	3
Greece	97.2	22.8	3.1	31.6	1.4	0	6
Spain	418.2	19.7	62.9	150.4	7.6	2	15
France	208.6	26.8	33.5	160.6	6.0	1	10
Ireland	3.3	92.5	0.2	54.4	0.6	0	4
Italy	243.6	36.3	47.3	194.3	5.3	1	23
Netherlands	61.5	46.2	29.4	477.6	10.3	2	5
Portugal	59.3	17.7	8.8	147.8	8.3	2	24
United Kingdom	114.2	24.3	33.5	293.5	12.1	2	18
EUR 12	1,291.7	27.2	248.7	192.5	7.1	1	10

Source: Eurostat/LEI-DLO.

Table 5.8 Costs of pesticides to grow flowers and ornamental plants (averages of the period 1989-1990-1991)

Country	UAA (1,000 ha)	Yield (ton/ ha)	Costs of pesticides				
			total (million ECU)	per ha (ECU)	per ton product (ECU)	percentage of output	percentage of variable costs
Belgium	1.5	152.0	2.7	1,750.8	11.5	1	2
Germany	8.5	121.8	0.3	39.4	0.3	0	0
Greece	0.9	264.2	0.4	461.0	1.7	0	10
Spain	4.9	84.2	0.9	191.9	2.3	0	4
France	6.7	126.9	3.5	527.4	4.2	0	3
Italy	9.2	188.2	4.0	431.2	2.3	0	7
Netherlands	23.2	124.4	25.4	1,090.7	8.8	0	4
United Kingdom	7.7	35.6	8.6	1,118.0	31.4	2	6
EUR 12	62.6	122.3	45.2	721.6	5.9	0	4

Source: Eurostat/LEI-DLO.

Flowers and ornamental plants

The area cultivated with flowers and ornamental plants is very small in the EC (about 62,500 ha), of which more than one third is located in the Netherlands (see table 5.8). As in the case of other vegetables, the group of flowers and ornamental plants is rather heterogeneous. Yields per hectare vary from 100 to 200 tons, except for Greece, Spain and the UK. In Greece yields are considerably above and in Spain and the UK below the average. Costs of pesticides per hectare are rather high in Belgium (1,750 ECU), the UK (1,120 ECU) and the Netherlands (1,090 ECU). These costs fluctuate in a range between 200 and 800 ECU in Greece, Spain, France and Italy, and are low in Germany (39 ECU). Costs of pesticides per ton product in the UK amount to 31 ECU, in Belgium to 12 ECU and in the Netherlands to 9 ECU. In the other Member States costs of pesticides per ton product are 4 ECU or less. The share of costs of pesticides in the value of output is negligible and is even in the UK only 2%.

Grapes

About 3% of the EC agricultural area is used for grape cultivation. These areas are mainly located in Germany, France and the southern Member States. Grapes can be used for the production of table wines and other wines. We analyse both the costs of pesticides for the production of grapes for table wine and those for other wine as in a number of countries costs of pesticides to treat grapes for other wine are considerably higher than those for grapes for table wine. Any differences among these products might have economic reasons since table wine generally is lower priced than other wine. Other wine does generally meet higher quality standards. Yields per hectare within each country are identical for both types of grapes. Yields per hectare in Luxembourg (13 ton) and Germany (12 ton) are more than twice as high as yields in the other countries (see tables 5.9 and 5.10). Costs of pesticides per hectare for grapes for table wine are about 400 ECU in Germany, about 120 ECU in France, Portugal and the UK, 70 ECU in Italy, 30 ECU in Greece and 12 ECU in Spain. Costs of pesticides per hectare for grapes for other wine are about 20-30 ECU above those for table wine, except for Germany and Portugal, where costs for both types of grapes are at the same level. Costs of pesticides per hectare of grapes for other wine in Luxembourg are only 11 ECU. Costs of pesticides per ton grapes for table wine are on average 14 ECU and those for grapes for other wine 23 ECU. On the whole the share of costs of pesticides in the value of output varies from 1-3% for grapes for table wine and from 3-5% for grapes for other wine.

Table 5.9 Costs of pesticides to grow grapes for table wine (averages of the period 1989-1990-1991)

Country	UAA (1,000 ha)	Yield (ton/ ha)	Costs of pesticides				
			total (million ECU)	per ha (ECU)	per ton product (ECU)	percentage of	
						output	variable costs
Germany	3.1	11.9	1.2	400.9	33.6	3	9
Greece	74.9	4.7	2.3	30.8	6.5	1	17
Spain	896.1	2.4	11.2	12.4	5.2	1	11
France	433.0	6.1	54.0	124.7	20.5	1	26
Italy	773.7	6.0	54.2	70.1	11.7	2	32
Portugal	180.0	3.8	22.1	122.9	32.1	9	56
United Kingdom	0.6	3.0	0.1	120.6	40.2	25	25
EUR 12	2,359.0	4.4	143.0	60.6	13.7	1	27

Source: Eurostat/LEI-DLO.

Table 5.10 Costs of pesticides to grow grapes for other wine (averages of the period 1989-1990-1991)

Country	UAA (1,000 ha)	Yield (ton/ ha)	Costs of pesticides				
			total (million ECU)	per ha (ECU)	per ton product (ECU)	percentage of	
						output	variable costs
Germany	98.6	11.9	38.7	392.8	32.9	3	9
Greece	10.1	4.7	0.6	57.8	12.2	3	17
Spain	521.3	2.4	17.7	34.0	14.3	3	16
France	475.9	6.1	75.1	157.9	26.0	5	14
Italy	192.7	6.0	18.4	95.5	16.0	2	34
Luxembourg	1.2	13.1	0.0	10.7	0.8	0	5
Portugal	75.3	3.8	8.9	118.4	30.9	5	65
EUR 12	1,373.7	5.0	158.8	115.6	23.3	4	14

Source: Eurostat/LEI-DLO.

Table 5.11 Costs of pesticides to grow apples, pears and peaches (averages of the period 1989-1990-1991)

Country	UAA (1,000 ha)	Yield (ton/ ha)	Costs of pesticides				
			total (million ECU)	per ha (ECU)	per ton product (ECU)	percentage of output	percentage of variable costs
Belgium	10.7	21.6	6.2	581.4	26.9	4	22
Denmark	3.1	11.5	0.9	282.8	24.6	8	29
Germany	25.8	28.7	17.0	660.0	23.0	4	23
Greece	61.2	14.1	9.8	160.8	11.4	4	33
Spain	145.4	8.3	5.5	37.7	4.5	0	22
France	104.1	18.1	27.8	266.8	14.8	2	21
Ireland	0.7	12.9	0.0	41.6	3.2	0	1
Italy	213.1	15.4	28.9	135.4	8.8	1	43
Netherlands	21.5	19.2	7.0	326.8	17.0	3	21
Portugal	58.7	5.1	98.5	1,677.3	326.7	93	80
United Kingdom	25.3	13.3	9.2	364.1	27.5	4	35
EUR 12	668.9	13.9	214.8	321.1	23.1	4	39

Source: Eurostat/LEI-DLO.

Apples, pears and peaches

The share of area cultivated with apple, pear and peach (including nectarines) trees is about 0.5% of the EC agricultural area. In Belgium, Greece, Italy, the Netherlands and Portugal this share is about 1%. The largest areas are situated in Italy, Spain and France (see table 5.11). Yields per hectare are about 20 ton in Belgium, France and the Netherlands. In the southern Member States yields per hectare are lower: about 15 ton in Greece and Italy and less than 10 ton in Spain and Portugal. Costs of pesticides per hectare vary from about 600 ECU in Belgium to about 40 ECU in Spain. Costs of pesticides per ton product are about 27 ECU in Belgium, 15 ECU in France and the Netherlands, 10 ECU in Greece and Italy and 5 ECU in Spain. The share of costs of pesticides in the value of output ranges from 4% in Belgium to almost nothing in Spain.

Other fruits

The group of other fruits consists of cucumbers, melons, egg plants, apricots, cherries, plums, other stone fruit, nuts, strawberries and other berries. The cultivation of other fruits covers about 2.5% of the EC agricultural area. The cultivation is mainly concentrated in Spain and Italy and to a lesser extent in Portugal, Greece and France (see table 5.12). Comparisons between countries are hampered by the heterogeneous

Table 5.12 Costs of pesticides to grow other fruits (averages of the period 1989-1990-1991)

Country	UAA (1,000 ha)	Yield (ton/ ha)	Costs of pesticides				
			total (million ECU)	per ha (ECU)	per ton product (ECU)	percentage of output	percentage of variable costs
Belgium	2.5	201.6	1.5	620.5	3.1	1	22
Denmark	8.0	14.4	1.5	184.5	12.8	5	28
Germany	30.5	67.7	24.8	813.4	12.0	2	22
Greece	156.1	19.4	9.6	61.8	3.2	2	30
Spain	1,463.9	3.6	49.0	33.5	9.4	4	19
France	123.1	33.7	33.5	272.0	8.1	4	20
Ireland	1.4	20.7	0.1	46.7	2.3	0	1
Italy	1,183.0	7.9	140.0	118.3	14.9	21	38
Netherlands	3.8	200.4	0.9	235.1	1.2	1	21
Portugal	304.1	2.2	83.7	275.1	125.9	117	71
United Kingdom	23.6	31.6	8.4	355.8	11.3	4	35
EUR 12	3,296.6	8.1	344.0	104.4	12.9	7	33

Source: Eurostat/LEI-DLO.

composition of the group other fruits. Yields per hectare are highest in France (34 tons) and lowest in Spain (4 tons) and Portugal (2 tons). Costs of pesticides per hectare amount to about 275 ECU in France and Portugal, 120 ECU in Italy, 60 ECU in Greece and 34 ECU in Spain. Costs of pesticides per ton product vary from 15 ECU in Italy to 3 ECU in Greece. Costs of pesticides are about one fifth of the value of output in Italy. In Spain, France and Greece this share is 4% or less.

Citrus fruits

Citrus fruit production covers less than 0.5% of the EC agricultural area. The largest areas of citrus fruits are located in Spain (263,000 ha), Italy (184,000 ha), Greece (55,000 ha) and Portugal (30,000 ha) (see table 5.13). Yields per hectare vary from 14 to 21 tons, except for Portugal, where yields are only 5 tons per hectare. Costs of pesticides per hectare are relatively high in Spain and France (217 ECU) and low in Greece (66 ECU). Costs of pesticides per ton amount to about 14 ECU in Spain and France, to 6 ECU in Italy and to 3 ECU in Greece. The share of costs of pesticides in the value of output is 5% in Spain and France, 2% in Greece and 1% in Italy.

Table 5.13 Costs of pesticides to grow citrus fruits (averages of the period 1989-1990-1991)

Country	UAA (1,000 ha)	Yield (ton/ ha)	Costs of pesticides				
			total (million ECU)	per ha (ECU)	per ton product (ECU)	percentage of output	percentage of variable costs
Greece	54.5	21.4	3.6	66.3	3.1	2	21
Spain	263.3	17.9	57.0	216.5	12.1	5	26
France	2.3	13.9	0.5	217.1	15.6	5	10
Italy	184.0	17.1	18.3	99.6	5.8	1	10
Portugal	30.3	4.7	3.3	108.3	23.2	7	52
EUR 12	533.8	17.2	83.8	156.9	9.1	3	20

Source: Eurostat/LEI-DLO.

Horticultural crops reconsidered

The horticultural crops discussed above cover almost 10% of the EC agricultural area. The share of these crops in total EC costs of pesticides is about 25%. The average costs of pesticides per hectare vary in a range between 100 and 225 ECU for tomatoes, other vegetables, grapes for other wine, other fruits and citrus fruits. Average costs per hectare for apples, pears and peaches (320 ECU) and for flowers and ornamental plants (720 ECU) are higher and those for grapes for table wine (60 ECU) lower. On the whole costs of pesticides per hectare in the northern Member States are higher than those in the southern Member States, which can largely be explained by the higher yields per hectare in the northern Member States. In the group of the northern Member States costs of pesticides per hectare are highest in Belgium, the Netherlands, the UK and Germany. For most crops in the group of southern Member States costs of pesticides per hectare are highest in Italy and lowest in Spain, while costs in Greece are in between. Average costs of pesticides per ton product are about 5-10 ECU for tomatoes, other vegetables, flowers and ornamental plants and citrus fruits, about 14 ECU for grapes for table wine and other fruits and about 23 ECU for grapes for other wine and apples, pears and peaches. In the southern Member States costs of pesticides per ton product are somewhat lower relative to the northern Member States, except for tomatoes. The average share of costs of pesticides in the value of output is 1% or less for tomatoes, other vegetables, flowers and ornamental plants and grapes for table wine, 3-4% for citrus fruits, grapes for other wine and apples, pears and peaches, and 7% for other fruits. The average share of costs of pesticides in variable costs ranges from 10-20% for tomatoes, other vegetables, grapes for other wine and citrus fruits, from 25-40% for grapes for table wine, apples,

pears and peaches and other fruits, whereas the share for flowers and ornamental plants is only 4%.

5.4 Concluding remarks

1. From an EC perspective the five arable crops in this chapter (soft wheat, barley, potatoes, sugar beet, rape and turnip rape seed) cover about 25% of the EC agricultural area and the eight (groups of) horticultural crops about 10%. The share of these arable crops in EC costs of pesticides is about one third, whereas the share of horticultural crops is about one quarter.
2. Costs of pesticides per hectare for arable crops are on average lower than those for horticultural crops. Costs per hectare for cereal crops and rape and turnip rape seed vary between 40-100 ECU against a range of 100-225 ECU for horticultural crops. However, costs per hectare for some horticultural crops are considerably above (e.g. flowers and ornamental plants) or below (e.g. grapes for table wine) this range.
3. Costs of pesticides per hectare for both arable and horticultural crops in the northern Member States exceed those in the southern Member States, which can largely be explained by the higher yields per hectare in the northern Member States. Costs per hectare in Belgium are rather high for both arable and horticultural crops. The same applies for costs in the Netherlands, but to a lesser extent than in Belgium. Spain has the lowest cost level per hectare for arable and horticultural crops in the group of southern Member States.
4. The efficiency of the expenditures of pesticides is reflected by the costs of pesticides per ton of agricultural product. For arable crops it is in the range between 3 and 11 ECU, except for (turnip) rape seed. Costs per ton of tomatoes, other vegetables, flowers and ornamental plants and citrus fruits lie at the same level, but costs for the other horticultural crops are higher (between 14 and 23 ECU per ton).
5. Although costs of pesticides per ton of arable crop tend to be somewhat below those per ton of horticultural crop (see conclusion 4), the opposite is true for the share of costs of pesticides in the value of output. This is due to the fact that horticultural crops are relatively high valued goods. The share of costs of pesticides in the output value of horticultural crops is 4% or less, except for that of other fruits, which amounts to 7%. For arable crops the share of costs in output value fluctuates between 3-7%.
6. The share of costs of pesticides in variable costs for arable crops, tomatoes, other vegetables, grapes for other wine and citrus fruits varies between 10-20%. This share ranges from 25-40% for the other horticultural crops, except for flowers and ornamental plants. Costs of pesticides for flowers and ornamental plants amount only to 4% of all variable costs.

6. COSTS OF PESTICIDES FOR MAJOR FARMING TYPES

6.1 Introduction

In this chapter we will examine costs of pesticides for major farming types among EC regions. It is intended to provide insight into the variation among farming types in the use of pesticides and to get an idea of the scope for reduction. As already remarked in section 5.1 costs of pesticides are an imperfect indicator of the use of active ingredients. The analysis in this chapter is based on the Farm Accountancy Data Network (FADN) of the Commission of the European Communities. The use of FADN data enables an analysis at regional level instead of the Member State level. The advantage of such a regional analysis is that any differences in the costs of pesticides among regions within the same Member State become clear and that regions with high costs can be compared among Member States. There are two main differences between this chapter and the previous one, in which costs of pesticides are assessed by using SPEL data. Firstly, in this chapter the analysis is carried out at the farm (i.e. micro) level, whereas in the previous chapter the analysis is made at a macro level. Secondly, in this chapter costs of pesticides of a whole farm are considered, whereas in the previous chapter costs of pesticides refer to separate crops.

The farm is the unit in which decisions about the use of pesticides are taken. The application level of pesticides largely depends on farm size (in hectares), cropping plan, intensiveness of the cropping plan, climatological conditions, professional skills of the farmer, regulations on use of pesticides, availability of pesticides and prices of pesticides.

In the next section some remarks on the use of FADN data and the methodology in this chapter are made. In section 6.3 costs of pesticides are analysed for the main farming types and in the final section some conclusions are given.

6.2 The use of FADN

FADN contains farm level data on the structure of the farm (economic size, labour input, agricultural area and livestock population), total output, intermediate consumption, a balance sheet account and a profit and loss account. FADN is based on the annual accounting results of a sample of commercial farms in the EC Member States. Commercial farms refer to farms that are large enough to provide a main activity for the farmer and a level of income sufficient to support the farmer's family

(CEC, 1989: 4). Farms are classified as "commercial" when they exceed a minimum economic size, measured in European Size Units. Because of the different farm structures in the Community, thresholds applied for the economic size of farms vary among Member States. The farms in the sample are rather heterogeneous. FADN stratifies farms according to region, economic size and farming type in order to reflect this heterogeneity adequately. FADN distinguishes 91 regions in the EC. In this study a division of the EC into 87 regions is used. This division is more or less equal to the FADN division and is given in Appendix B of the report.

By using FADN data, the following issues should be considered:

- The FADN data that are available do not refer to individual farm data, but to averages of groups of farms. So distribution figures based on these data are no real distribution figures but give only insight in the distribution between groups of holdings;
- FADN does not provide data on the physical use of pesticides, but only data on the costs of pesticides;
- FADN does not identify costs of pesticides per crop, but only the costs per farm. This implies that differences in cropping plan between farms can have considerable consequences for the costs at farm level.

Like in the previous chapter costs of pesticides are related to economic and structural farm characteristics in order to assess their role in the agricultural production process, costs efficiency and any scope for policy intervention. In the analysis the focus is on the next indicators:

(a) Costs of pesticides per farm (ECU).
This indicator gives information on the amount of money involved in the use of pesticides.

(b) Costs of pesticides per hectare of utilized agricultural area (ECU per hectare).
This indicator shows how much money is spent on pesticides per hectare and gives indirectly an idea of the intensiveness of production.

(c) Costs of pesticides per 100 ECU of output.
This indicator presents the share of the costs of pesticides in the value of output. Comparisons of this indicator among farms and regions give rise to an assessment of the level of costs of pesticides.

(d) Costs of pesticides per 100 ECU of Farm Net Value Added (FNVA).
This indicator provides information on the share of costs of pesticides relative to FNVA.

(e) Costs of pesticides per 100 ECU of Family Farm Income (FFI).
This indicator illustrates the share of costs of pesticides relative to FFI.

(f) Costs of pesticides per 100 ECU of input.
This indicator shows the share of costs of pesticides in total costs (i.e. intermediate consumption, depreciation and external factors).

