ANALYSIS OF INTENSIVE FARMING SYSTEMS IN THE EUROPEAN UNION

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1. Introduction

Intensive farming systems with high output levels generally are characterized by high usage levels of agrochemicals. This applies to farming conditions in Europe and elsewhere in the world. Rice production in Japan for example, is characterized by intensive and small-scale farming practice. Inputs used to grow this crop are high on a per hectare basis. Rice planted area of this country in 1991 covers only 1.4% of global total area to grow rice. Their share in global rice production is some 2.5%, which is almost twice their share in rice planted area. Rice agrochemical use in Japan however was more than 40% of the global rice agrochemical market (County NatWest WoodMac, 1992). Similar phenomena are observed in the European Union. Cereals planted area in Western Europe covers approximately 8% of global total. Their share in global cereals production in 1991 was some 18%, and their share in cereals agrochemical usage is around 55%. High levels of productivity and of inputs used are largely due to the intensive farming practices employed in this part of the world. Land is being used rather intensively in the European Union compared to other continents of the world. This phenomenon is reflected by a high input of labour or capital or both. This high intensity of farming in Europe is also reflected by usage patterns of plant protection products and mineral fertilizers. Farming systems in the European Union however show a diverse pattern, with intensive systems which contribute largely to agricultural production. Contrary to this, highly extensive systems may contribute largely to the provision of landscape and the maintenance of biodiversity and nature. Dehesas in Spain for example, covering more than 3 million hectares, includes extensive arable cultivation and complementary silviculture (Brouwer and Van Berkum, 1996).

This paper is to investigate linkages among use of agrochemicals with characteristics of farming systems in the European Union. The objectives of the paper are (i) to examine present use of agrochemicals in the European Union on farms with intensive systems; and (ii) to relate use of agrochemicals to indicators which reflect farm structure and economic characteristics. Emphasis is given to the use of plant protection products at intensive farming systems. Linkages with the use of mineral fertilizers are established as well. An assessment is made in this paper of the distribution in using agrochemicals across intensive farming systems in the European Union. Such an assessment on use of agrochemicals allows to contribute to answering questions like:

- What is the distribution among farms in using agrochemicals?
- To what extent does high usage of agrochemicals relate to economic performance of intensive farming systems and to farm structure characteristics?
- Is there a positive causal relationship in expenditures of plant protection products and of mineral fertilizers?

- What is the future scope to reduce usage of agrochemicals by European agriculture?

The assessment is mainly based on the Farm Accountancy Data Network (FADN) of the European Commission. FADN is based on the annual accounting results for a sample of commercial farms in the EU 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). Results are based on the accounting year 1992/93. This sample includes almost 60,000 farms which in total represent over 4 million farms in the European Union. FADN contains farm level data on the structure of the farm, total output and intermediate consumption. Farm level data are available on purchases of fertilizers and of plant protection products.

It needs to be mentioned that costs of plant protection products are an imperfect indicator of the use in terms of active ingredients. Costs of plant protection products however tend to be higher when intensiveness of production increases and that costs of plant protection products differ among crops. These findings give rise to the hypothesis that costs of plant protection products per hectare can be explained by (i) intensiveness of production and by (ii) specific crops.

2. Usage of fertilizers and plant protection products by European agriculture

Total costs of plant protection products by agriculture in EUR 12 in 1992/93 amounts to 5.7 billion ECU (table 1), which is some 7% above the average costs of the three years' period 1988/89-1990/91 (Brouwer et al., 1994). Expenditures decreased during that period by almost 15%, both in Germany and in Spain. Use of inorganic fertilizers also ranges largely across countries and farming systems. Costs of fertilizers and of plant protection products in the European Union are highest at arable farms.

Table 1 Total costs of fertilizer and plant protection products by farming type (million ECU), 1992/93

Country	Costs of fertilizer					Costs of plant protection products				
	arable	horti-culture	gra-zing livestock	other farms	all types	arable	horti-culture	gra-zing livestock	other farms	all types
Belgium	34	36	85	55	210	43	19	28	50	140
Denmark	142	17	64	71	293	87	9	35	50	180
Germany	260	57	448	289	1,054	249	64	126	204	643
Greece	173	120	12	18	324	119	109	2	5	235
Spain	427	220	53	37	738	136	204	8	12	360
France	1,177	237	768	466	2,649	1,156	452	214	314	2,138
Ireland	40	.	291	33	364	31	.	21	16	68
Italy	606	408	118	109	1,240	381	429	31	50	891
Luxembourg	.	.	10	1	11	.	.	2	1	3
Netherlands	79	153	168	20	420	148	122	25	20	314
Portugal	94	35	34	37	200	42	39	5	10	95
United Kingdom	438	40	425	137	1,040	493	29	55	85	662
EUR 12	3,471	1,324	2,476	1,273	8,543	2,884	1,477	552	816	5,729

