REGIONAL ANALYSIS OF USE PATTERNS OF PLANT PROTECTION PRODUCTS IN SIX EU COUNTRIES

PES - A/Phase 2

EXECUTIVE SUMMARY

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1.0 BACKGROUND

This study followed a review conducted by LEI-DLO in Phase 1 of the project on possibilities for future EU environmental policy on plant protection products (PES-A).

In their review LEO-DLO suggested three avenues for investigation:

1. Areas of more than moderate use of plant protection products:

   Germany - Nordrhein Westfallen, Rheinland Pfalz, Berlin

   France - Champagne-Ardennes, Alsace, Haute Normandie, Centre, Provence-Alpes-Cote d'Azur, Ile de France, Picardie, Nord-Pas de Calais, Languedoc-Rouissillon

   Belgium - Belgium

   Netherlands - Netherlands

   Spain - Rioja, Murcia, Canarias, Valencia

   United Kingdom - East Anglia

2. The intensity of use of plant protection products which vary substantially between countries.

3. Possible crops to be studied were given as:

   - Soft wheat
   - Barley
   - Vegetables
   - Fruit

With this as a background the following sub-project terms of reference were issued.

2.0 TERMS OF REFERENCE

Through a basis of agronomic analysis at farm level, the objective was to study:

2.1 Differences at farm level (within regions)

- What differences in use between farms can be found within a region?
- What are the reasons for these differences?
- What is the scope for reduction that is economically acceptable?
- What are the possible future developments or trends related to the use of plant protection products?

2.2 Differences at crop level (between regions)

- What are the reasons for these differences?
- Are these differences merely explained by variations in natural conditions, diseases, crop rotations, plant protection product prices or other reasons?
- Are there other differences that might give scope for reduction?

3.0 CROP AND REGIONAL SELECTION

It was evident at the outset that budgetary constraints would not permit as wide a geographical review as suggested by the LEI-DLO study and that, as a consequence, the crops studied might have to be modified.

3.1 Crop selection

Landell Mills' in-house agrochemical database showed the following crops to be of importance in total agrochemical load across the EU.

Table 3.1 The top 10 EU crops for agrochemicals

Crop	Crop area '000 ha	Total Active Ingredient Volumes tonnes				Average dose Active Ingredient
		Fungicides	Herbicides	Insecticides	Total	kg/ha
Vines	**3,936**	**100,906**	**5,124**	**2,150**	**108,181**	**27.5**
Cereals	**27,323**	**15,840**	**34,449**	**1,301**	**51,590**	**1.9**
Vegetables	1,330	8,566	1,217	25,619	35,402	26.6
Potatoes	**1,509**	**9,556**	**10,236**	**9,237**	**29,030**	**19.2**
Pome/stone fruit	**782**	**11,384**	**1,003**	**6,649**	**19,037**	**24.3**
Corn	3,986	*	15,091	2,676	17,767	4.5
Citrus	526	1,630	824	8,599	11,053	21.0
Beets	2,107	1,714	6,827	1,148	9,689	4.6
Tobacco	198	833	141	5,478	6,454	32.6
Oilseed rape	2,295	1,282	3,229	119	4,631	2.0

* some seed treatment

Crops emboldened are those selected for study.

Source: Landell Mills Agrochemical Database
Data year: 1992
Countries: Belgium, Denmark, Netherlands, France, Germany, Greece, Italy, Portugal, Spain, United Kingdom.

Vegetables were regarded as too fragmented a crop for satisfactory review at farm level so the four crops selected were:

- Vines
- Winter wheat (the major agrochemical user in cereals)
- Potatoes
- Apples (the major agrochemical user in pome and stone fruit).

3.2 Regional selection

Regions were selected across Europe where it was believed that there was above-average use of plant protection products for the crop and country concerned.

The target regions and eventual selection for study were the following:

Table 3.2 Regional selection

Crop	Country	Target	Actual
Cereals (winter soft wheat)	Germany UK France Italy	S Niedersachsen East Anglia Centre Piemonte	Hannover Cambridgeshire, Norfolk, Suffolk Eure, Eure-et-Loire, Oise, Loiret, Loir-et-Cher, Yonne Piemonte
Potatoes	Germany Netherlands UK France	N Niedersachsen Flevoland East Anglia Nord/Pas de Calais	Lüneburg Flevoland Cambridgeshire, Norfolk, Suffolk Nord, Pas de Calais, Somme
Pome/ stone fruit	France Italy Spain	Languedoc-Rouissillon Trentino Cataluña	Bouche du Rhône, Vaucluse, Gard, Herault, Drome Trentino Lerida
Vines	France Spain Italy	Bordeaux Rioja Veneto	Gironde, Charente and Charente Maritime Rioja Verona

These regions proved satisfactory though in hindsight a better choice for wheat in

Italy would have been Emilia Romagna, where the crop is grown more intensively than in Piemonte.