Indicators mentioned under item (e) and (f) may provide some insight in the scope to achieve a reduction of pesticide use through economic instruments. When the costs of pesticides per 100 ECU of input are high, the incentive to achieve savings (i.e. to reduce costs) in relation to risks will likely be stronger than in the case costs are low.

Besides the indicators mentioned above, the following general characteristics are also given:

(g) Number of represented farms.
This reflects the relative importance of the region for a farming type.

(h) Economic farm size (ESU).
The economic size of the farm is based on the utilized agricultural area as well as on the intensiveness of the cropping plan and the livestock population of a holding. One European Size Unit (ESU) equals 1,200 ECU of standard gross margins.

(i) Utilized agricultural area per farm (hectare).

(j) Cropping plan (area of different crops in percentage of agricultural area per farm).
This indicator gives insight in the share of crops with high or low usage of pesticides.

(k) Output of crop products per hectare of crop (ECU per hectare) (exclusive of forage crops).
This indicator provides information on the intensiveness of production.

In the previous chapter it appeared that costs of pesticides per hectare tend to be higher when intensiveness of production increases and that costs of pesticides per hectare differ among crops. These findings give rise to the hypothesis that costs of pesticides per hectare can be explained by (i) intensiveness of production and by (ii) specific crops. Moreover, climatological conditions and scale effects may influence the level of costs. This hypothesis is tested here at the farm level by using regression analysis (ordinary least squares). As a variable for intensiveness of production, economic size per hectare is used and as a variable for specific crops the share of each crop in the farm cropping plan is used. A dummy variable is introduced to reflect differences of climatological conditions (humid/dry). Also, scale effects are represented by the variable farm size in hectares.

The use of pesticides also shows a wide variation among comparable farms (chapter 4). Farm management practices are considered to be important in this respect. It is not possible to examine such phenomena because the available information is limited to averages of groups of farms. Such an examination would require a detailed analysis at individual farm level.

The analysis in this chapter covers only farming types with a large share of arable and horticultural crops in their cropping plan. These farming types are specialist cereals, general field cropping, specialist

horticulture, specialist vineyards and specialist fruit and citrus fruit. A further limitation in the analysis is that only EC regions are taken into account with a cultivated area above a certain threshold. Applied thresholds per farming type are given in table 6.1.

Table 6.1 Thresholds for the selection of EC regions per farming type

Farming type	Threshold	
specialist cereals	>= 100,000	ha cereals
general field cropping	>= 200,000	ha field crops
specialist horticulture	>= 5,000	ha market gardening and flowers
specialist vineyards	>= 20,000	ha vineyard
specialist fruit and citrus fruit	>= 15,000	ha fruit and citrus fruit

The most recent year for which FADN data are available is the accounting year 1990/91. In order to reduce annual fluctuations, a three years average of the accounting years 1988/89-1990/91 is used.

6.3 Analysis: costs of pesticides for farming types

6.3.1 An average FADN farm

Figure 6.1 gives an overall picture of the costs of pesticides per hectare of utilized agricultural area (UAA) for the average farm (all types) in a region. A comparison of the realized crop output per hectare in the EC regions (see figure 6.2) and the costs of pesticides per hectare shows that regions with high costs per hectare usually also generate high outputs. The intensity of agriculture is related to the use of pesticides. This is due to the fact that intensive cropping techniques may increase the occurrence of pests and diseases. Farmers might avert such risks by a relatively high usage of pesticides. The costs of pesticides per 100 ECU of output to grow crops is lowest in the Mediterranean regions with extensive agriculture as well as in the Netherlands (figure 6.3). This phenomenon meets the hypothesis examined by De Wit (1992) that the efficiency of using resources in agriculture may be high in high yielding regions as well as in low yielding regions.

The regions with highest costs of pesticides per hectare are Hamburg, Bremen and Berlin (648 ECU), Liguria (213 ECU), Trentino-Alto Adige (200 ECU), Murcia (245 ECU) and the Canarias (1,489 ECU; see table 6.2). These regions also have an intensive crop production. On the Spanish Plateau and in Wales, regions with a very extensive production system, costs of pesticides per hectare are rather low (less than 10 ECU).

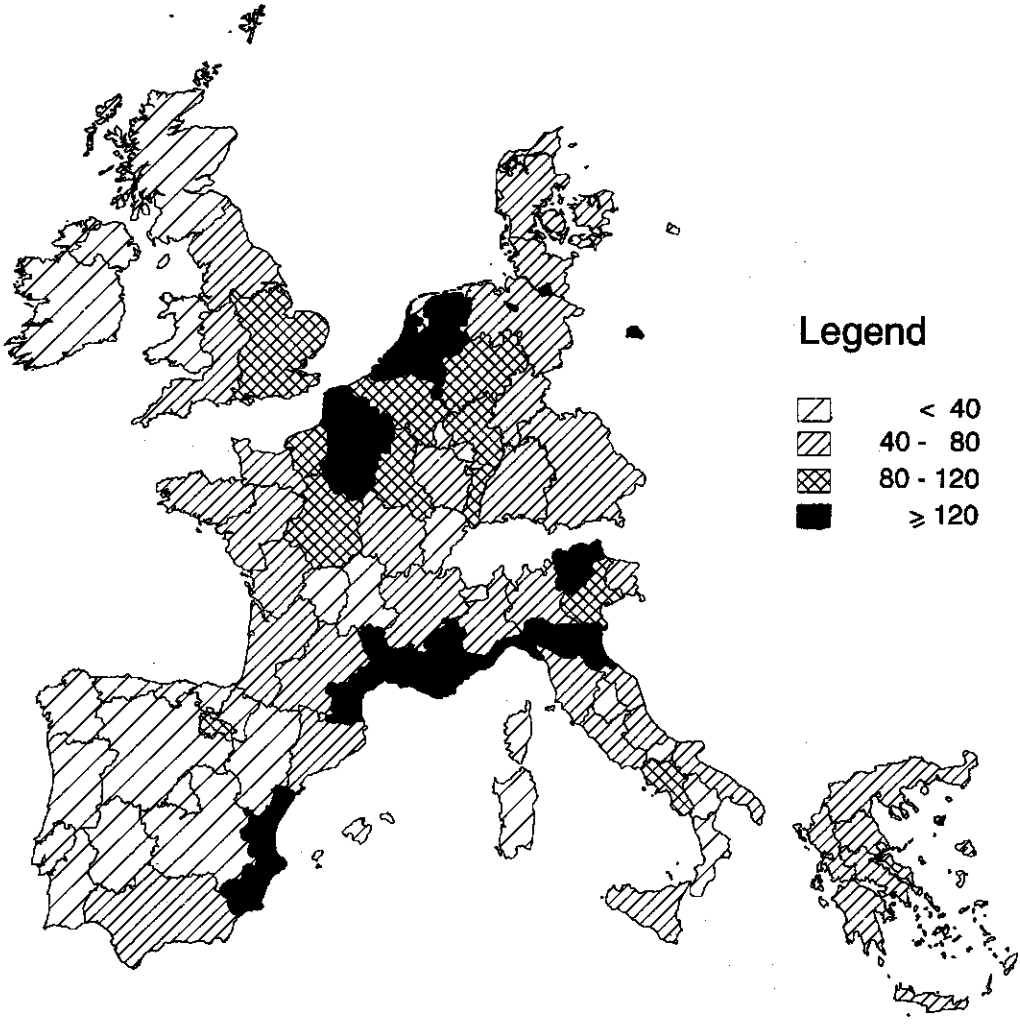

Figure 6.1 Costs of pesticides per hectare of utilized agricultural area (in ECU)

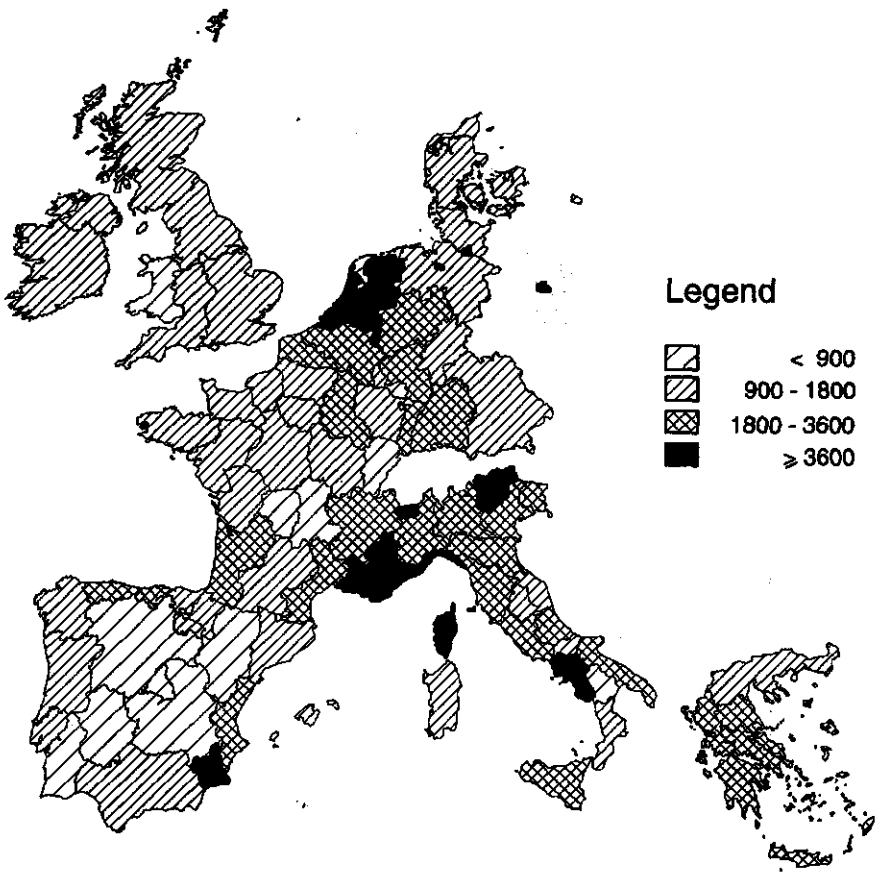

Figure 6.2 Output of crop production (excluding forage crops) per hectare of utilized agricultural area, excluding forage crops (in ECU)

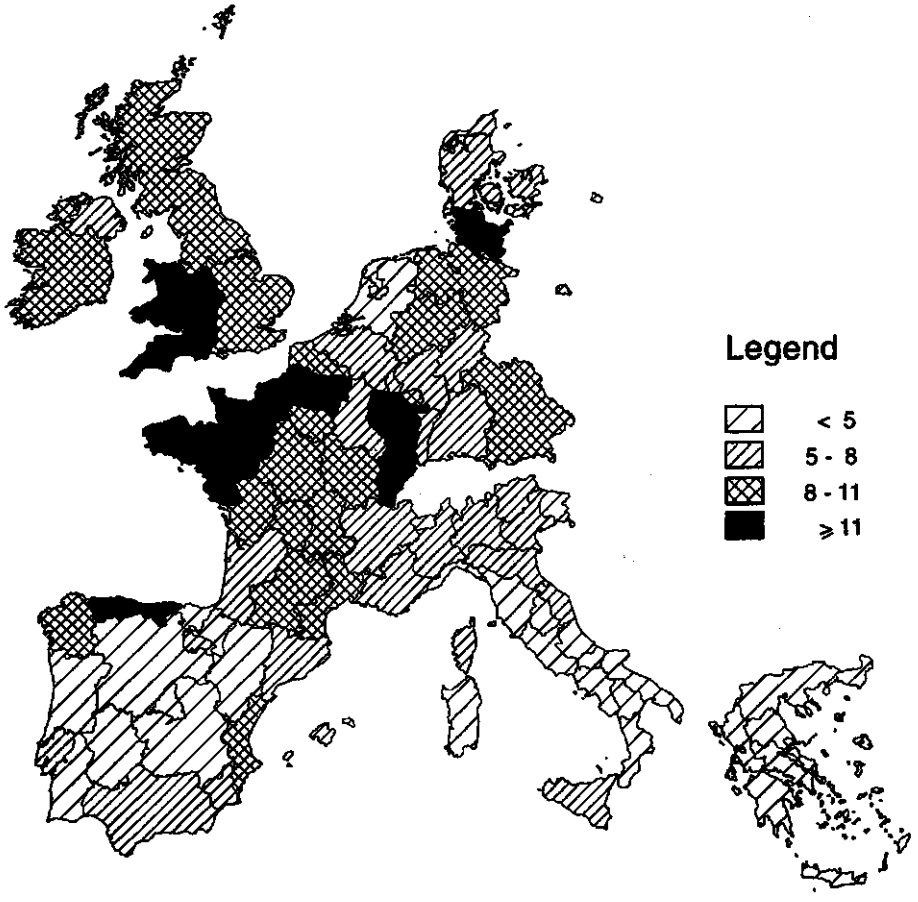

Figure 6.3 Share of costs of pesticides in output to grow crops (excluding forage crops) (in %)

Table 6.2 Regions with a high level of costs of pesticides per hectare (average costs of 1988/89-1990/91 in ECU)

Region	Costs
Hamburg, Bremen, Berlin	648
Ile de France	131
Picardie	138
Nord-Pas-de-Calais	120
Languedoc-Roussillon	121
Prov.-Alpes-Côte d'Azur	163
Trentino-Alto Adige	200
Liguria	213
Emilia-Romagna	126
Netherlands	122
Comunidad Valenciana	173
Murcia	245
Canarias	1,489

Source: FADN/LEI-DLO.

In most regions with high costs of pesticides per hectare the main farming types are specialist horticulture, specialist fruit and citrus fruit and specialist vineyards. Apart from these farming types, specialist cereals are major crops in England East and general field cropping is important in the Netherlands and Belgium. In the northern French regions the high use of pesticides per hectare is concentrated on specialist cereals and general field cropping.

Most of the regions with high costs of pesticides achieve high levels of output. For example, regions with costs of pesticides that exceed 120 ECU per hectare of utilized agricultural area achieve average output levels over 3,600 ECU per hectare of UAA (exclusive of forage crops). Contrary to this, output of agriculture is lowest (i.e. less than 900 ECU per hectare) in regions with costs of pesticides below 40 ECU per hectare (table 6.3).

Table 6.3 Costs of pesticides per hectare of utilized agricultural area (in ECU) by output of crop production (excluding forage crops) per hectare (in ECU)

Output	Costs of pesticides			
	< 40	40 - 80	80 - 120	>= 120
>=3600	Corse Valle d'Aosta Acores-Madeira		Campania	Hamburg, Bremen, Berlin Prov.-Alpes-Côte d'Azur Trentino-Alto Adige Liguria Netherlands Murcia Canarias
1800-3600	Asturias Cantabria	Baden-Wuerttemberg Aquitaine Rhône-Alpes Piemonte Lombardia Friuli-Venezia Giulia Toscana Lazio Abruzzi Puglia Sicilia Ipiros Pelop.N.Ioniou Thessalia St.Ellas N.Egae. Kriti	Nordrhein-Westfalen Rheinland-Pfalz Champagne-Ardenne Alsace Veneto Belgium	Nord-Pas-de-Calais Languedoc-Roussillon Emilia-Romagna Comunidad Valenciana
900-1800	Umbria Molise Calabria Sardegna Luxembourg Ireland Scotland Northern Ireland Galicia Pais Vasco Navarra Baleares Norte-Centro Lisboa-Vale do Tejo	Schleswig-Holstein Niedersachsen Hessen Bayern Basse-Normandie Bourgogne Lorraine Pays de la Loire Bretagne Poitou-Charentes Midi-Pyrénées Marche Denmark England North England West Makedonia Thraki Cataluna Andalucia	Haute-Normandie Centre (F) England East Rioja	Ile de France Picardie
<900	Saarland Franche-Comté Limousin Auvergne Basilicata Wales Aragon Castilla-Leon Madrid Castilla-La Mancha Extremadura Alentejo-Algarve			

Source: FADN/LEI-DLO.

6.3.2 Specialist cereals

The costs of pesticides on the large cereal farms in England and northern France are around 10,000 ECU per farm, while they are less than 500 ECU in some Spanish and Italian regions and Greece (table 6.4). Measuring in costs per hectare, differences between regions are still very large: between less than 20 ECU/ha in most Spanish regions and over 100 ECU/ha in northern France, Piemonte and England East. The costs in the southern French regions, Lombardia, Denmark and the other regions in the United Kingdom range from 50 to 100 ECU/ha.

The cropping plan of specialist cereals varies largely among regions. Common wheat and oil-seeds tend to have higher costs of pesticides per hectare than barley (section 5.2). In the French and UK regions with high costs of pesticides, the cropping plan consists for about 40-50% of common wheat. Besides, oil-seeds is an important crop in these regions (table 6.5). On the other hand, in the Spanish regions with a low costs level, the share of barley in the cropping plan is rather large (about 40-50%) and agricultural production is rather extensive. Another factor that could affect the costs of pesticides per hectare is the farm size (hectare UAA). On larger farms labour could be substituted by a higher use of pesticides.

Cereal farms include rather homogeneous farms since at least two thirds of the economic activities relate to growing cereals. Differences among regions may exist regarding the intensity of farming practice. Linkages between the costs of pesticides and the economic size of a farm therefore are examined. The hypothesis that costs of pesticides per hectare depend on economic size per hectare UAA (ESU/ha), share of oil-seeds and share of barley in cropping plan (% of UAA) and farm size (in hectare) is tested by a regression analysis. An ordinary least squares regression provides the following equation (t-statistics between brackets) 1):

PCH = -27.97 + 104.49 * ESH + 3.26 * SO -0.25 * SB + 0.30 * FS
(3.47) (10.34) (5.35) (2.01) (3.22)

R^2(adj) = 0.91
Cases: 25 F = 62.8
in which:

PCH = costs of pesticides per hectare UAA (ECU/ha)
ESH = economic size per hectare UAA (ESU/ha)
SO = share of oil-seeds in cropping plan (% of UAA)

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1) The so-called corrected multiple coefficient, R^2 (adj), has been used for the following reason. The multiple coefficient R^2 can never decrease if independent variables are added. R^2 (adj) may diminish if variables are added that contribute only a small increment to the total explained variance.