Source: FADN-CCE-DG VI/A-3; adaptation LEI-DLO

The application of agrochemicals largely depend on cropping plan, intensity of the cropping plan, climatological conditions, professional skills of the farmer, market and price support, regulations on the use of agrochemicals, as well as availability and price of such products. Costs of agrochemicals on a per hectare basis in all countries are highest at horticulture farms (table 2). Differences across countries however remain to be large at horticulture holdings. Linkages among intensity of farming systems and the use of plant protection products at specialist horticulture holdings will be investigates in the next section.

Table 2 Costs of fertilizer and plant protection products by farming type (ECU per hectare), 1992/93

Country	Costs of fertilizer					Costs of plant protection products				
	arable	horti-culture	gra-zing livestock	other farms	all types	arable	horti-culture	gra-zing livestock	other farms	all types
Belgium	140	1,140	116	142	151	181	605	38	129	101
Denmark	115	782	96	85	106	70	391	52	59	65
Germany	107	280	93	94	100	102	315	26	66	61
Greece	104	108	61	68	100	71	98	10	20	72
Spain	54	85	19	31	51	17	79	3	10	25
France	123	177	76	102	104	121	338	21	69	84
Ireland	144	.	61	116	69	112	.	4	55	13
Italy	117	154	37	63	98	74	162	10	29	70
Luxembourg	.	.	97	88	96	.	.	20	36	29
Netherlands	134	1,532	143	98	203	251	1,214	21	98	152
Portugal	50	54	24	31	39	22	59	4	8	19
United Kingdom	93	588	39	78	60	105	433	5	48	38
EUR 12	97	151	61	82	85	81	169	14	53	57

Source: FADN-CCE-DG VI/A-3; adaptation LEI-DLO

Expenditures on fertilizers and plant protection products on a per hectare basis are highest in the Netherlands. Differences across farming types also are large in that country. Expenditures of agrochemicals per hectare in that country are highest at horticulture holdings. A detailed picture of the use of plant protection products (in kg of active ingredients) at farm level is available by farming type in the Netherlands (table 3). Data are based on the LEI Accounting Network. The use of plant protection products at arable farms on average amounts to 16 kg of active ingredients per hectare. It is highest (more than 50 kg/ha) at farms with mushrooms and greenhouse floriculture, and lowest (around 1 kg/ha) at farms with grazing livestock. It is around 100 kg/ha at farms with mushrooms. Also, it is high at farms with greenhouse vegetables and farms with orchards. The use of plant protection products per farm on average amounts to 9 kg per hectare. This includes all farms represented by the sample in the Netherlands and total size of utilized agricultural area, including arable crops, permanent crops and forage crops. Also, the ratio between costs of using inputs is related to total costs.

The intensity of plant protection products used enable an examination of the inputs used in the context of key economic indicators of farming. The ration between costs of using agrochemicals and total costs reflects the intensity of using this kind of inputs in agriculture. When the costs of plant protection products in total costs are high, the incentive to achieve savings (i.e. to reduce costs) in relation to risks are likely to be stronger than in the case costs are low. The

intensity of using plant protection products in the Netherlands is highest (7%) at arable farms. Although the use of plant protection products on a per hectare basis exceeds 30 kg per hectare at greenhouse vegetables, greenhouse floriculture and mushrooms, the intensity of using plant protection products is less than 2%. This is among others due to the high costs of energy used to grow crops in greenhouses.The incentive to achieve a reduction on plant protection products therefore is likely to be higher at arable farms than at holdings with greenhouse vegetables or with floriculture.