4.0 METHODOLOGY

The basis of the method used in the study was face-to-face farmer interviews in each of the 14 regions. Preceded by a restricted number of farmer group discussions, a questionnaire of approximately one hour in length was developed (presented in the crop review volumes). Fieldwork was conducted in mid-1995 and details were asked regarding product use in the previous season (1994) as well as qualitative and attitudinal aspects. Approximately 60 farmers were interviewed in each region.

Once results had been provisionally analysed, a series of interviews were held with key extension personnel in the regions in order to deepen the discussion and obtain models of growing costs and returns where possible. The sources of information used were:

Table 4.0 Sources of information

Crop	Group discussions No.	Farm survey		Local specialists No.
		No.	Area - ha	
Wheat				
Hannover (D)	-	60	1,956	3
East Anglia (UK)	1	61	4,627	7
N Central France	-	65	2,603	5
Piemonte (I)	-	59	563	4
Sub total	1	245	9,749	19
Potatoes				
Lüneburg (D)	-	60	1,076	4
Flevoland (NL)	-	60	897	8
E Anglia (UK)	1	60	2,060	5
N E France	-	62	862	5
Sub total	1	242	4,895	22
Apples				
S E France	-	62	862	5
Trentino (I)	1	60	213	3
Lerida (E)	1	60	676	4
Sub total	2	182	1,751	12
Vines				
Bordeaux (F)	1	59	1,420	6
Rioja (E)	-	62	1,383	4

Verona (I)	1	61	412	5
Sub total	2	182	3,215	15
Total	**6**	**851**	**19,610**	**68**

5.0 MAIN FINDINGS

Cross-regional reviews are presented by crop in this volume. These are in turn supported by more detailed individual regional crop studies provided in Volumes II-V.

The main findings are summarised below, both generally across crops and by individual crop.

5.1 Cross crop summary

5.1.1 Chemical loads

Taking a very simplistic approach for broad comparative purposes, the chemical loads in the regional sample of farms surveyed were:

Table 5.1.1 Chemical loads by crop

Crop	Region	Chemical load per hectare of crop grown per farm kg ai/ha	
		Average	Range
Wheat	Hannover (D) E Anglia (UK) N Central France Piemonte (I)	4.5 4.6 3.8 2.1	0.08 - 8.5 0 - 10.1 0.7 - 13.7 0.02 - 7.3
Potatoes	Lüneburg (D) Flevoland (NL) E Anglia (UK) N E France	9.8 12.6 13.1* 32.0	2.7 - 22.3 1.6 - 34.6 2.0 - 26.7 9.0 - 73.7
Apples	S E France Trentino (I) Lerida (E)	41.4 33.7 27.4	1.7 - 146.7 0.6 - 83.4 1.4 - 109.6
Vines	Bordeaux (F)	45.0	7.9 - 87.3

	Rioja (E) Verona (I)	16.8 (42)** 33.6 (43)**	2.9 - 146.9 0.8 - 142.4

* Excludes the use of sulphuric acid as a desiccant.

** There was suggestion by local specialists that farmers' use of sulphur was understated. Figures in brackets are computed as if all farms used sulphur.

Chemical load is the cumulative weight of active ingredient applied per hectare of crop per farm. Definitions may be found in the appendices of each crop section.

Chemical loads per crop varied widely between farms and regions. Comparative differences between regions are discussed in the sections below. Individual reasons for variability between farms were more difficult to identify specifically as there were so many variables in play. These are also discussed below. Not the least of these variables is the difference in inherent activity between chemicals. This can result in dose rate differences varying often by a factor of 100 and up to 6,000 (sulphur compared to pyrethroids).

The difference in inherent activity of chemicals makes the broad comparison by weight of active ingredient of limited value. However, in the absence any other parameter, this measure has been used consistent with other pan European studies.

Fungicides dominated the chemical load in all crops except wheat.