Table 6.4 General characteristics of specialist cereals in 1988/89-1990/91

	Number of repre-sented farms	Eco-nomic farm size (ESU)	UAA (ha)	Costs of pesticides (ECU)					
				per farm	per ha UAA	per 100 ECU of output	FNVA	FFI	input
Denmark	12,319	16	25.8	1,560	60	5	27	-35 a)	5
Greece									
Makedonia Thraki	21,171	7	13.8	383	28	3	5	6	4
Spain									
Navarra	5,108	11	42.9	391	9	2	5	7	3
Aragon	13,064	8	59.2	597	10	3	8	9	4
Cataluna	12,188	14	22.8	688	30	4	12	16	5
Castilla-Leon	41,021	13	50.6	403	8	2	7	11	2
Castilla-La Mancha	13,016	9	80.4	250	3	1	2	3	1
Extremadura	6,836	8	30.0	443	15	3	7	9	4
Andalucia	9,605	9	32.0	497	16	3	7	11	4
France									
Ile de France	2,930	63	86.9	10,556	121	10	29	49	13
Champagne-Ardenne	2,057	42	72.8	8,210	113	11	35	52	15
Centre (F)	11,239	50	78.3	9,719	124	10	32	52	14
Bourgogne	2,054	38	76.3	9,216	121	11	35	52	16
Aquitaine	5,460	26	34.0	2,506	74	4	14	19	5
Midi-Pyrenéés	2,618	34	58.7	3,926	67	6	23	42	7
Italy									
Piemonte	12,121	17	16.7	1,738	104	6	15	21	8
Lombardia	8,919	21	17.4	1,371	79	3	8	9	6
Puglia	11,643	10	21.0	462	22	3	8	10	4
Basilicata	9,096	10	22.8	278	12	2	5	6	3
Sicilia	15,729	5	11.8	292	25	3	6	7	5
Portugal									
Alentejo-Algarve	3,551	18	96.8	1,779	18	5	17	23	6
United Kingdom									
England North	2,659	86	117.2	9,767	83	8	23	65	9
England East	7,644	99	130.1	14,332	110	10	31	95	11
England West	2,542	83	136.2	12,331	91	10	32	190	10
Scotland	2,091	71	111.8	5615	50	5	16	45	6

a) Family farm income is negative.
Source: FADN/LEI-DLO.

Table 6.5 Cropping plan of specialist cereals in 1988/89-1990/91 (% of UAA)

	Cereals			Other field crops				Forage crops
	total	common wheat	barley	total	pota-toes	sugar beet	oil-seed	
Denmark	81	21	54	14	0	1	9	5
Greece								
Makedonia Thraki	92	27	8	3	0	1	1	4
Spain								
Navarra	58	11	39	2			1	39
Aragon	64	8	43	1	0	0	1	33
Cataluna	86	18	58	3	0		2	8
Castilla-Leon	81	18	59	4	0	1	2	15
Castilla-La Mancha	66	13	45	9	0		8	19
Extremadura	73	22	15	6	0	0	5	19
Andalucia	78	24	29	3			2	16
France								
Ile de France	77	46	13	21		1	12	2
Champagne-Ardenne	70	35	25	20	0	16	11	
Centre (F)	75	41	9	21	0	0	16	4
Bourgogne	71	43	18	24			21	5
Aquitaine	86	4	1	5			4	9
Midi-Pyrenéés	80	19	6	15	0		14	5
Italy								
Piemonte	91	13	3	2	0	0	1	7
Lombardia	94	5	5	2		0	1	4
Puglia	82	0	15	1		0	0	14
Basilicata	81	1	6	0		0		16
Sicilia	76			1	0			23
Portugal								
Alentejo-Algarve	49	21	8	5			5	44
United Kingdom								
England North	69	36	30	11	0	1	7	20
England East	74	52	22	14	0	1	6	11
England West	70	36	31	6	0		2	24
Scotland	63	14	45	4	0		3	30

Source: FADN/LEI-DLO.

SB = share of barley in cropping plan (% of UAA)
FS = farm size (hectare UAA)

and:

Weighted by the number of represented farms in each of the 25 regions.

The coefficient of determination in the equation is quite high (R^2(adj)= 0.91). Costs of pesticides per hectare increase with rising economic size per hectare, share of oil-seeds in the cropping plan and farm size. Costs decrease with an increasing share of barley in the cropping plan.

Quite large differences exist in the proportion of costs of pesticides and the economic performance of specialist cereals. The costs of pesticides in Denmark, most French regions and the United Kingdom are more than half of the family farm income (FFI). Changes in the costs of pesticides through e.g. levy measures may have large consequences for the incomes in those regions. In most southern EC regions costs of pesticides are less than 20% of FFI. Costs of pesticides are more than 10% of total input in most regions of France as well as in England East and West. The incentive to reduce the costs of pesticides is likely to be higher at such farms than at farms with smaller shares in total input.

6.3.3 General field cropping

The costs of pesticides on the large general cropping farms in northern France and the United Kingdom are above 10,000 ECU per farm, while they are less than 500 ECU in Castilla-La Mancha and Makedonia Thraki (see table 6.6). Costs of pesticides per hectare of UAA are highest in the Netherlands (224 ECU). In Belgium and some regions in Germany and France the costs are about 150 ECU/ha, whereas in Spain and Greece costs are less than 60 ECU/ha.

Root crops like potatoes and sugar beet require a higher use of pesticides than e.g. barley. Common wheat and oil-seeds are in between (see section 5.3). The reason for the high costs of pesticides per hectare in the Netherlands is the very large share of potatoes (28%) and sugar beet (19%) in the cropping plan. Another 20% is taken by common wheat (see table 6.7). In Belgium and in the French and German regions with a high cost level the share of common wheat and sugar beet in the cropping plan is rather high. The regions with lower costs per hectare generally have larger shares of barley, oil-seeds or forage crops in their cropping plan.

General field cropping includes a very heterogeneous group of farms. This group of farms includes a wide variety of cropping patterns. The hypothesis that costs of pesticides per hectare depend on the share of sugar beet and barley in the cropping plan and on the farm size is tested by a regression analysis, which leads to the predicted equation (t-statistics between brackets):

Table 6.6 General characteristics of general field cropping in 1988/89-1990/91

	Number of represented farms	Economic farm size (ESU)	UAA (ha)	Costs of pesticides (ECU)					
				per farm	per ha UAA	per 100 ECU of output	FNVA	FFI	input
Belgium	6,059	50	42.6	6,859	161	7	15	19	11
Denmark	21,806	30	39.6	2,944	74	5	16	-483 a)	5
Germany									
Niedersachsen	10,433	44	53.5	8,624	161	8	26	45	10
Nordrhein-Westfalen	5,978	37	42.6	6,163	145	7	23	42	8
Bayern	12,416	28	31.3	3,613	115	5	20	34	6
Greece									
Makedonia Thraki	89,021	7	6.5	390	60	3	5	6	7
Spain									
Castilla-Leon	25,934	15	34.2	891	26	3	8	13	4
Castilla-La Mancha	11,912	9	71.9	213	3	1	1	3	1
Andalucia	24,417	13	32.0	1,525	48	5	11	25	6
France									
Ile de France	2,357	71	89.1	12,280	138	10	25	37	14
Champagne-Ardenne	8,077	63	89.8	12,185	136	9	23	30	14
Picardie	7,492	67	79.5	12,791	161	10	30	54	13
Centre (F)	9,138	59	84.0	9,670	115	10	31	58	13
Bourgogne	4,052	51	97.1	10,994	113	10	29	44	13
Nord-Pas-de-Calais	8,405	41	42.3	6,647	157	7	20	32	10
Poitou-Charentes	7,484	34	57.2	5,535	97	9	30	49	12
Midi-Pyrénées	11,547	31	47.3	3,865	82	8	28	46	9
Italy									
Emilia-Romagna	33,080	18	11.4	1,547	136	5	9	10	10
Puglia	23,869	18	12.6	975	77	4	7	10	6
Netherlands	13,473	68	41.9	9,374	224	8	18	31	10
United Kingdom									
England North	3,613	113	116.0	12,206	105	7	19	44	8
England East	9,926	169	175.5	21,336	122	8	23	72	9
England West	2,396	109	133.6	13,818	103	8	24	108	9
Scotland	2,550	128	159.8	12,370	77	6	17	44	7

a) Family farm income is negative.
Source: FADN/LEI-DLO.

Table 6.7 Cropping plan of general field cropping in 1988/89-1990/91 (% of UAA)

	Cereals			Other field crops				Forage crops
	total	common wheat	barley	total	pota-toes	sugar beet	oil-seed	
Belgium	50	35	14	37	5	23	2	11
Denmark	58	19	36	34	3	6	12	7
Germany								
Niedersachsen	59	35	17	33	6	19	5	8
Nordrhein-Westfalen	64	34	23	30	1	17	8	6
Bayern	59	30	22	31	5	11	11	9
Greece								
Makedonia Thraki	66	27	7	27	2	5	5	6
Spain								
Castilla-Leon	55	14	38	25	2	12	7	19
Castilla-La Mancha	43	8	26	31	1	0	24	16
Andalucia	24	4	14	53	2	6	30	20
France								
Ile de France	62	42	11	36	0	10	11	2
Champagne-Ardenne	52	33	14	34	1	8	11	14
Picardie	58	40	15	35	5	14	5	7
Centre (F)	56	33	7	31	0	1	21	13
Bourgogne	55	37	12	32	0	2	25	13
Nord-Pas-de-Calais	53	36	16	36	7	12	4	11
Poitou-Charentes	52	28	9	34	0	29	13	
Midi-Pyrénées	51	20	8	36	0	29	12	
Italy								
Emilia-Romagna	41	22	3	36	2	14	4	20
Puglia	52	0	5	30	3	9	3	9
Netherlands	28	20	6	64	28	19	0	4
United Kingdom								
England North	59	33	24	25	4	5	7	15
England East	56	37	18	30	3	9	7	12
England West	49	29	18	21	3	6	5	27
Scotland	51	18	30	16	6		8	28

Source: FADN/LEI-DLO.

PCH = 48.34 + 0.57 * FS + 6.35 * SS -2.22 * SB
(3.80) (3.63) (6.36) (4.09)
R^2(adj) = 0.71
Cases: 24 F = 19.7
in which:

PCH = costs of pesticides per hectare UAA (ECU/ha)
FS = farm size (hectare UAA)
SS = share sugar beet in cropping plan (% of UAA)
SB = share barley in cropping plan (% of UAA)

and:

Weighted by the number of represented farms in each of the 24 regions.

The coefficient of determination is relatively good given the heterogeneous group of farms (R^2(adj) = 0.71). The costs of pesticides per hectare UAA increase with rising shares of sugar beet in cropping plan and with increasing size of farms. An increasing share of barley in the cropping plan results in lower costs of pesticides.

In Denmark, England East and England West costs of pesticides per hectare UAA are close to or even higher than family farm income (FFI), while they are in a range between 30 and 60% in Germany, France, the Netherlands and the other UK regions. In Belgium, Italy, Greece and most Spanish regions costs of pesticides are less than 20% of FFI (see table 6.6). Costs of pesticides related to farm net value added (FNVA) vary between 15 and 30% in the northern EC Member States and are less than 10% in the southern Member States.

6.3.4 Specialist horticulture

The costs of pesticides per horticultural holding range from less than 2,000 ECU in Liguria, Belgium and Murcia to more than 7,000 ECU in Andalucia. Costs of pesticides per hectare fluctuate in a range of less than 300 ECU in some regions of the United Kingdom and in Pays de la Loire to more than 2,500 ECU in Andalucia and Canarias (table 6.8). The costs of pesticides per hectare are also high in the Netherlands (1,150 ECU).

The share of market gardening and flowers in the cropping plan of specialist horticulture ranges from 35 to 95% (table 6.9). The product group market gardening and flowers consists of a large number of heterogeneous products, produced according to different production processes: crops grown in the open or under shelter, irrigated or non-irrigated areas, vegetables or flowers. The share of protected crops in the product group market gardening and flowers largely varies among regions. In Denmark, the UK and some Spanish regions this share is less than 10%, while it is more than 20% in the Netherlands, Liguria and Canarias. In the Spanish region Andalucia the share of protected crops in market gardening and flowers is even 90%. The cultivation of protected

Table 6.8 General characteristics of specialist horticulture in 1988/89-1990/91

	Number of repre-sented farms	Eco-nomic farm size (ESU)	UAA (ha)	Costs of pesticides (ECU)					
				per farm	per ha UAA	per 100 ECU of output	FNVA	FFI	input
Belgium	5,565	47	2.4	1,876	781	2	4	5	3
Denmark	1,856	72	5.7	2,465	429	1	3	39	1
Spain									
Cataluna	7,379	8	4.8	2,646	550	6	15	52	7
Comunidad Valenciana	5,344	4	5.8	2,199	382	7	13	17	14
Murcia	3,321	6	6.3	1,947	307	7	12	15	12
Andalucia	14,957	7	2.8	7,302	2,641	11	22	35	17
Canarias	3,058	4	1.8	4,674	2,540	9	20	47	12
France									
Pays de la Loire	1,444	78	10.0	2,186	218	2	5	10	3
Prov.-Alpes-Côte d'Azur	5,175	68	4.8	3,041	636	3	7	15	4
Italy									
Liguria	9,165	42	1.2	987	853	2	4	4	5
Netherlands	15,248	117	3.9	4,501	1,149	2	4	9	2
United Kingdom									
England North	1,221	67	10.1	2,836	281	2	4	8	2
England East	2,731	115	8.5	5,100	603	2	4	10	2
England West	1,073	127	13.4	3,984	296	3	8	65	3

Source: FADN/LEI-DLO.

crops is expected to be much more intensive than crops grown in the open. On the other hand, it is supposed that specialist horticultural farms with a large farm size (hectare UAA) are less intensive and are characterized by lower costs of pesticides per hectare.

The hypothesis that costs of pesticides per hectare depend on the share of protected crops in the product group market gardening and flowers and on farm size (hectare UAA) is tested by a regression analysis, which leads to the equation (t-statistics between brackets):

$$PCH = 512.44 + 25.13 * SPM - 30.97 * FS$$
$$\quad\quad (2.04) \quad\quad (7.79) \quad\quad\quad (0.74)$$
$$R^2(adj) = 0.87$$
$$Cases: \quad 14 \quad\quad F = 42.9$$

Table 6.9 Cropping plan of specialist horticulture in 1988/89-1990/91 (% of UAA)

	Market gardening + flowers		Fruit and citrus fruit	Vineyards	Olive groves	Forage crops	Cereals	Other field crops
	total	shelter a)						
Belgium	63	19	0			8	25	4
Denmark	51	9	1			5	35	8
Spain								
Cataluna	76	8	1	2	7	11	3	0
Comunidad Valenciana	95		2			3		0
Murcia	65	5				34	0	1
Andalucia	69	90				10		20
Canarias	92	37	4					3
France								
Pays de la Loire	35	12	2	2		25	22	15
Prov.-Alpes-Côte d'Azur	55	20	10	7		10	9	9
Italy								
Liguria	58	28	6	5	11	15	1	4
Netherlands	70	23				12	1	2
United Kingdom								
England North	52	6				12	30	3
England East	78	9	0			4	9	8
England West	73	5	2			19	0	2

a) 1988/89-1989/90; in % of total market gardening and flowers.
Source: FADN/LEI-DLO.

in which:

PCH = costs of pesticides per hectare UAA (ECU/ha)
SPM = share protected crops in area market gardening+flowers (%)
FS = farm size (hectare UAA)

and:

Weighted by the number of represented farms in each of the 14 regions.

The coefficient of determination in the equation is high (R^2(adj)= 0.87). Costs of pesticides per hectare increase with a rising share of pro-

tected crops in the cropping plan. The significance of the coefficient of farm size is rather low.

The economic performance of specialist horticulture shows large differences among regions. The level of costs of pesticides per 100 ECU of family farm income (FFI) is in the range between 35 and 65 ECU in Denmark, England West and some Spanish regions, while it is around 5 ECU in Belgium and Liguria. Costs of pesticides related to farm net value added (FNVA) are less than 10% in all regions, except for Spain, where the share of costs ranges from 12 to 22%.

6.3.5 Specialist vineyards

The costs of pesticides per vineyard holding range from some 300 ECU in Greece to more than 5,000 ECU in some French regions. Costs of pesticides per hectare in Greek, Spanish and Portuguese regions are rather low: 70 ECU or less (table 6.10). In the other regions costs of pesticides per hectare vary between about 150 and 250 ECU, except for Bourgogne (320 ECU) and Champagne-Ardenne (700 ECU). As a consequence of the dry climate, mildew occurs less in vineyards in Greece, Spain and Portugal relative to the other wine growing countries, which are situated in the central parts of the Community. In these parts the climate is more humid and pesticide use consists to a considerable extent of fungicides against mildew.

The share of vineyards in the cropping plan of specialist vineyards varies from 45% in Poitou-Charentes to 93% in Comunidad Valenciana (see table 6.11). Other crops are mainly cereals, forage crops and other field crops in Germany, France and most Italian regions, whereas olives is the most important second crop in Greece and Portugal. The intensiveness of the cropping plan on specialist vineyards is quite divergent (different use of vineyards and more or less olive groves, field crops or forage crops). The economic size per hectare has a range of less than 1 ESU in the Spanish and Portuguese regions to 15 ESU in Champagne-Ardenne.

It is supposed that costs of pesticides per hectare on specialist vineyards depend on economic size per hectare, farm size and climatological conditions. In dry areas it is expected that less fungicides against mildew are used than in more humid areas. Climatological conditions are reflected by a dummy variable (table 6.11). This hypothesis is tested by regression analysis, which leads to the following equation (t-statistics between brackets):

Table 6.10 General characteristics of specialist vineyards in 1988/89-1990/91

	Number of repre-sented farms	Eco-nomic farm size (ESU)	UAA (ha)	Costs of pesticides (ECU)					
				per farm	per ha UAA	per 100 ECU of output	FNVA	FFI	input
Germany									
Rheinland-Pfalz	13,119	29	7.4	1,880	253	3	8	13	5
Greece									
St.Ellas N.Egae. Kriti	11,864	5	4.3	287	66	2	3	3	6
Spain									
Castilla-La Mancha	1,490	3	23.2	512	22	3	9	-479 a)	3
Comunidad Valenciana	4,626	6	13.0	802	62	6	11	15	11
France									
Champagne-Ardenne	7,270	67	4.4	3,124	708	2	3	4	4
Bourgogne	2,831	59	14.6	4,674	320	4	6	8	7
Pays de la Loire	1,577	38	20.6	5,019	244	5	8	11	8
Poitou-Charentes	3,635	34	27.0	5,206	193	5	8	10	11
Aquitaine	7,707	42	20.0	4,482	224	4	8	13	6
Rhône-Alpes	4,244	48	14.3	3,480	243	4	7	10	7
Languedoc-Roussillon	20,628	32	18.3	3,839	210	8	15	30	10
Prov.-Alpes-Côte d'Azur	5,019	34	17.9	3,926	220	5	9	14	8
Italy									
Piemonte	19,123	8	3.7	771	206	4	8	8	10
Lombardia	5,679	11	4.5	888	199	3	5	6	7
Veneto	8,592	9	5.3	1,387	263	6	10	10	15
Toscana	3,587	15	10.7	1,565	146	4	7	9	7
Lazio	9,552	6	3.1	498	160	3	6	7	6
Abruzzi	8,668	8	3.6	668	185	5	10	11	11
Puglia	40,220	8	3.5	700	201	6	9	13	10
Sicilia	25,250	6	4.6	650	142	5	7	8	11
Portugal									
Norte-Centro	8,777	5	5.9	361	61	4	6	9	6

a) Family farm income is negative.
Source: FADN/LEI-DLO.