Table 3 Use of plant protection products in the Netherlands by farming type (kg of active ingredients per hectare) and the intensity of inputs used in 1993/94

Farming type	Insect-icides	Fungi-cides	Herbi-cides	Other	Total	Intensity
Arable farms	1.8	4.1	2.7	7.8	16.4	7.2
Grazing livestock	0.3	0.2	0.5	0.0	1.0	0.4
Field vegetables	1.8	5.0	2.0	9.1	17.9	2.9
Greenhouse vegetables	5.1	12.8	0.8	13.0	31.7	1.5
Greenhouse floriculture	10.9	18.5	1.3	27.5	58.2	1.4
Mushrooms	7.8	5.8	1.7	90.2	104.8	0.5
Orchard	2.4	24.1	3.5	3.3	33.2	3.9
Tree nursery	2.2	7.1	2.5	10.2	22.0	1.6
Average	1.3	2.4	1.5	3.7	8.9	1.6

Source: Poppe et al., 1995

The intensity of farming practice is related to the costs of using plant protection products. Output of crop production is highest in regions with relatively high costs of plant protection products. This is explained by the fact that intensive cropping techniques may increase the occurrence of pests and diseases. Farmers may respond to this through an overuse of plant protection products in order to avert risks. Research in the Netherlands indicates that differences among farms with lowest use of plant protection products and those with highest application levels may be up to a factor of 3 to 6 (Vernooy, 1992).

3. Distribution of agrochemicals used among farms in the European Union

Patterns of using agrochemicals differ largely in the European Union, both according to differences among Member States and farming systems. The use of plant protection products ranges across Member States from less than 3 kg of active ingredients per hectare (Denmark, Spain, Ireland and Portugal) to over 10 kg of active ingredients per hectare (Belgium and the Netherlands). Costs of using plant protection products are highest in regions with intensive horticulture, like 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 (Brouwer et al., 1994).

A more detailed picture on the use of agrochemicals by European agriculture is provided in the remaining part of this section. It is to focus on the distribution of agrochemicals used among farms in the European Union. The use of agrochemicals increase with the intensity of

farming practice. Farm management may also contribute to the distribution in using agrochemicals. Insight into the efficiency of using agrochemicals, i.e. the amount of input used per unit of output produced, is also important in this respect. Two farming types will be considered in an assessment of the use of agrochemicals among farms, i.e. specialist cereal farms and specialist horticulture farms.

Use of plant protection products at specialist cereal farms in the Paris Basin is relatively high compared to elsewhere in the European Union (Brouwer et al., 1994). Purchased plant protection products at specialist cereals in this region will be compared with the situation in Denmark as expenditures of plant protection products are below levels in the Paris Basin. We will focus on specialist horticulture holdings in the region of Andalucia (Spain) and the Netherlands because of high usage levels in these regions.

In the region of Centre, the share of costs of plant protection products in total costs increase with rising purchased plant protection products per hectare. Family farm income per hectare is highest at the group of farms with medium purchased plant protection products (table 4). Crop output per hectare UAA increase with rising purchased plant protection products. The share of forage crops, requiring low amounts of plant protection products, in total UAA is highest at group 'low'.

Table 4 Farm structure and farm output characteristics on the 33% of farms with lowest purchased plant protection per ha uaa (low) and the 33% of farms with highest purchased plant protection per ha uaa (high) and the category in between (medium) on specialist cereal farms in Centre (F) in 1992/93

	Low	Medium	High	All
Purchased plant protection (ECU) per ha uaa	75	121	167	122
Purchased fertilizer (ECU) per ha uaa	105	122	129	119
Crop output (ECU) per ha uaa	770	1,006	1,143	975
Economic size (ESU) per ha uaa	0.5	0.6	0.7	0.6
Family Farm income (ECU) per ha uaa	170	246	226	215
Farm net value added (ECU) per ha uaa	301	399	418	374
Share costs plant protection in total input (%)	11	14	17	14
Utilised Agricultural Area (ha)	90.9	99.6	93.7	94.7
- of which forage crops (%)	18	7	2	9
- of which cereals (%)	65	72	77	71
- of which other field crops (%)	17	21	21	20

Source: FADN-CCE-DG VI/A-3; adaptation LEI-DLO

In Denmark, differences on purchased plant protection are modest across the groups distinguished (table 5). Expenditures of plant protection products at group 'low'only are 1 per cent of total costs. The share of cereals and of other field crops in total UAA increases with rising purchased plant protection products, at the expense of forage crops.

Table 5 Farm structure and farm output characteristics on the 33% of farms with lowest purchased plant protection per ha uaa (low) and the 33% of farms with highest purchased plant protection per ha uaa (high) and the category in between (medium) on specialist cereal farms in Denmark in 1992/93

	Low	Medium	High	All
Purchased plant protection (ECU) per ha uaa	14	48	91	59
Purchased fertilizer (ECU) per ha uaa	107	109	136	120
Crop output (ECU) per ha uaa	471	695	896	730
Economic size (ESU) per ha uaa	.6	.7	.7	.7
Family Farm income (ECU) per ha uaa	-421	-293	-270	-313
Farm net value added (ECU) per ha uaa	-93	158	186	111
Share costs plant protection in total input (%)	1	4	7	5
Utilised Agricultural Area (ha)	18.5	25.9	34.4	26.3
- of which forage crops (%)	11	4	2	5
- of which cereals (%)	82	83	84	83
- of which other field crops (%)	6	11	11	10

Source: FADN-CCE-DG VI/A-3; adaptation LEI-DLO

At regional level, expenditures of plant protection products in the European Union are highest in regions specialized in horticulture and regions in France with emphasis on specialist cereals and general field cropping (Brouwer et al., 1994). At specialist horticulture holdings, costs of plant protection products per hectare fluctuate in a range of less than 500 ECU/ha in Denmark and England East to more than 1,000 ECU/ha (region of Liguria in Italy, and the Netherlands) (table 6).

In the analysis the focus is on the next indicators:

(a) Costs of plant protection products per hectare of utilized agricultural area (ECU per hectare). This gives indirectly an idea of the intensiveness of production;

(b) Costs of plant protection products per 100 ECU of output. The indicator presents the share of the costs of plant protection products in the value of output;

(c) Costs of plant protection products per 100 ECU of Farm Net Value Added (FNVA). This indicator provides information on the share of costs of plant protection products relative to FNVA;

(d) Costs of plant protection products per 100 ECU of Family Farm Income (FFI). This indicator reflects the share of the costs of plant protection products relative to FFI;

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

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

(g) Economic farm size (ESU). The economics 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 the holding. One European Size Unit (ESU) equals 1,200 ECU of standard gross margin;

(h) Utilized agricultural area (UAA);

(i) Cropping plan (area of different crops in percentage of UAA). Share of crops in total

UAA shows crops with high or low usage of plant protection products);

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

Table 6 General characteristics of specialist horticulture in 1992/93

Country	Number of repre-sented farms	Eco-nomic farm size (ESU)	UAA (ha) per farm	Costs of plant protection (ECU) per ha UAA	per 100 ECU of output	FNVA	FFI	input
Belgium	5,080	60	3.2	725	2	5	8	3
Denmark	1,670	101	6.4	479	1	3	35	2
Spain								
- Andalucia	14,580	17	2.9	546	6	8	13	9
France								
- Prov.-Alpes-Côte d'Azur	5,580	76	6.4	577	3	7	14	4
Italy								
- Liguria	8,330	25	.9	1,050	2	4	5	5
Netherlands	15,192	145	4.5	1,469	2	6	20	2
United Kingdom								
- England East	2,280	62	9.4	456	2	5	23	2

Source: FADN-CCE-DG VI/A-3; adaptation LEI-DLO

A more detailed investigation of specialist horticulture in Andalucia and in the Netherlands is provided in tables 7 and 8. The total number of represented farms in these two regions are around 15,000. Expenditures of plant protection products per hectare range between 550 ECU/ha (Andalucia) and almost 1,500 ECU/ha (the Netherlands). The share of costs of plant protection products in total costs on average ranges between 2% (the Netherlands) and 9% (Andalucia).

The use of plant protection products on specialist horticulture holdings may differ largely across individual farms. Average use might be high for a specific farming type, but the distribution within such a group of farms might be large as well. In the Netherlands it ranges between less than 500 ECU/ha at the group of farms with lowest purchased plant protection products per hectare UAA and around 5,500 ECU/ha at the group of farms with highest purchased plant protection products per hectare. The share of costs of plant protection products in total costs in this country is rather stable (2%) across the groups considered. Expenditures on plant protection products increase with a rising share of protected crops in the cropping plan.The share of costs of plant protection products in total costs are stable across the groups distinguished. This also applies to the share of the costs of plant protection products in output.

The share of market gardening and flowers in the cropping plan of specialist horticulture is around 70% in the Netherlands and in Andalucia. 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 the areas considered. It is almost 80% in the Netherlands, and about 50% in Andalucia.