Table 6.11 Cropping plan of specialist vineyards in 1988/89-1990/91 (% of UAA) and climatic conditions of the regions

	Vine-yards	Fruit and citrus fruit	Olive groves	Forage crops	Cere-als	Other field crops	Climate (humid=0, dry=1)
Germany							
Rheinland-Pfalz	55	1		6	28	10	0
Greece							
St.Ellas N.Egae. Kriti	49	1	43	4	3	0	1
Spain							
Castilla-La Mancha	87	0	3	3	7	1	1
Comunidad Valenciana	93	5	1	0	1	0	1
France							
Champagne-Ardenne	69			7	7	3	0
Bourgogne	51	1		14	26	8	0
Pays de la Loire	68	0		15	11	5	0
Poitou-Charentes	45			18	23	14	0
Aquitaine	73	1		19	6	1	1
Rhône-Alpes	64	4	0	18	9	4	1
Languedoc-Roussillon	87	1	0	7	3	1	1
Prov.-Alpes-Côte d'Azur	83	1	0	6	8	2	1
Italy							
Piemonte	70	2		16	11	1	0
Lombardia	84			13	3	0	0
Veneto	71	2	0	20	6	2	0
Toscana	61		7	19	10	3	1
Lazio	75	1	11	6	3	0	1
Abruzzi	74	2	9	3	9	2	1
Puglia	77	2	10	4	6	1	1
Sicilia	78	0	1	5	14	1	1
Portugal							
Norte-Centro	57	3	19	15	4	2	1

Source: FADN/LEI-DLO.

PCH = 110.51 + 2.41 * FS - 36.14 * dummy + 39.70 * ESH
(4.85) (1.90) (1.90) (11.51)
R^2(adj) = 0.90
Cases: 21 F = 60.7

in which:
PCH = costs of pesticides per hectare UAA (ECU/ha)
FS = farm size (hectare UAA)
dummy = climatological conditions (0 = humid; 1 = dry)
ESH = economic size per hectare UAA (ESU/ha)
and: Weighted by the number of represented farms of the 21 regions.

The coefficient of determination in the equation is quite high (R^2(adj) = 0.90). Costs of pesticides per hectare increase with rising economic size per hectare and farm size, and are higher in regions with humid climatological conditions.

The costs of pesticides in percents of family farm income are less than 15% in all regions, except for Castilla-La Mancha (-479%) and Languedoc-Roussillon (30%). Measured in percents of farm net value added costs of pesticides are less than some 10%, except for Languedoc-Roussillon (15%). In Champagne-Ardenne, costs of pesticides per hectare are quite high, but measured in percents of family farm income or farm net value added these costs are only a few percent.

6.3.6 Specialist fruit and citrus fruit

The costs of pesticides per fruit and citrus fruit holding are in a range of less than 500 ECU in some regions in Italy, Spain and Portugal to more than 5,000 ECU in some French regions, the Netherlands and England East (see table 6.12). Costs of pesticides per hectare are in the range of less than 100 ECU in some Spanish and Portuguese regions and Lazio (Italy) to more than 400 ECU in Languedoc-Roussillon, Trentino-Alto Adige and the Netherlands.

The share of fruit and citrus fruit in the cropping plan of specialist fruit and citrus fruit holdings is in the range between 33 and 83% (see table 6.13). Other important crops are olives, grapes, cereals and forage crops. The specialist fruit and citrus fruit holdings with a relatively high share of olives in the cropping plan are characterized by rather low costs of pesticides per hectare. The economic size per hectare on specialist fruit and other fruit holdings varies from less than 1 ESU in some Spanish and Portuguese regions to 5 ESU in the Netherlands. As in the case of vineyards, climatological conditions affect the occurrence of mildew and hence the use of fungicides.

It is supposed that costs of pesticides per hectare depend on the share of olive groves in the cropping plan, the size of farms (hectare) and climatological conditions (represented as a dummy variable). This

Table 6.12 General characteristics of specialist fruit and citrus fruit in 1988/89-1990/91

	Number of represented farms	Economic farm size (ESU)	UAA (ha)	Costs of pesticides (ECU)					
				per farm	per ha UAA	per 100 ECU of output	FNVA	FFI	input
Greece									
Makedonia Thraki	18,876	7	3.3	723	220	6	10	11	13
Ipiros Pelop.									
N.Ioniou	19,351	7	3.8	531	139	4	6	6	10
Thessalia	6,100	8	4.9	1,069	219	9	15	19	16
Spain									
Aragon	15,696	10	20.0	953	48	6	14	16	10
Cataluna	11,465	13	12.5	1,052	84	7	18	27	9
Comunidad Valenciana	52,517	6	4.3	881	203	8	19	28	12
Andalucia	15,713	6	14.3	302	21	2	3	4	4
France									
Rhône-Alpes	1,940	27	13.2	3,667	279	6	12	18	9
Languedoc-Roussillon	2,291	39	13.2	5,373	407	6	13	25	9
Prov.-Alpes-Côte d'Azur	2,630	43	15.8	6,053	383	7	13	21	10
Italy									
Piemonte	9,937	12	4.5	1,026	230	6	11	12	11
Trentino-Alto Adige	9,500	21	4.8	2,681	562	7	11	14	13
Veneto	5,281	23	6.1	2,152	351	8	12	13	18
Emilia-Romagna	12,027	31	7.0	2,256	321	6	10	11	13
Lazio	8,725	7	3.4	311	93	3	6	6	7
Campania	28,445	8	2.4	430	176	4	6	7	12
Calabria	10,753	8	2.8	351	125	3	4	5	6
Sicilia	43,800	10	3.6	486	136	4	6	8	8
Netherlands	1,774	54	10.7	5,004	468	5	12	20	7
Portugal									
Norte-Centro	6,057	10	11.0	677	61	7	12	15	11
Lisboa-Vale do Tejo	5,859	8	6.6	752	114	8	18	17	11
Alentejo-Algarve	5,715	10	11.3	374	33	4	12	21	5
United Kingdom									
England East	772	107	32.1	9,952	310	6	15	101	7

Source: FADN/LEI-DLO.

Table 6.13 Cropping plan of specialist specialist fruit and citrus fruit in 1988/89-1990/91 (% of UAA) and climatic conditions of the regions

	Fruit and citrus fruit	Vine-yards	Olive groves	Forage crops	Cere-als	Other field crops	Climate (humid=0, dry=1)
Greece							
Makedonia Thraki	68	2	2	4	22	2	1
Ipiros Pelop. N.Ioniou	54	1	24	15	4	1	1
Thessalia	53	1	20	4	21	1	1
Spain							
Aragon	40	14	17	14	15	0	1
Cataluna	58	5	28	3	5	2	1
Comunidad Valenciana	73	18	5	2	0	1	1
Andalucia	65	0	25	3	7	0	1
France							
Rhône-Alpes	63	7		11	13	6	1
Languedoc-Roussillon	73	10		12	3	2	1
Prov.-Alpes-Côte d'Azur	59	3	0	22	11	3	1
Italy							
Piemonte	64	4		20	9	3	0
Trentino-Alto Adige	71	5	0	23		2	0
Veneto	58	3		20	12	6	0
Emilia-Romagna	67	12		2	12	7	0
Lazio	65	7	17	5	6	1	1
Campania	81	4	6	3	2	2	1
Calabria	81	1	14	1	3	1	1
Sicilia	65	3	7	11	15	0	1
Netherlands	83			8	0	1	0
Portugal							
Norte-Centro	33	15	18	29	4	2	1
Lisboa-Vale do Tejo	52	10	5	29	2	1	1
Alentejo-Algarve	72	1	1	21	3	1	1
United Kingdom							
England East	71			15	8	3	0

Source: FADN/LEI-DLO.

hypothesis is tested by regression analysis, which leads to the predicted equation (t-statistics between brackets):

PCH = 389.86 - 3.60 * FS - 172.86 * dummy - 4.33 * SO
(8.32) (1.06) (3.43) (2.00)
R^2(adj) = 0.57
Cases: 23 F = 10.9

in which:

PCH = costs of pesticides per hectare UAA (ECU/ha)
FS = farm size (hectare UAA)
SO = share of olive groves in cropping plan (% of UAA)
dummy = climatological conditions (0 = humid; 1 = dry)and:
Weighted by the number of represented farms in each of the 23 regions.

The coefficient of determination in the function equals 0.57. Costs of pesticides per hectare decrease with rising farm size and share of olives in the cropping plan, and are lower in regions with dry climatological conditions.

The costs of pesticides per 100 ECU of family farm income differ largely between regions, from 4 ECU in Andalucia to 101 ECU in England East. When the costs are related to farm net value added (FNVA) costs per 100 ECU FNVA are less than 20% in all regions.

6.4 Concluding remarks

1. Costs of pesticides per hectare tend to be lower on arable farming types than on horticultural farming types. This observation corresponds with the findings of the SPEL/EC model (chapter 5) that costs of pesticides per hectare for arable crops are usually below those for horticultural crops.
2. The intensity of farming practice is related to the costs of pesticides according to the Farm Accountancy Data Network. Output of crop production is highest in regions with relatively high costs of pesticides. This is explained by the fact that intensive cropping techniques may increase the occurrence of pests and diseases. Also, output of crop production is highest in Member States with high usage of pesticides (see chapter 3).
3. The incentive to achieve a reduction on the expenditure of pesticides is likely to be highest in regions where costs of pesticides are a considerable part of total costs of input. These costs exceed 10% for some regions of all farming types considered across the Member States. They are relatively high at specialist cereals and general field cropping farms in large parts of France (10-16%), specialist horticulture across the south-east coast of Spain (12-17%), specialist vineyards in northern Italy (10-15%) and at specialist fruit and citrus

fruit holdings across southern Europe (Greece, Spain, northern Italy and Portugal; 10-18%).

4. On specialist cereal and general field cropping farms costs of pesticides per hectare are relatively low in Spanish regions and high in the UK and the French regions. Cereal farms in Piemonte and general cropping farms in Belgium, Germany, Emilia-Romagna and the Netherlands are also characterized by a high cost level. For the Netherlands this can be explained by the large share (47%) of potatoes and sugar beet in the cropping plan, which consume relatively more pesticides than cereals. Farms with a high share of cereals in the cropping plan tend to have lower costs of pesticides than those with a high share of other field crops.
5. Within the group of horticultural farms specialist horticultural farms are characterized by the highest costs of pesticides per hectare. Especially in Andalucia and the Canarias these farms have high costs per hectare (about 2,600 ECU). Costs on specialist horticultural farms tend to be higher in regions with a relatively large share of protected crops. Costs of pesticides compared to the value of output in the Spanish regions is about two to three times as much as in other regions.
6. Costs of pesticides per hectare on (citrus) fruit holdings are relatively high in Trentino-Alto Adige (560 ECU), the Netherlands (470 ECU) and Veneto, Emilia-Romagna, England East, Provence-Alpes-Côte d'Azur and Languedoc-Roussillon (300-400 ECU). Costs of pesticides per hectare in Andalucia on fruit farms are low (21 ECU), which is a violent contrast to the extremely high costs on specialist horticultural farms in that region. Costs of pesticides per hectare on vineyards are relatively low in Greek, Spanish and Portuguese regions and relatively high in Rheinland-Pfalz, Veneto, Bourgogne and Champagne-Ardenne. Regional differences in the costs of pesticides on specialist vineyards can largely be explained by the intensiveness of production and climatological conditions.
7. On average, costs of pesticides expressed as percentage of FFI on arable farming types vary in a broader range (6-60%) than on horticultural farming types (5-40%). Costs of pesticides as percentage of FFI on cereal farms are about 10% in Italian and Spanish regions and about 50% in French and UK regions. On general cropping farms the costs of pesticides amount to about 10% of FFI in Italy, Greece and Spain and circa 40% in French, German and UK regions. Costs of pesticides on specialist horticultural farms as percentage of FFI is relatively high in Andalucia (35%), Denmark (39%), Canarias (47%), Cataluna (52%) and England West (65%); in other regions 15% or less. On fruit farms costs of pesticides relative to FFI in Spanish regions (except for Andalucia) are also rather high (16-30%). Costs in French and Portuguese regions are at the same level. On fruit farms in the Italian regions the percentage is 15% or less. The same applies for the percentage of costs relative to FFI on vineyards in all regions, except for Languedoc-Roussillon (30%).

7. INFRASTRUCTURE OF DISTRIBUTION NETWORKS

7.1 Introduction

It was mentioned in chapter 2 that the production and trade of pesticides is increasingly being managed by multinationals. A more detailed overview of the infrastructure of pesticide distribution networks, patterns of sale and extension services in each of the Member States is given in this chapter. Such a description is aimed to provide insight into the main actors who are involved in the distribution process of pesticides, and in the way farmers are informed about the use of pesticides. Distributors and traders of pesticides play an important role in most of the countries in advising farmers how to use pesticides in an optimal manner. The main bodies of governmental extension services will also be identified. This insight will contribute to the identification of those parts in the pesticide chain from manufacturers to farmers, which need to be considered for any action in the field of pesticides policy, if desired.

7.2 Belgium

A scheme of the distribution structure of pesticides in Belgium is given in figure 7.1. Producers and importers are associated with the Fédération des Industries Chimiques (Phytofar). Wholesale trade consists of

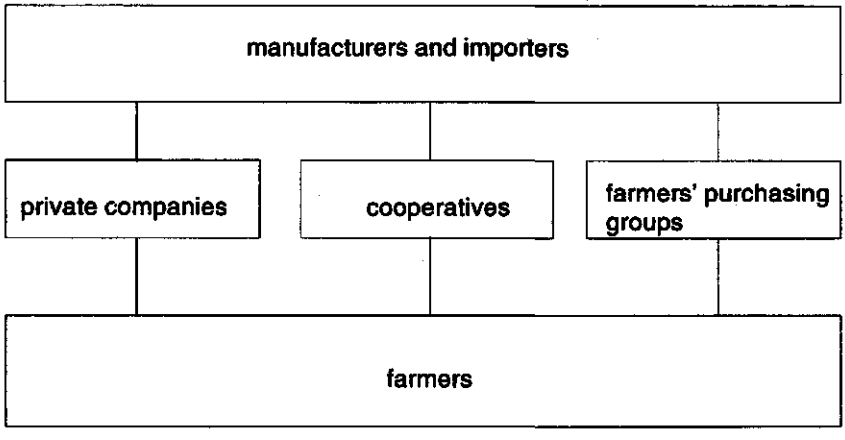

Figure 7.1 Distribution network of pesticides in Belgium

three market parties: private companies, cooperatives and farmers' purchasing groups. The number of farmers' purchasing groups and their market share show an increasing trend. They attempt to realize lower prices by joint purchasing.

7.3 Denmark

The main actors in the distribution of pesticides in Denmark include cooperatives and private companies. Both of them have a market share of about 50% (figure 7.2). The producers and importers of pesticides are associated with the Dansk Agrokemisk Forening (Danish Agrochemical Association). Cooperatives include central cooperatives (e.g. DLG), with a market share of some 23%, and independent local cooperatives that have a national association. The market share of these local cooperatives (27%) is assessed to be slightly higher than that of central cooperatives. Sales of pesticides are also arranged by private companies such as KFK, Superfos and PPH.

The distribution of pesticides in Denmark is firstly characterized by the strong competition among firms and secondly by the fact that the sales of pesticides are only of limited importance to the firms. In many villages one can find shops from several companies or cooperatives. Such firms provide a full package of inputs to the farmers, including fertilizers, seed and oil. The share of pesticides in total sales is rather limited.

The extension service in Denmark is a very important source of information to farmers, also regarding the use of pesticides. The agricul-

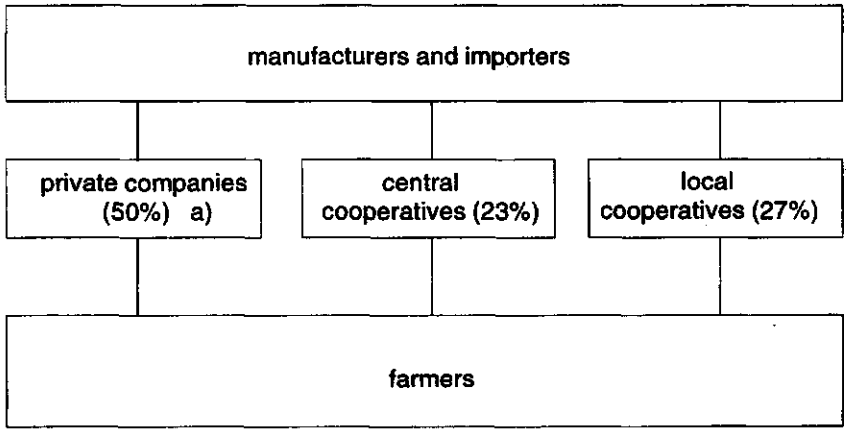

Figure 7.2 Distribution network of pesticides in Denmark
a) Percentages refer to the market share.

tural sector considers it to be very important that the advice to farmers is arranged for by an independent body. The extension service is mainly organised through the Landbrugets Rådgivningscenter (Center of Agricultural Extension Service). This body arranges for extension to farmers on behalf of the Danske Landbofereninger (Danish farmers' union of large and medium-sized firms) with about 50,000 members and the Dansk Familiebrug (Danish small farmers' union) with about 10,000 members. The extension service is also widely informed by the Danish Agrochemical Association on a proper use of pesticides. Some multinational firms approach farmers directly.

The extension service already makes use of computer packages in order to advise farmers on an optimal use of pesticides. The system PC-Plant Protection is aimed to optimize weed control. It was developed by the Institute of Plant and Soil Science, Department of Weed Control and Soil Science (Rydahl, 1993). Such a system is an advisory system for pest control and is aimed to contribute to a reduction of the quantity of pesticides as well as of the number of treatments. Advice on the amount to be applied and the frequency depends on weather conditions and the possible occurrence of pests. The registration of the use of pesticides is already widely used by farmers. Registration includes the amount of pesticides used per hectare as well as the number of times that the land is being treated. The introduction of a pesticide balance sheet will be considered for the year 1994/1995. It is expected that all farmers with at least ten hectare of land are obliged to use this balance sheet, as well as all horticultural farms. This balance sheet is considered to be an important tool for farmers to manage the use of pesticides and the way to treat them. There are no plans yet to collect the sheets from farmers for monitoring purposes or to use the available material for policy purposes. Control of farmers will be done by local representatives of the Plantedirektoratet (Plant Protection Department of the Ministry of Agriculture). It is expected that about 5% of all farmers will be controlled annually. Control on the registration of the use of pesticides is part of a whole package of control at a farm. It was also decided that the Plantedirektoratet will control field sprayers in order to prevent drifting of pesticides while spraying. This control is also done right now by the Plantedirektoratet. A relatively simple control system is already considered to help avoid wasting pesticides and subsequently reduce the use of pesticides.