Table 7 Farm structure and farm output characteristics on the 33% of farms with lowest purchased plant protection per ha uaa (low) and the 33% of farms with highest purchased plant protection per ha uaa (high) and the category in between (medium) on specialist horticultural holdings in the Netherlands in 1992/93

	Low	Medium	High	All
Purchased plant protection (ECU) per ha uaa	461	1,595	5,616	1,469
Purchased fertilizer (ECU) per ha uaa	385	2,812	8,604	2,157
Crop output (ECU) per ha uaa	23,958	81,735	293,117	76,197
Economic size (ESU) per ha uaa	11.6	34.1	119.8	32.4
Family Farm income (ECU) per ha uaa	4,166	10,908	14,987	7,444
Farm net value added (ECU) per ha uaa	9,735	30,177	92,982	26,577
Share costs plant protection in total input (%)	2	2	2	2
Utilised Agricultural Area (ha)	8.1	3.6	1.8	4.5
- of which open market gardening +flowers (%)	68	61	8	58
- of which sheltered market gardening +flowers (%)	3	15	75	16
- of which forage crops (%)	9	12	14	10
- of which cereals (%)	-	-	-	-
- of which other field crops (%)	-	-	-	-

Source: FADN-CCE-DG VI/A-3; adaptation LEI-DLO

Table 8 Farm structure and farm output characteristics on the 33% of farms with lowest purchased plant protection per ha uaa (low) and the 33% of farms with highest purchased plant protection per ha uaa (high) and the category in between (medium) on specialist horticultural holdings in Andalucia in 1992/93

	Low	Medium	High	All
Purchased plant protection (ECU) per ha uaa	146	678	1,065	546
Purchased fertilizer (ECU) per ha uaa	233	743	1,160	628
Crop output (ECU) per ha uaa	6,272	10,993	14,694	9,888
Economic size (ESU) per ha uaa	5.2	4.0	9.8	5.9
Family Farm income (ECU) per ha uaa	4,052	3,581	4,757	4,059
Farm net value added (ECU) per ha uaa	5,024	7,297	9,111	6,773
Share costs plant protection in total input (%)	6	9	11	9
Utilised Agricultural Area (ha)	4.0	2.7	2.1	2.9
- of which open market gardening +flowers (%)	4	91	14	36
- of which sheltered market gardening +flowers (%)	32	8	84	36
- of which forage crops (%)	1	1	2	1
- of which cereals (%)	13			5
- of which other field crops (%)	50			21

Source: FADN-CCE-DG VI/A-3; adaptation LEI-DLO

The share of sheltered market gardening and flowers in total UAA at group 'low' is very small in the Netherlands, whereas almost all market gardening and vegetables at group 'high' are produced under shelter (table 7).

Farming systems in Andalucia on average are much less intensive than they are in the Netherlands. Purchased plant protection products in the region of Andalucia ranges between less than 150 ECU/ha at the group of farms with lowest purchased plant protection products per hectare UAA and around 1,000 ECU/ha at the group of farms with highest purchased plant protection products per hectare UAA (table 8). Purchased plant protection products at group 'high' are about a third below the average of the Netherlands. The share of costs of plant protection products in total costs of specialist horticulture holdings in Andalucia increases from 6% (group 'low') to 11% (group 'high'). Costs of plant protection products increase with a rising share of protected crops in the cropping plan. The share of sheltered market gardening and flowers in total UAA is only 32% at group 'low', whereas it is 84% at group 'high' (table 8). The share of sheltered market gardening and flowers in total UAA is only 8% at group 'medium'. The share of open market gardening and flowers in total UAA is around 90% at that group of specialist horticulture farms in Andalucia.

The incentive to achieve a reduction on the expenditure of plant protection products is likely to be highest at farms where these costs are a considerable part of total costs of inputs used. These costs exceed 10% at specialist cereal farms in Centre (France) and the group of specialist horticulture farms in Andalucia with highest purchased plant protection costs per hectare.

Table 9 Farm structure of farms with at least 75% of UAA used for tomatoes in the Netherlands and in Campania in 1992/93

	Netherlands	Campania
Purchased plant protection (ECU) per ha uaa	4,260	397
Purchased fertilizer (ECU) per ha uaa	9,037	495
Crop output (ECU) per ha uaa	266,601	9,810
Economic size (ESU) per ha uaa	126.5	10.0
Family Farm income (ECU) per ha uaa	-20,485	6,628
Farm net value added (ECU) per ha uaa	71,829	6,910
Share costs plant protection in total costs (%)	1	13
Utilised Agricultural Area (ha)	1.9	.7
of which sheltered market gardening (%)	96	2
of which tomatoes (%)	96	94

Source: FADN-CCE-DG VI/A-3; adaptation LEI-DLO

Figures presented so far mainly focussed on specialist cereals and specialist horticulture holdings. Some characeristics of farm structure of horticulture holdings which are specialized in growing specific crops (i.e. tomatoes) are provided in table 9. Farm size in terms of utilized agricultural area is small, both in the Netherlands and Campania (Italy). Purchased plant protection products per hectare UAA in the Netherlands is approximately tenfold that of Campania. Similarly, crop output in the Netherlands is about 25 times that of Campania. Farming conditions in both areas largely differ because the share of sheltered market gardening in total UAA ranges between 96% (the Netherlands) and 2% (Campania). More than

90% of production is on fields in the open.