7.4 Germany

A scheme of the distribution structure of pesticides in Germany is given in figure 7.3. Production of pesticides is mainly concentrated at a few multinational firms (e.g. Bayer, Hoechst, BASF and Schering). Producers and importers are associated with the Industrieverband Agrar (IVA). The wholesale trade consists of three market parties: central

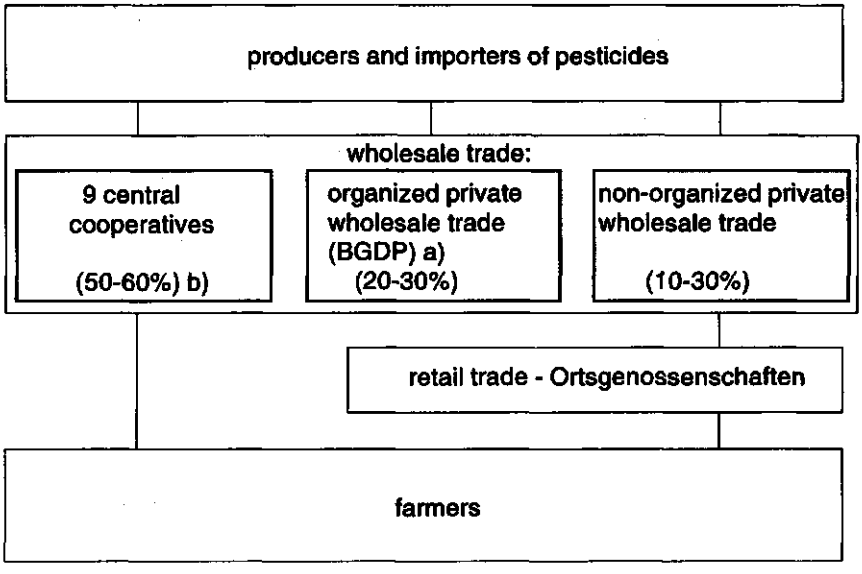

Figure 7.3 Distribution network of pesticides in Germany
a) Bundesverband des Grosshandels des Düngemittel und Pflanzenschutzmittel; b) Percentages refer to the market share.

cooperatives, organized private traders and non-organized private traders. The market share of the cooperatives amounts to about 50-60% and that of organized private traders to about 20-30%. The remaining part of the market is in control of non-organized private traders. In the southern part of Germany (Baden-Wuerttemberg, Bayern, Hessen and Rheinland-Pfalz) wholesale traders are the only intermediate link between industry and farmers. This system is referred to as the "Einstufigkeitsprinzip". Both wholesale traders and agricultural holdings are here relatively small. In the northern part of Germany (Schleswig-Holstein, Niedersachsen and Nordrhein-Westfalen) retail traders (Ortsgenossenschaften) are a second intermediate link in the distribution network, the so-called "Zweistufigkeitsprinzip". In the former German Democratic Republic the distribution network is also characterized by the Einstufigkeitsprinzip. Here however, big farms usually bought their pesticides from industry without intervention from wholesale traders.

Information on the use of pesticides is provided by four sources: Landwirtschaftskammer, Pflanzenschutzmittel Dienste, suppliers of pesticides and agricultural universities. Landwirtschafskammer are mixed organizations of the government and farmers, which exist in each of the Länder. Pflanzenschutzmittel Dienste are organized at the level of Bundesländer and issue "amtliche Empfehlungen" (official recommenda-

tions) about the use of pesticides. Information is provided both verbal and in writing.

A periodic control of spraying equipment is required in Germany by a Decree of May 15, 1992. A periodic control of all spraying equipment is required every two calender years as of mid 1993. The system differs from the one in Denmark because farmers in Germany have to pay for this control. Costs of control are around 100-200 DM (Raiffeissen Hauptgenossenschaft, 1992).

7.5 Greece

It was already mentioned in Section 3.5 that there is no production of active ingredients in Greece and all pesticides used are therefore imported. In total there are 33 manufacturers and importers of pesticides. The market of pesticides in Greece includes cooperatives and private companies, with market shares of successively about 70 and 30%. The wholesale trade has three components, i.e. (i) multinational companies (e.g. Bayer, ICI/Zeneca and Rhône-Poulenc) that sell their own products, (ii) multinational companies (e.g. Dow Elanco and Du Pont) that sell their products through representatives and (iii) Greek companies that formulate products themselves and also arrange for sales.

Cooperatives and private companies arrange for sales through the circa 1,200 shops that are specialized in the sales of agrochemicals.

Farmers are informed about a proper usage of pesticides through:

- the extension service and crop protection institutes of the Ministry of Agriculture;
- crop protection departments from universities (e.g. Pesticide Science Laboratory of the Agricultural University of Athens); and
- private consultants.

7.6 Spain

The structure of the distribution network of pesticides in Spain is presented in figure 7.4. Producers are associated through the Asociación Española de Fabricantes de Agroquimos Para la Protección de las Plantes (AEPLA). AEPLA represents a market share of about 93% of national sales of pesticides for agricultural use. About 10% of all active ingredients is produced in Spain. The largest part of pesticides (80%) is distributed by wholesale traders, who are usually not specialized in pesticides. Cooperatives have a market share of 35-40% in retail trade; private companies 60-65%. About 15% of all sales is bought by applicators, who are hired by farmers to apply pesticides. (See also Zurita and Moya (1991) for an overview of the market of pesticides in Spain.) The number of selling points has drastically declined in recent years. Some years ago the number of selling points amounted to about 30,000. It is expected that with-

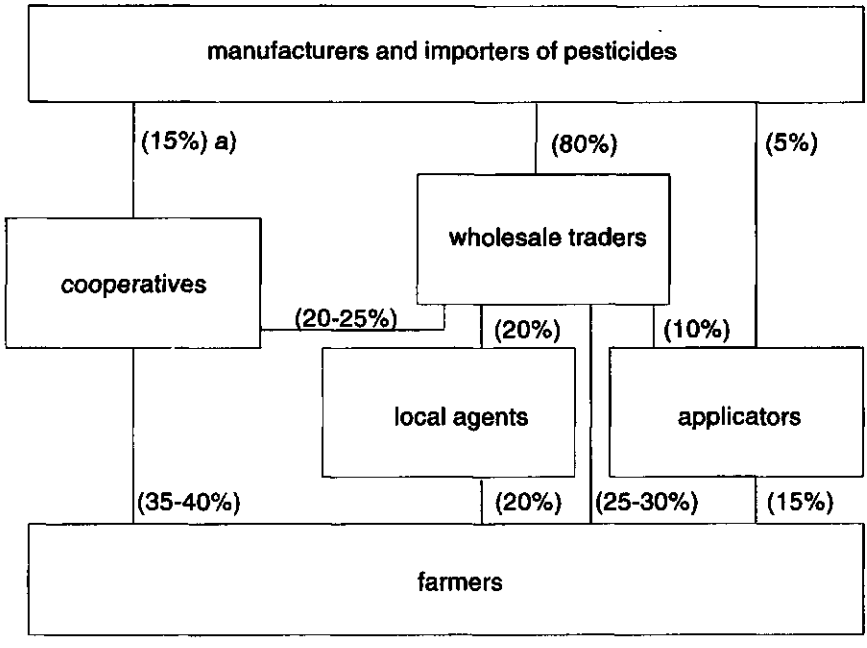

Figure 7.4 Distribution network of pesticides in Spain
a) Percentages refer to the market share.

in five to ten years this number will be reduced to 500-600. The concentration of selling points is due to legislation (among others tight safety conditions for stocks), professionalization of advice and absorption of small selling points by larger ones.

Some five years ago in Valencia the system was introduced that only professionals, who have a permission certificate, are allowed to apply pesticides. Small farmers hire these professionals and their equipment; larger farmers often pass for a certificate. Presently there are about 4,000 professionals in Valencia; this number will likely increase in the next couple of years to about 8,000. The application of pesticides was also limited to professionals in some other regions. This system will likely be introduced in the whole country in the future.

Extension services are provided by regional authorities, producers and farmers' organizations. Information on integrated pest control is given by ATRIAS and ADV. The Integrated Treatment Associations in Agriculture (ATRIAS) is a network of experimental stations, directed towards integrated pest control. Their role is to advise farmers about appropriate ways to apply pesticides. It is a joint programme from the Ministry of Agriculture and the regional departments of agriculture.

There are also associations initiated by the Autonomies which arrange for advice to farmers on integrated pest control. These are the so-called Vegetable Protection Associations (ADV). ATRIAS and ADV are organized per product. The first ATRIAS department started in 1984; in 1992 there were 45, of which 22 for citrus fruits, eleven for plums, four for grapes, one for olives and seven for vegetables. Farmers have a positive attitude towards integrated pest control as it lowers pesticides costs and may affect the level of residues. In the scope of ATRIAS and ADV cooperatives can employ a technician, who advises farmers on integrated pest control. In the first year the local government reimburses 80% of the salary costs of the technician. In a period of five years this co-financing rate is gradually reduced to 40% in the last year. Afterwards the salary of the technician has to be fully paid by the cooperative.

An integrated crop management programme was launched in 1993, called Agrofuturo. It was initiated by representatives from amongst others government, AEPLA, farmers, consumers and food industry. The main objective of the programme is to encourage farming techniques that are environmentally sound and minimize health risks. Up to fifteen farms are in the 1993 programme to provide advice on technical problems and environmental issues.

Recently AEPLA, the producers' association, launched the "safe use programme", which is primarily concerned with distributors and protective clothing. The Ministry of Agriculture, the Ministry of Health and the Ministry of Labour and Social Security also participate in AEPLA's safe use programme. In 1991 about 1,600 distributors and retailers in all Spanish regions were attended and informed about warehouses, transport, handling and use, first aid and legislation. The campaign on protective clothing was set up as pilot project in Valencia and Almeria in 1991 and a full campaign in these two regions followed in 1992. The 1993 objective of the protective clothing campaign was to cover all Spanish regions. Farmers in Valencia and Almeria were informed about protective clothing by billboards, booklets, posters, video-tapes, radio and tv spots, press conferences and round table discussions. Besides about 6,000 kits with protective equipment (cotton garments, nitrile gloves, apron and face shield) were distributed free of charge. Based on the positive response of farmers in final surveys, AEPLA considers the campaign in Valencia and Almeria as successful.

7.7 France

France is a large producer of pesticides. About 23% of the sales of industry consists of exports (SCEES, 1992). In volume it is even more. This percentage is increasing as sales on the home market have been declining in recent years and exports are still growing. Especially the exports of insecticides are relatively high: more than 40% of total exports are insecticides. The French market of pesticides is, in volume, the third in the

world. The larger part of the consumption is produced by French industry. Between 40-50% of the consumption comes from imports.

On the wholesale level cooperatives play an important role. Their share in the market is about 60% against about 40% for private wholesalers (figure 7.5). The number of cooperatives in this sector decreases due to an ongoing process of concentration, but nevertheless their market share is increasing in the course of time.

More than 50% of all transactions of farmers consists of quantities of less than 20 liters or kilograms (FNSEA-IGER, 1990). In total consumption these transactions count however for only 10%, whereas transactions of 100 liters or kilograms and more represent nearly half of total consumption. The packaging of most of the deliveries consists of units of 1 liter or kilogram. Deliveries in this packaging count for three-fourths of total volume. In less than 30% of all deliveries the farm (or the field) is the place of delivery. In all other cases the farmer takes the pesticides from the depot.

Although pesticides are often used to prevent diseases, there is an increasing tendency to use pesticides in a curative way. This will require major skills of farmers. The Ministry of Agriculture plays an important role in stimulating that development. The government developed a warning system on when and how to use what pesticides. The farmers have to pay for using of this system. In 1992 about 6,000 advices on the application of pesticides were given. The influence of the system is however more important than follows from the number of participants, as there is a major spin-off on neighbouring farmers.

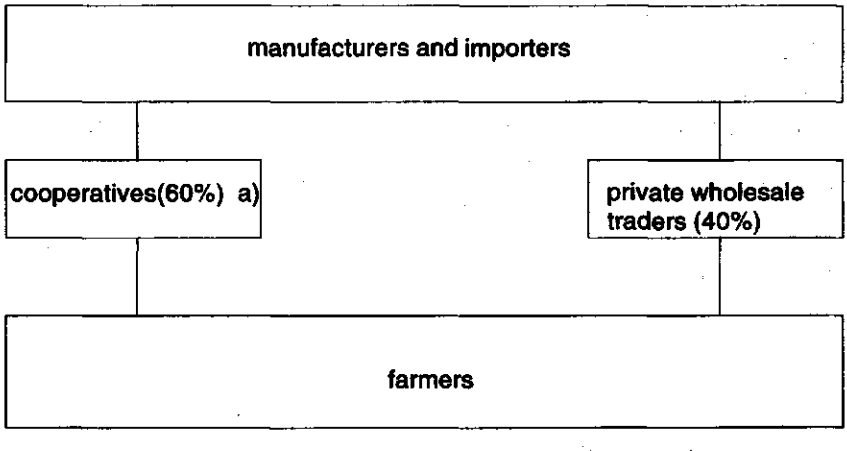

Figure 7.5 Distribution network of pesticides in France
a) Percentages refer to the market share.

Information to farmers on the use of pesticides is provided by the Services Régionaux de la Protection des Végétaux (SRPV) of the Ministère de l'Agriculture et de la Forêt, the Chambres d'Agriculture, distributors, cooperatives and farmers' organizations. There are in total 26 agencies of the SRPV. Each Département has a Chambre d'Agriculture. They also advise farmers on the use of pesticides, although their advice in this respect might be rather limited compared to their main emphasis on the improvement of product quality. The work of the Chambres d'Agriculture is paid through a financial contribution from farmers.

7.8 Ireland

All pesticides used in Ireland are imported, mostly from multinational chemical companies. Pesticides are distributed from importers to cooperatives or agricultural merchants who then retail them to the farmer.

The main information service on pesticides to farmers is the Agricultural and Rural Development Authority (TEAGASC), which has a specialist advisory service for crops. In addition chemical companies and cooperatives have a network of field advisors.

7.9 Italy

There are about seventy firms producing or importing pesticides for use in Italy. One of the characteristics of the Italian pesticides industry is that the largest part of active ingredients is imported. Only five Italian producers are involved in the production of active ingredients, but these firms do not have their own research and development division. A scheme of the distribution structure of pesticides in Italy is given in figure 7.6. About half of the sales of pesticides is being managed by private companies and the other half by cooperatives. Direct sales from producers to farmers are of minor importance (about 1% of total sales).

Information on the use of pesticides is given by regional authorities, producers, cooperatives and farmers' organizations. Until 1972 the national government informed farmers on the use of pesticides; from 1972 onwards this task has been delegated to regional authorities. The quality of the public information services varies per region. The recent EC regulation on the accompanying measures of the MacSharry reform (reg. 2078/92) meant a new impulse. In that regulation it was determined that there is a co-financing of 50% by the EC on training of information officers. Coldiretti, a farmers' organization that represents about 60-70% of Italian farmers, initiated the CONIAN research project on the negative impacts of farming practice on the environment. This programme is elaborated in cooperation with about fifty university researchers. One of the results of this project is a computer programme, which Coldiretti applies to advise farmers on the use of pesticides. When these farmers use rec-

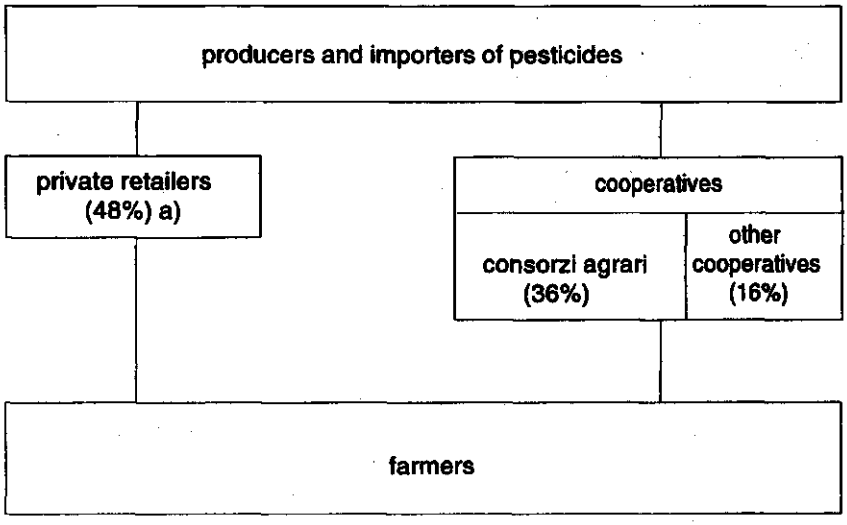

Figure 7.6 Distribution network of pesticides in Italy
a) Percentages in brackets refer to the share in total retail trade.
Source: Agrofarma, Gli Antiparassitari e l'Agricoltura, Milano, 1990, p.36.

ommended dosages of pesticides and no residues are left with the products, they can be rewarded by a certificate. This certificate guarantees a higher price for the products. As part of the Conian project the presence of residues of pesticides on products was measured in 1992. In a sample of more than 800 products it appeared that over 50% of the products were free of residues, 43% of the products contained permitted amounts of residues and 3% of the products exceeded the maximum norm of residues.

7.10 Luxembourg

Pesticides are not produced in Luxembourg. They are imported by wholesale traders, who either sell products directly to farmers or distribute them among retail traders. Products that are highly toxic are only allowed to be sold by officially recognized agents.

7.11 Netherlands

A scheme of the distribution network of pesticides in the Netherlands is given in figure 7.7. Producers and importers (about twenty) are associated with Nefyto, which represents about 90% of the market. Private distributors (about a hundred) and the three central wholesale

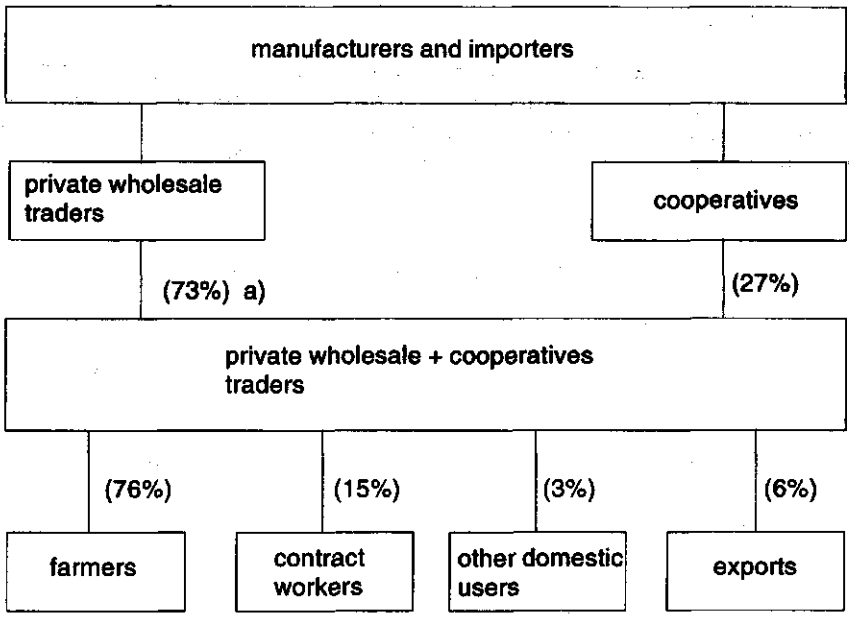

Figure 7.7 Distribution network of pesticides in the Netherlands
a) Percentages in brackets refer to the share in sales.
Source: Hof (1988: 22).

cooperatives (Cebeco-Handelsraad, Cehave and Landbouwbelang) are united in the Registration and Training of Distributors of Pesticides (Registratie en Opleiding Distribuanten Gewasbeschermingsmiddelen RODIS) 1).