4. Scope for a reduction in use of agrochemicals

There is a general tendency in the European Union towards lower use of agrochemicals. This holds both for mineral fertilizers and plant protection products:

- Consumption of nitrogen fertilizers in Europe diminished by some 30 per cent during a period of only 5 years. Similar reduction levels are observed in use of phosphate (45 per cent) and of potassium (45 per cent). Consumption of fertilizers during that period increased mainly in Asia, and was rather stable in the United States of America. The use of mineral fertilizers in the Netherlands, for example, was partly replaced by animal manure, especially in arable crop production. Important factors in this respect are:
  - Increasing awareness among farmers of environmental problems due to farming practices. A more rational use of agrochemicals has been achieved partly in response to this change.
  - Agricultural policy presently aims to alter farming practice towards the adoption of less intensive production methods. The system of milk quota for example, has stimulated extensification of dairy production, because of the autonomous increase of productivity. The use of fertilizers also reduced at specialist dairy farms in the Netherlands.

  Linkages among agricultural production and use of fertilizers may change in response to more strict regulation on the treatment and application of organic fertilizers.
- Annual sales of plant protection products (in kg of active ingredients) showed a decreasing trend over the past couple of years. Sales of plant protection products reduced by some 15% since the mid1980s. There are several plausible reasons for this reduction. Important elements to be considered 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;
  - Climate and weather conditions could largely affect the use of chemicals to prevent pests and diseases. The use of fungicides for example is high in the northern part of Italy, compared to countries like Spain and Portugal. This is among others 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 plant protection products with the lapse of time.
  - Farm management aspects increasingly focus on the provision of modern spraying equipment, which could contribute to a further reduction on the application of agrochemicals.
  - Agricultural policy which increasingly is to encourage less intensive farming practices by direct payments subject to conditionality regarding the intensity of farming and the treatment of inputs. Council Regulation 2078/92 for example includes an aid system to encourage farmers to use production methods with reduced vulnerability to the environment or to conserve the environment and landscape. It involves measures for a significant reduction in the use of agrochemicals in crop production.

- Consumer behaviour with an increasing interest into quality marks for food products and for biological food products.

5. Concluding remarks

Some findings and concluding remarks are provided in this section regarding the analysis of intensive farming systems in the European Union.

- Expenditures on fertilizer and plant protection products in the EU varies largely across countries, between farming types within the countries considered and across groups of farms within a farming type in a country.
- Expenditures on plant protection products per hectare in EUR 12 on average are lowest at grazing livestock and highest at horticulture farms. Although 50% of all expenditures on plant protection products are done at arable farms.
- Structural characteristics of farming practice like the cropping plan, production method (sheltered) and intensity of crop production (number of harvests) determine the distribution of expenditures on plant protection among farms. The use of agrochemicals depends also on climatological conditions, farm management (skills of farmers), prices and regulations.
- The share of costs of plant protection products in total costs provides an indicator for the incentive to achieve savings by reducing the input of plant protection products. Intensity of plant protection products at arable farms of the Netherlands is higher than at specialist horticulture holdings in that country.
- There is a tendency towards lower use of agrochemical in Europe, not only induced by environmental policy regulations but also by agricultural policy and environmental awareness among farmers. Information on the use is an important aspect. Horticulture products however are not part of the market and price regime. Agricultural policy is therefore mainly to affect use of plant protection products in cereal production.
- Positive linkages are observed among expenditures for plant protection products and for fertilizers. Correlation coefficients between expenditures of plant protection products and of fertilizers at specialist horticulture in the Netherlands and in Andalucia respectively are 0.98 and 0.86. Output of crop production is highest in regions and farming systems with relatively high costs of agrochemicals. Correlation coefficients among expenditures for plant protection products and crop output are highest in the Netherlands (0.99). They also are high in Andalucia (0.65).

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