The share of cooperatives on the domestic market amounts to about one third (Hof, 1988:27). There are about 350 selling points (Hof, 1988:23). A quarter of the wholesale trade is distributed to retail traders, the remainder is directly sold to the users. About 90% of all sales are delivered in the agricultural sector; the other 10% consists of sales to other domestic users and of export. From the sales to the agricultural sector about one sixth is purchased by contract workers.

Advice to farmers on the use of pesticides is given by the Extension Service (Dienst Landbouwvoorlichting DLV) of the Ministry of Agriculture, Nature Management and Fisheries. Extension is considered to be an important part of the Research, Extension and Training trinity. Farmers also get advice on the use of pesticides from distributors, cooperatives, farmers' organizations and study clubs.

1) Before 1993 the name of the association was Federation of Distributors of Pesticides (Federatie van Distribuanten van Bestrijdingsmiddelen FDB).

7.12 Portugal

A rough outline of the distribution network of pesticides in Portugal is given in figure 7.8. The ten manufactures and importers, of which six multinationals, have been associated in the Associaçao Nacional da Industria Para a Protecçao das Plantas (ANIPLA) in 1992.

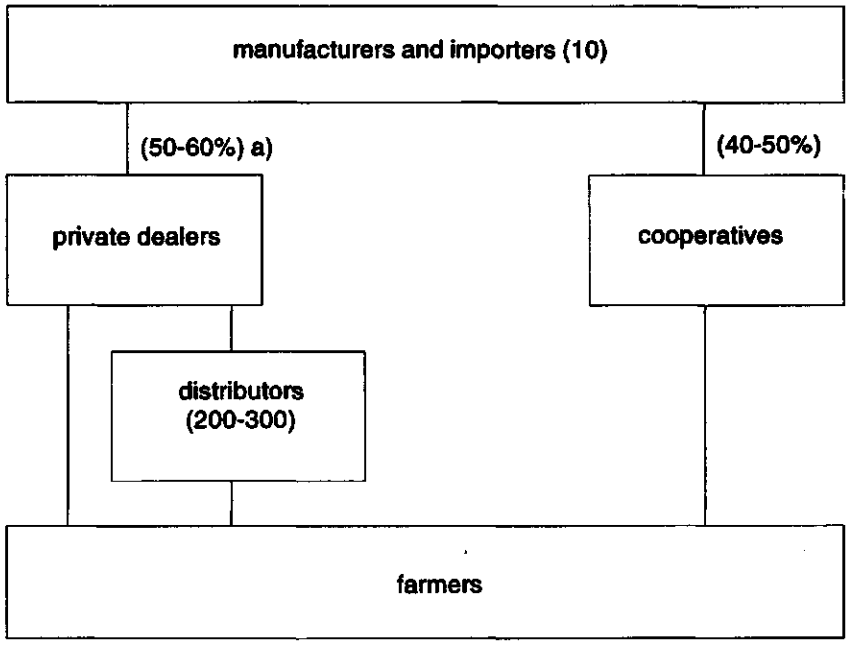

Figure 7.8 Distribution network of pesticides in Portugal
a) Percentages refer to the market share.

About 95% of all sales is imported. Sulphur is the only active ingredient produced in Portugal. Over 50% of the market share of wholesale traders is in hands of private companies. The market share of cooperatives declined in recent years and amounts currently to about 40-50%. A part of the private wholesale trade is directly sold to farmers; the other part is sold by means of retail traders. In total there are a few thousand selling points.

Extension services are provided by industry, traders, cooperatives and the State Service of the Ministry of Agriculture. The efforts of the State Service are limited in the field of pesticides, since civil servants are hampered in their work by a lot of bureaucratic rules. Moreover, they are very busy in filling in forms for all kind of subsidies under terms of the recent MacSharry reform of the CAP. Information is provided by

means of leaflets, mailings, farm magazines, cartoons, tv spots and symposia. As about 30% of Portuguese farmers is illiterate, audiovisual methods are very important. Information is given about masks, gloves, clothing, interval between treatments, cleaning, disposal etc. Some tv spots are directed towards children in order to warn them against the dangers of playing with empty containers of pesticides, which have been left in the field.

7.13 United Kingdom

An overview of the structure of the UK agrochemical distribution network is given in figure 7.9. Nearly all producers and importers are united in the British Agrochemicals Association (BAA).

Some forty agrochemical manufacturers operate in the UK market. The wholesale trade is dominated by five private companies, which have a market share of 70%. The market share of cooperatives (15%) is relatively small, although this share varies considerably among regions. About 5% of all sales are directly sold to farmers by Schering, a large

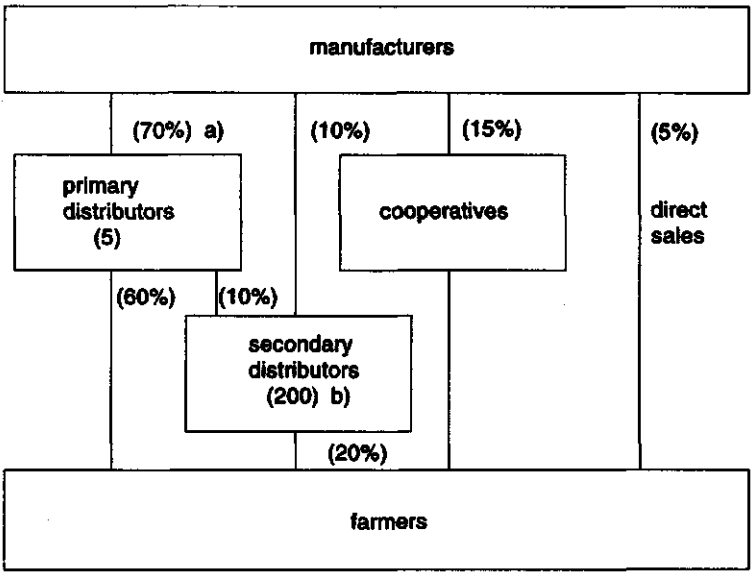

Figure 7.9 Distribution network of pesticides in the United Kingdom
a) Percentages refer to the market share; b) Secondary distributors are in general rather small, except for five secondary distributors. These five secondary distributors have a market share of about 10%.

German multinational. The group of secondary distributors consists of small companies, except for five big ones. The market share of these "big five" amounts to about the half of all secondary distributors. The number of distributors declined rapidly in recent years. From all distributors only a small percentage is specialist agrochemical distributor.

Extension services are provided by producers and distributors, consultants, the Agricultural Development and Advisory Service (ADAS) and Arable Research Centers. Consultants can be independent or employed by distributors. ADAS is the extension service of the Ministry of Agriculture, Fisheries and Food (MAFF). Arable Research Centers are set up by industry, government and farmers. In most cases farmers have to pay for these services. On the whole private consultants often advise full rates, while ADAS advises less. The practice, like in France, that farmers apply the same amount of pesticides as is recommended to their neighbour, is not common in the UK. This is due to the relatively large size of farms, on which it makes sense to get advised on the correct amount of pesticides for economic reasons.

7.14 Concluding remarks

1. The infrastructure of distribution networks of pesticides shows no big differences among EC Member States. Manufacturers and importers of pesticides arrange delivery to wholesale traders (private companies and cooperatives). Manufacturers and importers primarily are multinational companies, associated in producer organizations at a national level and at the European level (by means of the European Crop Protection Association). In Luxembourg, which imports all pesticides, there is no producers association.
2. In most countries wholesale traders are the sole link between manufacturers and importers of pesticides and farmers, except for Germany, Spain, Portugal and the UK, where part of the wholesale trade is distributed by retail merchants. The share of private companies and cooperatives in wholesale trade varies considerably. The share of cooperatives ranges from about 15% in the UK to about 50-60% in Germany, France and Italy. Cooperatives in Greece have a share of around 70% of the market of pesticides. In Belgium farmers' purchasing groups are a distinguished market party in wholesale trade. Direct sales from manufacturers to farmers are uncommon, except for the UK, where about 5% of all sales is directly sold to (big) farmers.
3. The extension service plays an important role in advising farmers about the use of pesticides. The parties involved in extension services for farmers are quite similar in all countries: (regional) authorities, industry, distributors and farmers' organizations. Especially in Denmark, Germany, the Netherlands and the UK research centers

also play an important role as information service. Often two or more parties closely cooperate, for instance the Landwirtschafts-kammer in Germany, ATRIAS, ADV and the safe use programme in Spain, CONIAN in Italy and the Arable Research Centers in the UK. Integrated pest control, codes of a correct use of pesticides and residues are main information topics.

8. COLLECTION OF CONTAMINATED PACKAGING AND DISPOSAL OF UNUSED STOCKS

8.1 Introduction

Dumping empty pesticide containers and disposing of unused stocks of pesticides may pose serious risks for environmental contamination and human exposure. There are various ways to treat these containers, ranging from burying them in a remote site of a field to re-using them.

In this chapter the infrastructure and practice for the collection of contaminated packaging and the disposal of unused stocks in each of the Member States is examined. Unused stocks consist both of products that cannot be used by farmers because they are banned and of products that are not used because they are superfluous. An important item in this respect is the way how unused stocks, banned products and the package material of empty boxes need to be treated. The examination in this chapter provides information on what actors are involved in the process, on some legislation, on the operation and experiences of the systems and differences among Member States.

With regard to banned products it is worthwhile to refer to EC Directive 91/414. In the scope of this directive all 700 active ingredients that are registered for use in the EC, will be reevaluated. This Directive is aimed to harmonise the registration of agrochemicals in the EC. Approximately some ninety active ingredients will be evaluated annually under that Directive. It is considered that not all of them remain to be authorised for use in agriculture.

8.2 Belgium

Packaging of pesticides and unused stocks of highly toxic, toxic, corrosive, harmful and irritant products are treated as toxic waste in Belgium (Royal Decree, February 1976). These packaging and unused stocks have to be destroyed in specialized and officially recognized destruction centers. However, in practice this legislation is not obeyed, either as destruction is too expensive or as farmers do not know the rules.

Currently local authorities, industry and the Ministry of Agriculture deliberate on the introduction of rinsing equipment at farms. After rinsing, containers of harmful and irritant products can be collected with the normal household waste. On the other hand, empty containers of highly toxic, toxic and corrosive products should be collected separately and burnt at high temperatures. This should be paid by local authorities and

industry. Besides, it is intended to introduce a system of separate collection of chemical waste of households and small and middle-sized enterprises.

8.3 Denmark

Packaging from products classified as highly toxic or toxic along with unused stocks of any classification have to be delivered at the local chemical waste collection point, which is managed by the local authorities. Material from such collection points is sent to an incineration plant for chemical waste. There is only one such plant in Denmark. All other cleaned packaging can be delivered at the local waste-disposal service. Burning on site of cleaned packaging (non-pvc) is not prohibited, but in general not recommended.

8.4 Germany

In June 1991 a regulation on the collection of packaging (VerpackV) was implemented. This regulation aims at a reduction of waste materials by using packaging that can be recycled and that is separately collected. Producers are obliged to take back at least 30% of the package material in 1993. This should raise up to 80% in 1995. The response of the industry was to set up a system for the collection and recycling of package material, the so-called Duales System Deutschland (DSD). The costs of the collection and recycling are for the producers and they put a small tax on the products. In order to facilitate the collection of packaging, yellow waste boxes are distributed among consumers. Packaging for the yellow box is marked with a green label (Grüne Punkt), which makes recognition by consumers easy.

Regulation regarding VerpackV only focuses on non-harmful products. A regulation on the collection of rinsed contaminated packaging (among others from pesticides) and other harmful package is currently prepared (VerpackV für Verpackungen mit schadstoffhaltigen Fülgütern). It is expected that such a regulation will be implemented in the course of 1994. The requirements to this kind of package material are likely to be similar to the package of non-harmful products. The collecting system of contaminated packaging can be conducted by producers or it can be delegated by producers to third companies. Farmers have to pay for the collection by means of a small tax on the products.

Anticipating on this legislation, the Industrieverband Agrar (IVA, the German organization of producers of pesticides and fertilizers), in cooperation with farmers, traders and waste companies, introduced Pilotprojects for collecting rinsed contaminated packaging. IVA reserved a budget of 600,000 DM for these Pilotprojects. In 1990 an experimental collection site was set up in Vetweiss (Nordrhein-Westfalen). Aim of that

project was to gain insight into the way of organizing a collection site and in the response of farmers. In 1991 five collection sites were organized in Hessen, Nordrhein-Westfalen, Rheinland-Pfalz, Sachsen-Anhalt and Schleswig-Holstein, which were open for two days. These collection sites were chosen in such a way that various agricultural structures were covered. The collection was directed towards rinsed synthetic, metal, paper, cardboard and foil packaging. About 300 farmers participated in the collection, who delivered 23,000 pieces of synthetic packaging and 2,000 of other packaging. The rate of rinsed packaging in the various collection sites ranged from 45 to 95%. Based on the experience of these collection sites the IVA concluded that (IVA, 1992:41-42):

- farmers need more information on the delivery of packaging;
- there is an insufficient number of rinsing machines;
- rinsed packaging in the collection sites should be checked by independent persons;
- more attention should be paid to the transport of packaging to the collection site.

IVA is currently involved in 24 experimental collection sites in twelve Bundesländer. On each collection site there is a well-trained person of a private specialized waste company, who checks the collected packaging on the rate of rinsing. These collection sites are open twice a year: in spring and in the autumn after the harvest. The final aim of IVA is to establish a countrywide network of about 300 collection sites without government participation. The maximum distance from a farm to a collection site is in that case about 25-30 km.

Whether IVA will be successful in creating a collecting system without government participation, depends on the extent to which farmers deliver sufficiently rinsed packaging. Criterium for sufficient rinsing is that no more than 0.01% of the active material is left in the packaging. Industry considers it to be critical to the success that checking the rinsing of the packaging is executed by independent persons. The economic link between industry and farmers gives rise to the threat of false competitiveness. When one producer refuses to take insufficiently rinsed packaging from a farmer, the farmer can go to another producer. This producer may offer to take the insufficient rinsed packaging if the farmer buys pesticides from him in exchange.

For the rinsing of contaminated packaging farmers need a rinsing machine. The rinsing water is caught in a tank. When the farmer rinses the packaging immediately after use, he may spread the rinsing water on the field. The costs of a rinsing machine vary from less than 1,000 DM (± 500 ECU) to about 1,500 DM (± 750 ECU). IVA currently make efforts to supply packaging that can be easily rinsed. Such packaging has big openings, smooth inside surfaces and no hollow handles.

The collected contaminated packaging may be used for several purposes: for re-use, for chemical recycling and for thermal energy. Re-use of plastics is only possible when the packaging is refilled with the same active material of the same producer. Because of the rather large num-

ber of different pesticides in Germany, prospects for re-use are not favourable. Probably about 10-15% of collected plastic packaging can be used for re-use. The packaging that is presently available for re-use without the disadvantages of plastics, are made of stainless material. However, these packaging are expensive and difficult to handle by farmers.

The disposal of unused stocks is not a major topic in Germany. Until now there is no national legislation that obliges producers of pesticides to take back prohibited products. Farmers can supply unused stocks without costs at the municipal chemical cars. The list of prohibited products differs in Western Germany and the former German Democratic Republic. In the eastern part of Germany there are large stocks of products that are already banned in Western Germany. In order to use these East German stocks, a transition period of a few years has been announced before the list of prohibited products in the western part of Germany is enforced in Eastern Germany.

8.5 Greece

There are no special regulations on the collection of contaminated packaging of pesticides. Current practice by farmers is to bury empty containers of pesticides and other material in a remote site of the field, away from water sources and wells, or to dispose of them through the municipal waste system. Some companies have special furnaces to burn empty containers, and to a limited extent, unused pesticides. There is a limited number of special installations with all facilities to burn pesticides.

The collection of large amounts of banned chlorinated hydrocarbons was arranged for in the 1970s by the Ministry of Agriculture in cooperation with the Agricultural Bank of Greece. A large share of the collected products were exported to African countries. Once a product is unauthorized for use in agriculture, there is usually a transition period in which it is being used up in agriculture or it is exported to other countries.

8.6 Spain

The collection of packaging is an "unsolved" problem in Spain, although it is a topic in many discussions. The current practice is that empty containers are burnt, buried or left in the field. Since Spain is a thinly populated country, empty containers in the field hardly disturb anybody. AEPLA, the producer's association, recommends burying of empty containers far away from water points, after they have been cleaned.

Some years ago there was an experiment with the collection of empty containers in open boxes. The eventual remainders in the con-

tainers could evaporate in this way. Due to lack of coordination and an appropriate disposal route for the collected containers, this experiment failed. In the future three incineration plants for agricultural waste are planned under terms of a new law on waste. Any collection system is hampered by long distances, over which empty containers have to be transported from the farmer to their final destination.

Unused stocks are no problem in Spain. Once a product has been prohibited, there is a transition period in which it is permitted to use up the product. The length of the transition period varies per product, among others depending on the producer's stocks of the product and the degree of danger. From an environmental point of view Spain prefers to use up products instead of destroying them. Besides, the infrastructure for such disposal is insufficient, as there are only three chemical waste companies in Spain.

8.7 France

Since 1975 French farmers are obliged to rinse the packaging of pesticides (glass, plastics, etc.). The target is to rinse the packing three times with water. Also, the rinsed water has to be brought on the land. After rinsing the contents of pesticides on the packaging may not exceed 0.01%. Afterwards the packaging must be destroyed on the farm, which is often done by burning. The system of burning the packaging on the farm was introduced as no return system existed at that time.

The research project of SCEES on fruit production in 1992, mentioned in section 4.7, showed that 54% of fruit producers burned all their packaging and that 15% partly burned the packaging and partly disposed of it as waste. The first group mainly consists of producers with a larger acreage. Nineteen percent of the fruit producers disposed of all their packaging as waste. Only 2% of the fruit producers used a return system. This packaging is not re-used but processed to raw materials or burnt for the production of energy (Poiret and Vidal, 1993). Although this project only includes a limited sample of users of pesticides, it indicates that a considerable part of farmers in France does not meet the regulation from 1975 on the disposal of package material of pesticides.

A decree on household packaging waste, dated April 1, 1992, came into force on January 1, 1993. For the near future new legislation is expected. A decree on commercial and industrial packaging is currently discussed. It is not sure yet whether packaging of pesticides are exempted from the decree on commercial and industrial packaging and come under the jurisdiction of the decree on household packaging. As such, rinsed pesticide containers could be collected as household waste. A "valorization" system especially for the packaging of pesticides is currently under discussion. Industry as well as farmers are against such a return system as they consider it to be too costly for the only limited quantity of packaging. Besides, the industry expects that this quantity

will decline in the future as a consequence of a (further) reduction in using pesticides. Emphasis therefore is on reducing the amount of package material, to be followed by options as re-use and recycle. Industry and farmers advocate to consider the packaging as household waste. In that situation the possibility of so-called eco-packaging still exists. This means that packaging of all kinds of products are collected separately from other parts of household waste and are processed to raw materials or energy. Part of the costs of this eco-packaging system, which started recently, are paid by the industry. The phyto-pharmaceutical industry is discussing about joining this system.

According to the law of 1975, farmers are obliged to eliminate unused stocks of pesticides without causing damage to the environment or the health of people. Nevertheless, there is no policy to collect and eliminate these stocks on a permanent base. However, recently a temporary programme was started to collect and eliminate unused stocks. This programme can be seen as an answer to farmers' requests for such action. The programme is carried out by Pic Agri, an organization established for this purpose in 1991 by among others farmers' organizations, pesticides traders and producers' organizations. Per department or per region actions are developed to collect and eliminate unused stocks. Pic Agri gives technical assistance and besides subsidizes 30% of the costs of the departmental or regional programme. The larger part of the costs are paid at the level of the department or the region. Local agricultural banks, Chambres d'Agriculture, local trade organizations, but municipalities and agencies for the quality of (drinking) water as well, subsidize the costs of the departmental or regional action. Farmers are not charged. In most departments and regions the Chambres d'Agriculture play a leading role in the action to collect and transport the unused stocks. The organizations behind Pic Agri consider the programme as a success so far. Before starting the collection an inventory was made of the quantity of unused stocks. In general more unused stocks are collected than was expected from the inventories. It is expected that within a few years the programme can be terminated. A continuation or a new programme is not foreseen as the problem of unused stocks is considered as temporarily because the use of pesticides will decline and pesticides will only be bought in the quantities needed for direct use.

8.8 Ireland

There is no infrastructure for collecting contaminated packaging in Ireland. Industry constantly stresses the need to effectively rinse out containers, but specific initiatives in this area have not been taken. Unused stocks may be returned to the distributor/manufacturer. Banned products will be seized by inspectors of the Pesticide Control Service and disposed of at the owner's expense. Normally this takes place by way of export to the UK for incineration. At various points in the past ten years, initiatives

have been taken by the chemical industry to collect unused stocks of obsolete or banned products. As such, the Federation of Irish Chemical Industries does not expect that there are large quantities of unused stocks at either retail or farm level.

8.9 Italy

Hardly any legislation regarding collection of contaminated packaging exists in Italy. A recent law (1993) determines an obligation for industry to collect packaging of boxes with contents of 50 kg. or more for reuse. This system is now in an initial stage. However, boxes with contents of 20 kg. or less are most common in Italy. Packaging of pesticides that are highly toxic or toxic (classes 1 and 2) need to be delivered to firms specialized in the treatment of chemical waste. A few waste organizations provide collection sites for contaminated packaging. Coldiretti, a farmers' organization, tries to extend this system of collection points and to promote the distribution of rinsing machines for empty boxes among farmers. Agrofarma, the organization of producers, is currently involved in a joined research project with the University of Bologna on the rinsing of boxes and the amount of active ingredients left in the boxes after rinsing. When the results of the project are promising, Agrofarma considers to propose to the Ministry of Sanitary a law on the rinsing of boxes. In Italy it is a common practice that empty boxes are left on the farm. Farmers are not allowed to burn contaminated packaging.

The list of prohibited products differs per region, depending on the regional environmental situation and the condition of the groundwater. Industry is legally obliged to collect unused stocks of prohibited products at the farm. At this moment there are ten organizations involved in this collection and treatment of chemical waste, of which six are located in Northern Italy and four in the South. These organizations are financed by industry. However, this network is insufficient to collect all unused stocks and has still to be extended. It should be noted that there is a transition period after the announcement of a ban on a pesticide, in which it can still be used by farmers.

8.10 Luxembourg

Contaminated packaging has to be delivered at controlled disposal sites. Unused stocks are taken back by the exporting firm or are collected by a specialized company, which is financed by the Ministry of Environment. This company transports the collected material to firms abroad for recycling or destroying.

8.11 Netherlands

The re-use of packaging material is not allowed in the Netherlands with the exception of barrels for soil disinfectants. In 1989 a convenant on the collection of remnants and packaging was implemented. The convenant was signed as an agreement of the government, industry, distributors and the Agricultural Board. Cleaned containers, in which no more than 0.01% active ingredients are left, can be disposed of as normal farm waste, except for containers of chemical materials. These latter containers are treated as small chemical waste and have to be disposed of at the chemical waste depots. The costs of this disposal are for industry and distributors (united in the foundation on the clearing of unused stocks of agricultural pesticides STORL). On the label distributors have to indicate how to clean and dispose of the container. With regard to the disposal of unused stocks the convenant determines that remnants of pesticides in original containers can be delivered at the chemical waste depots. Distributors are obliged to take back unopened containers without costs for farmers. In the scope of this convenant the Agricultural Board enforced a regulation on the cleaning of containers of pesticides (Verordening Reiniging Verpakkingen Bestrijdingsmiddelen) in 1989, in which regulations for the cleaning of containers are listed. In some regions (for instance the Westland, an intensive horticultural region) farmers organized in cooperation with disposal companies a periodical collection of chemical waste at the farm gate.

The operation of the collection of empty containers of chemical materials and unused stocks is considered to be sufficient. Recently some capacity problems at the chemical waste depots arose, as some chemical waste depots were shut down and the quantity of chemical waste of private households exceeded the expectations.

8.12 Portugal

The use of pesticides is moderate in Portugal and hence pesticides, the collection of packaging and the disposal of unused stocks are hardly considered as a matter of concern. Empty containers are burnt, buried or left in the field. The Ministry of Agriculture recommends burying the containers, since burning is seen as too dangerous. There is no chemical waste system in Portugal. ANIPLA, the organization of producers of pesticides, intends to develop a strategy towards the disposal of containers.

8.13 United Kingdom

The safe disposal of empty pesticide containers is an area of increasing concern. The MAFF/HSC Code of Practice for the Safe Use of Pesticides on Farms and Holdings (1990) provides practical guidance to

farmers on different aspects of the use of pesticides. The Code has been issued in respect of Part III of the Food and Environment Protection Act 1985 (FEPA) and the Health and Safety at Work etc. Act 1974. With regard to the disposal of empty containers the Code gives the following recommendations (MAFF/HSC Code, 1990: 63-65):

1) Empty containers should never be re-used for any purpose, except to contain an identical pesticide transferred from a deteriorated or leaking container.
2) Empty containers should be cleaned according to the label instructions or by successive rinsing. Ideally cleaning should take place when a working strength spray dilution is being prepared so that the rinsing liquid can be added to the spray dilution.
3) After being cleaned containers should be punctured in several places to make them unusable, but labels have not to be disfigured. These crushed containers should be stored in a secure compound, pending their disposal.
4) Empty containers of hydrogen cyanide gassing powders and aluminum, magnesium or zinc phosphides, which produce hazardous gasses on contact with moisture, should not be rinsed. Instead they should be filled with dry earth, sand or other inert material. Immediately before disposal these containers should be punctured in several places.
5) The cleaned and crushed containers can be delivered at licensed disposal sites, buried or burnt. However, containers of products classified as highly flammable, pyrotechnic devices and atomisable fluids should not be burned. The burial site must be carefully chosen, with no risk of pollution of surface or ground water. The containers should be buried to a depth of at least 0.8 meter below the surface and below the level of any land drains. The burial area should be marked so that its location may be identified easily in the future, and a record should be kept of the type and quantity of the materials buried. Burning has to take place in an open space at least fifteen meters from a public highway and not in a location where smoke may drift over to people or livestock. Containers should be open and placed on a very hot fire. Any residues from the burning should be buried.
6) Holders of contaminated packaging should seek advice on a suitable disposal route from local authorities. Contaminated packaging can be buried if permitted on the product label. Disposal of containers that cannot be cleaned thoroughly and of heavily contaminated equipment should be arranged by a specialist disposal contractor.

It must be emphasized that the abovementioned guidelines are codes for good agricultural practice and are not enforced by law. At present the larger part of empty containers are buried or burnt. No legislation exists on rinsing empty containers.

The British Agrochemicals Association (BAA) has set up a Packaging Disposal Working Group, which worked on the development of a strat-

egy for the disposal of empty containers, including possible recycling and return systems. The reasons for doing so are threefold (BAA, 1993: 10). Firstly the MAFF/HSC Code can be improved. Secondly the EC Commission has recently published a proposal for a Council Directive on packaging and packaging waste that calls for recycling of materials and re-use of containers in the first place, with disposal as a last resort. Thirdly, there is an increasing public concern about waste, particularly packaging waste that could be re-used. There are close contacts between the BAA Working Group and the European Crop Protection Association (ECPA) in preparing a pan-European strategy in this field.

The Pesticides Container Group of the Ministry of Agriculture, Food and Fishery (MAFF) is working on a design for contaminated containers in such a way that they can be optimally used by farmers. There is a close cooperation with industry in this project.

Before 1986 pesticides were officially registrated at a voluntary basis and approvals of products were given for an unlimited period. Since the implementation of the Control of Pesticides Regulations (COPR) in 1986 registration of pesticides is obliged and approvals are subject to a review at ten years' intervals. When approval of a product is revoked, there is a transition period of two years, in which the product can be used up. Where there are safety concerns, the appropriate action to be taken with regard to the transition period is considered case by case. Generally a reduced timescale is given for withdrawing such products from the market. Unused stocks of prohibited products can be delivered at chemical waste companies. The costs of disposal have to be paid by farmers: 26 ECU (£ 20) per liter of identified products and 260 ECU (£ 200) of analysis costs when the name of the product is unknown. Farmers are advised not to keep large stores, since they cannot afford to dispose of pesticides that are no longer approved of.

In 1991 the temporary National Pesticides Retrieval Scheme was launched, which operated from 1 September to 31 December 1991. The aim of the scheme was to provide farmers with a safe, simple and inexpensive method of disposing of pesticides (BAA, 1992: 11). The scheme was a joint effort of the BAA, government, distributors of pesticides, the National Farmers' Union and disposal industry. Farmers were informed about the retrieval scheme by advertisements in the farming press and media coverage, by merchant's representatives and Health and Safety Executive (HSE) inspectors. Products for disposal were assessed at the farm by representatives of the scheme. These representatives decided which products should be included in the scheme and labelled them for return to the distributor's store. As a next step farmers disposed of the pesticides at a distributor's store. Subsequently the distributor delivered the products to incineration plants or to other legally recognized disposal sites. In terms of the quantity of products collected, about 300,000 tons, the scheme is considered to be successful. The collected pesticides were mainly out of date products from horticultural farmers and from small farmers in regions with extensive agriculture. Large farmers hardly par-

ticipated in the scheme, probably because they use up all their stocks. From a distributor's view the scheme was less successful, as in their stores an enormous mess arose due to leaking containers.

8.14 Concluding remarks

1. Empty containers of pesticides are treated in various ways: they are burnt, buried or just left in the field or on the farm, or they are removed by means of a chemical or household waste system. Containers have to be cleaned before they can be collected by a household waste system. Per Member State common practice of disposal depends on legislation, public attitude and infrastructure of waste collection systems. Whether collected waste should be recycled or burnt is still a major subject of discussion.
2. In all countries, except for Portugal, there is a tendency to deliver contaminated packaging at chemical waste sites. The crucial success factor for a systematic collection depends on the availability of an infrastructure of chemical waste companies. Such an infrastructure does not exist or is poor in Portugal, Ireland, Luxembourg, Spain and Italy; in other countries, with the Netherlands at the top, the infrastructure of chemical waste companies is more developed. This infrastructure is part of a system of separate waste collection, which is already operative or is planned to be introduced. Ireland and Luxembourg solve the problem of lack of chemical waste companies by exporting chemical waste abroad. The most suitable use of collected packaging - chemical recycling, thermal energy or re-use - is still a point of discussion.
3. Industry is often very concerned with a correct way of disposal of packaging, which can probably be explained by worries about the image of the pesticides branch. Its contribution varies from recommendations for the burying of packaging, like AEPLA in Spain, to the organization of a collection system of contaminated packaging, like IVA in Germany. The necessity of rinsing empty containers, which is only obliged in France and the Netherlands, and the design of containers are also main topics in which industry is involved.
4. In comparison with packaging, unused stocks are hardly considered to be a problem. From an economic point of view it is not rational to store large stocks of costly pesticides at the farm with the risk that these are prohibited in the near future. Moreover, there is often a transition period in which it is still allowed to use the product after it has been banned. Unused stocks of banned products in Belgium, Denmark, Germany, Italy, the Netherlands and the UK have to be delivered at the distributor or the chemical waste site; costs of disposal have sometimes to be paid by farmers. Recently temporary schemes for the disposal of unused stocks in Ireland, France (Pic Agri) and in the UK (National Pesticides Retrieval

Scheme) were launched. In Ireland this was initiated by industry; in France and the UK it was a joint action of authorities, industry, distributors and farmers.

9. MAJOR FINDINGS AND RECOMMENDATIONS FOR MONITORING AND RESEARCH

9.1 Introduction

The objective of this report is twofold. Firstly, sales of pesticides for agricultural use are assessed at national level. Besides, regions and crops within the EC with a high use of pesticides are identified. Secondly, the ways in which these pesticides are treated in the market system, in terms of the infrastructure of distribution networks and patterns of sale, are examined. In addition, recent initiatives regarding the collection of packaging material and the disposal of unused stocks are also discussed.

The major findings of the report are summarized in section 9.2; recommendations for monitoring and research are given in section 9.3.

9.2 Major findings

The market of pesticides in the EC

1. France, Germany and Italy are the three Member States with highest sales of pesticides and a share in the EC pesticides market of respectively 38, 16 and 13%. Cereals have a rather high share in total pesticide costs in most countries. It is highest in the United Kingdom (some 60% of national sales), Denmark and Germany (slightly less than 50% of national sales). The same holds in Spain and Italy for the share of pesticides to grow fruit, grapes and vegetables (over 50% of national sales).
   The EC is a net exporter of pesticides. The export value of pesticides exceeds the import value in Germany, the United Kingdom and the Netherlands. The four main producers of pesticides in Germany already account for 20% of global production.

Price differences among countries

2. The price of pesticides may differ among countries. Such price differences may arise in case the price ratio of pesticides among two countries differs from their official exchange rates of national currencies. Prices may also be higher in countries with a relatively long distribution network. This is the case in Germany where prices of pesticides are higher than in a country like France. Competition between private retailers and cooperatives or among cooperatives

may involve lower prices at farm level. In the past traders responded to such price differences by so-called parallel imports.

The available data on the costs of pesticides

3. Information on an EC scale is available on the costs of using pesticides at crop level (SPEL) and farm level (FADN). Market surveys and government statistics provide assessments on the sales of pesticides at national level.
   The costs of pesticides at crop level in the SPEL model are based on standard cost margins (Belgium, Germany, the Netherlands and the United Kingdom) and on the FADN for the remaining Member States. The total costs of pesticides at national level in SPEL are probably too high in Portugal (over 300 million ECU according to SPEL compared to 100 million ECU according to other sources). The costs of pesticides are probably too low in the Netherlands (around 175 million ECU according to SPEL compared to around 250 million ECU according to other sources). Costs of intermediate consumption are based on the economic accounts, provided by the Member States.
   The FADN provides information at farm level, but it does not represent the small farms. This might explain the underestimation of FADN compared to data from market surveys.

Sales of pesticides in kilogramme of active ingredients

4. Sales of pesticides are monitored at the national level in all Member States. Statistics are presently available for all Member States on the sales in kilogramme of active ingredients. Data mainly originate from national associations of producers, manufacturers and importers of pesticides. These statistics are limited to the companies that are affiliated to the national associations. Government statistics are also published by most of the countries with the exception of France, Portugal and the United Kingdom. All firms in the Netherlands need to report on their sales of pesticides for agricultural use as of 1993.
   Annual sales of pesticides for agricultural use in the EC are estimated to be around 340-350 million kg of active ingredients. This is considered to be a best available guess of the actual use of pesticides for agriculture in the EC.

5. Statistics on the sales of pesticides allow to assess usage levels for all Member States. The use of pesticides per hectare of arable land and land under permanent crops ranges from less than 3 kg of active ingredients (Denmark, Spain, Ireland and Portugal) to over 10 kg of active ingredients (Belgium and the Netherlands). Sales are around the average of the EC (4.5 kg per hectare) in Germany and France.

Sales of pesticides are between 3 and 4 kg per hectare in Luxembourg and the United Kingdom. They are also relatively high in Greece and Italy (6 to 8 kg per hectare).
Countries with a high output level per hectare in agriculture may also have high input requirements on the use of pesticides. The use of pesticides per hectare of arable land and land under permanent crops is highly correlated to the output from crop production (exclusive of forage crops). Countries with a high output level per hectare tend to have a high usage of pesticides.

6. The use of pesticides is related to the intensity of farming practice since intensive cropping techniques may increase the risks of harvest losses due to pests and diseases. Farmers may respond to this through an overuse of pesticides in order to avert risks. Sales of pesticides for agricultural use in the EC showed a decreasing trend during the past couple of years. Sales in kilogramme of active ingredients decreased by at least 10% during the last couple of years. Total reduction in Belgium, Denmark, Germany, Greece, France and the Netherlands was some 17% since the mid 1980s. Several explaining factors need to be considered in an examination of this trend:
   - The role of technological development (i.e. chemical substitution) is likely to be one of the major reasons for such a change. A smaller amount of active ingredients per hectare suffices to treat plants compared to the past. It is difficult to assess the effects of such product substitution on the use of pesticides. Decisions by pesticide regulatory authorities are also important in this respect since they might largely reduce the choice of inputs available to farmers. Some major pesticides may not be available for comparable crops in all Member States. In some cases, farmers will have access to more potent products, which are effective at lower dosages than those pesticides available in other Member States.
   - Climatic and weather conditions could largely affect the use of chemicals to prevent pests and a subsequent variation of the use of pesticides;
   - The impact of the autonomous development of a decrease in utilized agricultural area in the EC is likely to be rather limited.

   The use of pesticides might further reduce in the years after 1992:
   (a) The CAP reform (including the accompanying measures) of 1992.
   On the one hand, the set-aside requirements might lead to an intensive use of pesticides on the remaining land, while on the other hand it might also be considered that price reduction of cereals and oil-seeds leads to a reduction of the use of inputs. The set-aside scheme is also likely to contribute to a reduction of pesticides in the EC. It is assessed to be some 15-20 million

kg of active ingredients, given the 1993 levels of compulsory set-aside of almost five million ha and an average use of pesticides to grow cereals of 3-4 kg of active ingredients per hectare. This is equivalent to some 4-6% of total use of pesticides in the EC. Although the CAP reform does not affect intensive horticulture in a direct way, it may have a displacement effect, in such a way that cereals are replaced by vegetables. A large-scale switch of arable land to vegetable production will probably be limited because of market saturation. The role of alternative crops, including biofuels, also has to be considered in an assessment of future trends on the use of pesticides.

(b) Environmental policy in the various Member States.
Reduction goals are formulated (Denmark and the Netherlands) or special measures are taken to diminish deterioration of the environment (among others Germany). The use of pesticides also diminished in response to environmental policy aiming to improve water quality. The use of nematicides in Germany for example has reduced largely since 1987 in response to the Water Protection Act.

(c) The Council Directive 91/414.
This directive concerns the admission of plant protection products on the market and is aimed to harmonize the registration of agrochemicals in the EC. Relatively old products may not be registered under this directive. This directive should contribute to the introduction of high standards of protection for man and the environment throughout the Community.

Use of pesticides at crop and regional level

7. Regions and crops with a high use of pesticides have been identified. The use of pesticides is highest in areas with intensive horticulture (northern Italy, the south coast of France, the south-east coast of Spain and the Netherlands). The use of pesticides to grow vegetables and fruit is high along the south-east coast of Spain (Murcia, Comunidad Valenciana and Andalucia) and northern Italy (Valle d'Aosta, Trentino-Alto Adige, Veneto, Liguria and Emilia-Romagna).
The use of fungicides to grow grapes is highest in regions with relatively high precipitation levels (e.g. the northern part of Italy with a national average of around 45 kg per hectare of grapes) and much smaller in regions with dry and hot summers (most of Spain with a national average of 30 kg per hectare). The use of pesticides along the south-east coast of Spain with intensive horticulture (fruit and vegetables) is higher than the use in horticulture under glass in northwestern Europe.
The use of pesticides to grow green peppers in Almeria is over 100 kg per hectare and might be as much as around 300 kg per hectare. The use of pesticides to grow bulbs and flowers from bulbs in the

Netherlands is very high. More than 10% of national sales are used to grow bulbs while these crops only account for about 1% of utilized agricultural area of the Netherlands.
Data from a few countries (Denmark and the Netherlands) show a wide variation among farms in the use of pesticides for crops. This indicates that there is scope to reduce the use of pesticides with current farming practice.

The costs of pesticides for major crops

8. Costs of pesticides per hectare for arable crops are on average lower than those for horticultural crops. Costs per hectare for arable crops vary between 40-145 ECU against a range of 100-225 ECU for horticultural crops. However, costs per hectare for some horticultural crops are considerably above or below this range. Costs of pesticides per hectare for both arable and horticultural crops in the northern Member States exceed those in the southern Member States, which can be largely explained by the higher yields per hectare in the northern Member States.

The costs of pesticides for major farming types

9. The costs of pesticides at farm level show a considerable range among regions. The costs of pesticides are high in regions with intensive agriculture. Differences among regions are also large for similar farming types. Important phenomena to be considered in this respect are cropping patterns, climatic conditions, structural characteristics and management practice. The incentive to reduce the costs of pesticides is likely to be higher at farms with a large share of costs of pesticides in total costs.
The costs of pesticides per hectare are highest in regions specialized in horticulture (e.g. northern Italy, the south coast of France, the south-east coast of Spain and the Netherlands) and regions in France with emphasis on specialist cereals and general field cropping (e.g. Ile de France and Picardie).
Costs of pesticides tend to be lower on arable farming than on horticultural farming types. Costs of pesticides expressed as percentage of family farm income (FFI) on arable farming types vary in a broader range (6-60%) than on horticultural farming types (5-40%).
Costs of pesticides as percentage of FFI on cereal farms are about 10% in Italian and Spanish regions and about 50% in France and the UK. This share is also high on general field cropping farms in German, French and UK regions.
Costs of pesticides on specialist horticultural farms as percentage of FFI is relatively high in Andalucia (35%), Denmark (39%), Canarias (47%), Cataluna (52%) and England West (65%); in other regions

(Belgium, France, Italy, the Netherlands and most of the United Kingdom) it is 15% or less.

Scope for reduction

10. The incentive to achieve a reduction on the expenditure of pesticides is likely to be highest in regions where costs of pesticides form a considerable part of total costs of input. These costs exceed 10% for some regions of all farming types considered across the Member States. They are relatively high at specialist cereals and general field cropping farms in large parts of France (10-16%), specialist horticulture across the south-east coast of Spain (12-17%), specialist vineyards in northern Italy (10-15%) and at specialist fruit and citrus fruit holdings across southern Europe (Greece, Spain, northern Italy and Portugal: 10-18%). The incentive to reduce costs of pesticides to grow arable crops is therefore likely to be higher in northwestern Europe than in the southern part.
The efficiency of using pesticides needs to be considered in assessments on the scope for reduction. Efficiency might be depicted by crop output per kilogramme of active ingredients used.

The infrastructure of distribution networks

11. Differences among countries are rather small on the distribution network of pesticides. The production and import of pesticides is mainly organized through multinationals. The producers and importers of pesticides arrange for delivery to the farmers through wholesale traders. They are either organized as cooperatives or as private companies. Industry plays an important role in advising farmers on the use of pesticides in several countries. They also greatly contribute to initiatives for integrated crop management.

Collection of contaminated packaging and disposal of unused stocks

12. Empty containers of pesticides are treated in various ways: they are burnt, buried or just left in the field or on the farm, or they are removed by means of a chemical or household waste system. In all countries, except for Portugal, there is a tendency to deliver contaminated packaging at chemical waste sites. Industry is often very concerned with a correct way of disposal of packaging, which can probably be explained by worries about the image of the pesticides branch. In comparison with packaging, unused stocks are hardly considered to be a problem. From an economic point of view it is not rational to store large stocks of costly pesticides at the farm with the risk that these are prohibited in the near future.

9.3 Recommendations

A significant reduction of pesticide use per unit of land is required under the Fifth Environmental Action Programme up to the year 2000. Sales and use of pesticides also need to be registered and controlled. These objectives need to be supported by research efforts and monitoring programmes. In the following a series of recommendations are formulated in order to contribute to the objectives of the Fifth Environmental Action Programme.

Recommendation 1

It is recommended that the sales of pesticides are registered at national level by an independent body. This should also contribute to a consistent definition in the EC on the annual sales of pesticides for agricultural use. Such a registration might be organised by making use of the experiences from BBA (Germany) and Istat (Italy).
Harmonisation of data would also be required in order to improve their internal consistency. Emphasis should firstly be on achieving a consistent definition on the sales of pesticides for agricultural use, distinguished according to the product groups herbicides, fungicides, insecticides, nematicides and others and depicted in kilogrammes of active ingredients.
This effort should provide the basic material to improve the quality of the available information across the EC.

Recommendation 2

The environment is a public good and monitoring programmes are required on the state of the environment and health regarding pesticides in food and the environment. Sufficiently reliable data on the use of pesticides at regional and crop level are required. This holds especially in those regions with serious water quality problems due to leaching of pesticides. However, a reduction of the total sales of pesticides does not necessarily imply a reduction of deterioration of the environment. In order to diminish deteriorating effects, especially sales of pesticides that are most harmful, need to be reduced.

Recommendation 3

It is proposed to initiate research on future development trends of the use of pesticides for agricultural purposes in the EC. Such efforts should contribute to the basic aim of the Fifth EC Environmental Action Programme, i.e. to achieve an ecologically sustainable economic development. The notions mentioned under item 6 from Section 9.2 need to be considered in order to assess the scope for a reduction of the use of pesticides. It is also recommended to base such work on improving the efficiency of using pesticides in agricul-

ture. Farmers should search for minimum usage levels of pesticides that are required to achieve maximum returns in agriculture.

Recommendation 4

It is proposed to assess the impact of the (patterns of) pesticide use on the regional environment. In this respect it is recommended to consider the number of applications of pesticides used as well as the quantities of product used. This also requires insight into usage levels at the regional level. Environmental policies, EC agricultural policy and technological development need to be considered. This would include the impact of the MacSharry reform (market- and price policy, the accompanying measures) and national pesticides policies on the use of inputs and the environment. It would require a multidisciplinary approach.

Recommendation 5

Policies to diminish the use of pesticides should primarily focus at the individual farm level. It is therefore recommended to initiate research to analyse the scope for a reduction of pesticide use at farm level in the EC. It needs to be mentioned that the FADN data used in this report only refer to averages of groups of farms. FADN provides a solid source of information for such an assessment. FADN includes the cost structure of agricultural holdings. It might also be linked to information on the use of pesticides at crop and regional level, available from various national sources. Focus of such an effort at farm level might be on regions with highest use in kilogrammes per hectare. Additional information on the occurrence of weeds and pests is required.

It is recommended in this respect to register the use of pesticides in FADN as well. This will provide information on the use of pesticides at farm level. Such a registration may also start with the regions with highest usage of pesticides in the EC. This work may build upon the experience from the Farm Accountancy Data Network in the Netherlands and their experience to register the use of pesticides at farm level.

Recommendation 6

The provision of better information to farmers will contribute to a reduction in the use of pesticides. Farming practice that is aimed at full control of weeds, pests and diseases may transform towards more rational levels of use. It is recommended that the extension services focus their advice on the use of pesticides according to the perception of risks, weather conditions and farming practice. The extension services should also base their advice upon farm characteristics (application of nutrients and soil type), costs of pesticides and the perceived loss of harvest due to the occurrence of weed, pests and diseases. This could build on the expertise from decision

support systems for farm use. An example is the Epidemic Prevention (EPIPRE) system, developed to grow winter wheat, which is being used among others in Belgium, Germany and the Netherlands. A periodic control of spraying equipment is recommended. A mandatory training for pesticide users might also be considered for a system of pesticide user license for certain categories of pesticides. The available infrastructure of advice to farmers and farm management should contribute to a broader use of curative spraying rather than preventive spraying.

Recommendation 7

Stocks of pesticides at farms are presently of limited importance. Major policy initiatives on the collection and disposal of unused stocks and banned products are therefore not required at EC level. A sufficiently long transition period, announced in such a way that it is well known to farmers, should be a prerequisite in case pesticides are not allowed to be used any more.

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APPENDICES

APPENDIX A Contributing organizations

Belgium

Belgische Vereniging van de Industrie van Fytosanitaire Produkten/Fédération des Industries Chimiques (FYTOFAR/PHYTOFAR)
European Crop Protection Association (ECPA)
Ministerie van Landbouw, Dienst Inspectie Grondstoffen
Ministerie van Landbouw, Dienst Plantenbescherming
Openbare Vlaamse Afvalstoffenmaatschappij (OVAM)
Wetenschappelijke Raad voor Fytofarmacie

Denmark

Dansk Agrokemisk Forening (Danish Agrochemical Association)
Landbrugsministeriet, Plantedirektoratet (Plant and Environment Division)
Landbrugsraadet (the Agricultural Council of Denmark)
Miljøministeriet, Miljøstyrelsen (Ministry of Environment, National Agency of Environmental Protection)
Statens Jordbrugsøkonomiske Institut (Institute of Agricultural Economics)

Germany

Biologische Bundesanstalt für Land- und Forstwirtschaft (BBA), Abteilung für Pflanzenschutsmittel und Anwendungstechnik
Bundesministerium für Ernährung, Landwirtschaft und Forsten
Deutscher Bauernverband e.V.
Deutscher Raiffeissenverband e.V.
Industrieverband Agrar e.V.

Greece

Agricultural University of Athens, Pesticide Science Laboratory
Panhellenic Association of Importers and Manufactorers of Agrochemicals

Spain

Associación Agraria Jóvenes Agricultores (ASAJA)
Associación Española de Fabricantes de Agroquimos Para la Protección de las Plantes (AEPLA)
Escuela Técnica Superior de Ingenieros (E.T.S.I.) Agrónomos (High Technical School of Agronomic Engineers), Unidad de Protecion de Cultivos
Generalitat Valenciana, Conselleria d'Agricultura i Pesca, Cap de Servei de Sanitat Vegetal

Ministerio de Agricultura, Pesca y Alimentacion, Direccion General de Sanidad de la Produccion Agraria
Ministry of Public Works and Town Planning
Ministerio de Sanidad y Consumo, Direccion General de la Sulud Pública, Subdirectora General de Sanidad Ambiental

France

Association Nationale de Protection des Plantes (ANPP)
Centre National des Jeunes Agriculteurs (CNJA)
Ministère de l'Agriculture et de la Pêche, Sous-direction de la Protection des Végétaux
Ministère de l'Agriculture et de la Pêche, Service Central des Enquêtes et Études statistiques (SCEES)
Ministère de l'Agriculture et de la Pêche, Direction de l'Espace Rural et de la Forêt, Bureau Agriculture et Ressources Naturelles
Ministère de l'Environnement, Direction de l'Eau et de la Prévention des Pollutions et des Risques
Union des Industries de la Protection des Plantes (UIPP)

Ireland

Federation of Irish Chemical Industries
Pesticide Control Service, Department of Agriculture, Food and Forestry

Italy

Agrisiel
Associazione Nazionale imprese fitofarmaci (AGROFARMA)
Confederazione Nazionale Cultivatori Directi (Coldiretti)
Istituto Nazionale di Statistica (ISTAT)
Ministero dell'Agricoltura e Foreste
Ministero della Sanita, Direzzione Gen. Igiene Alimenti e Nutrizione

Luxembourg

Administration des Services Techniques de l'Agriculture, Commission d'Agrement de Produits Phytopharmaceutiques

Netherlands

Landbouw-Economisch Instituut, Agricultural Economics Research Institute (LEI-DLO)
Rijksinstituut voor Volksgezondheid en Milieuhygiëne, National Institute for Public Health and Environmental Protection (RIVM)

Nederlandse Stichting voor Fytofarmacie (Dutch Foundation for Phytopharmacy)
Nefyto

Portugal

Associaçao Nacional da Industria Para a Protecçao das Plantas (ANIPLA)
Centro National de Protecçao de Produçao Agrícola (CNPPA)
Confederaçao de Agricultores de Portugal (CAP)
Direccao Geral do Ambiente
Instituto Nacional de Defesa do Consumidor, Divisia de Estudos Tecnicos

United Kingdom

Agricultural Development and Advisory Service (ADAS)
British Agrochemicals Association Limited (BAA)
Linking Environment and Farming (LEAF)
The National Farmers' Union (NFU)
Pesticide Usage Survey Group, Ministry of Agriculture, Fisheries and Food (MAFF)
Pesticides Safety Directorate, Ministry of Agriculture, Fisheries and Food (MAFF)
The Pesticides Trust

APPENDIX B Regional division of the EC in this study

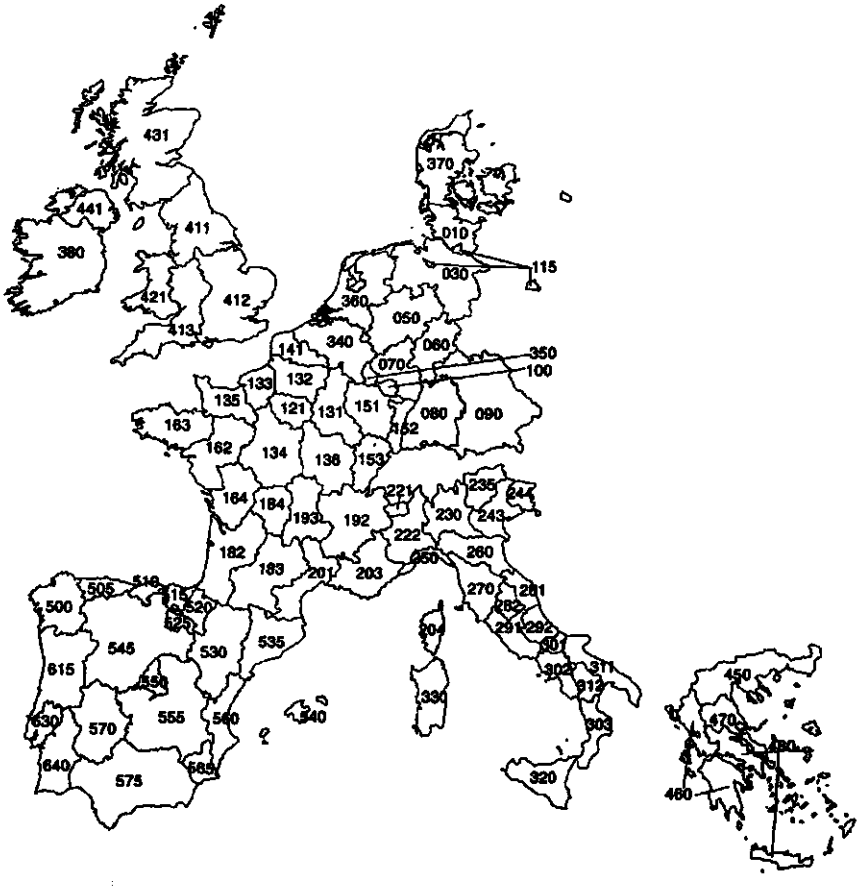

Figure B.1 Regional division of the EC in this study

The codes in the map refer to the following EC regions:

GERMANY
010 Schleswig-Holstein
030 Niedersachsen
050 Nordrhein-Westfalen
060 Hessen
070 Rheinland-Pfalz
080 Baden-Wuerttemberg
090 Bayern
100 Saarland
115 Hamburg, Bremen, Berlin

FRANCE
121 Ile de France
131 Champagne-Ardenne
132 Picardie
133 Haute-Normandie
134 Centre (F)
135 Basse-Normandie
136 Bourgogne
141 Nord-Pas-de-Calais
151 Lorraine
152 Alsace
153 Franche-Comté
162 Pays de la Loire
163 Bretagne
164 Poitou-Charentes
182 Aquitaine
183 Midi-Pyrénées
184 Limousin
192 Rhône-Alpes
193 Auvergne
201 Languedoc-Roussillon
203 Prov.-Alpes-Côte d'Azur
204 Corse

ITALY
221 Valle d'Aosta
222 Piemonte
230 Lombardia
235 Trentino-Alto Adige
243 Veneto
244 Friuli-Venezia Giulia
250 Liguria
260 Emilia-Romagna
270 Toscana
281 Marche
282 Umbria
291 Lazio
292 Abruzzi
301 Molise
302 Campania
303 Calabria
311 Puglia
312 Basilicata
320 Sicilia
330 Sardegna

BELGIUM
340 Belgique-België

LUXEMBOURG
350 Luxembourg

NETHERLANDS
360 Nederland

DENMARK
370 Danmark

IRELAND
380 Ireland

UNITED KINGDOM
411 England North
412 England East
413 England West
421 Wales
431 Scotland
441 Northern Ireland

GREECE
450 Makedonia Thraki
460 Ipiros Pelop. N.Ioniou
470 Thessalia
480 St.Ellas N.Egae. Kriti

SPAIN
500 Galicia
505 Asturias
510 Cantabria
515 Pais Vasco
520 Navarra
525 Rioja
530 Aragon
535 Cataluna
540 Baleares
545 Castilla-Leon
550 Madrid
555 Castilla-La Mancha
560 Comunidad Valenciana
565 Murcia
570 Extremadura
575 Andalucia
580 Canarias (not illustrated)

PORTUGAL
615 Norte-Centro
630 Lisboa-Vale do Tejo
640 Alentejo-Algarve
650 Acores-Madeira (not illustrated)