In potatoes, apples and vines, season-long disease protection is required. Given the chemicals available, this necessitates a series of prophylactic treatments throughout the season. In wheat, which shows relatively modest total chemical loads, herbicides were the major contributor closely followed by fungicides. Fewer applications are required compared to the other three crops.

5.1.2 Provisos

The difference in inherent activity together with the factors discussed in section 5.1.3 are the reasons for the great range of chemical loads presented in Table 5.1.1. Three general factors governing variability should be mentioned at the outset:

Managerial expertise:

Specialists emphasised the effect that good management can have on pesticide use. This covers particularly the choice of chemicals and the timing of applications. A mistimed application can lead to spiralling pest infestations later in the season and result in a requirement for excessive remedial use of chemicals as a consequence.

Pest incidence and infestation levels:

The study reported on the incidence of major pests at farm and regional level. However, it was not possible to determine the differences in intensity of infestations between farms.

Control achieved:

It was not possible to measure the level of control achieved by different pesticide application regimes. For example, farms using lower levels of pesticides may have achieved lower levels of control of the pests.

5.1.3 Agronomic variables

The following agronomic variables were found to have substantial influence on use of pesticides between both farms and regions.

Crop types

This is primarily of significance in potatoes.

Ware: Long growing season, blemish-free produce required, hence high fungicide use.

Seed: Shorter growing season, hence less disease protection required but high insecticide requirement to control the aphid virus vectors.

Starch: A lower priced, lower input crop.

All crop types may be grown on the same farm and the most sensitive crop type may dictate the regime for the whole farm in order to reduce reservoirs of infection. This attitude may be taken at times for all the crops studied.

Varieties

Variety choice is determined by end-use market demand. Only as a second priority are disease and pest susceptibility considered.

In all crops, varieties differ markedly in their susceptibility to disease, attacks from insects, nematodes, etc, the need for growth regulators and, in the case of potatoes, for desiccants. As with crop types, in certain circumstances for diseases and insecticides, the most susceptible variety on a farm can determine the spray regime.

In many instances, crops in a region are dominated by a single variety often susceptible to particular diseases. It is suggested that widening variety shares would lead to considerable easing of the pesticide load. However, this in turn is determined by market demand.

Target pests and levels of pest control required

The target pests are obviously the determining factor in chemical use. Technical levels of control required varied by pest and crop types (aphids in seed potatoes or ware, etc). Farmers were asked for the levels of control they were seeking. Weed control showed the greatest variation with regions showing considerable differences in willingness to accept less than complete weed control. This was particularly marked in vines in Verona whose farmers were least demanding in the levels of weed control sought.

Treatment timing

In all crops and in all the regions, an official warning system exists to help time the start of applications against major diseases and insects. Some of the systems are less than optimal or geographically restricted and more sophisticated techniques are being developed. Farmers make use of these systems to varying degrees employing them alongside less targeted techniques such as crop stage or date. It is felt that this area could be developed with advantage to assist improved targeting of fungicide and insecticide use and reduce any unnecessary treatments.

Dose rates

Dose rates generally followed recommended rates except in wheat, where considerable reductions were made in herbicides and fungicides, and in potatoes with herbicides. Specialists felt this practice had reached its maximum.

Application volumes and dose rates

For fungicide and insecticide applications in apples and vines, volumes of spray applied per hectare increase throughout the season as the leaf canopy develops. Differences in planting density, crop height and training architecture also influence spray volume per hectare. Seasonal average volumes of application were found to vary substantially.

Chemical dose rates are generally given in concentration of product per volume of spray mix though for vines in France this is only partially practised.

Given the variation in spray volume used, it is suspected that some unnecessary use of chemical is occurring.

Herbicide placement

In the perennial crops, application of herbicides along the crop rows was widely practised. Variations occurred between farms and regions suggesting that there was some room to increase the practice and further reduce the herbicide load.

Part-crop spraying

In all crops and chemical sectors, targeted spraying of parts of the crop most prone to or infected by a pest were evidently undertaken. This varied widely and it is suggested offers opportunity together with closer crop monitoring to wider exploitation.

Mechanical weed control

Only practised specifically for weed control in potatoes, this technique tentatively showed lower use of herbicides where it was practised. Soils vary considerably in their ability to permit this technique. Most widely practised in East Anglia, it is under further development there, and in Flevoland for potatoes.

5.1.4 Crop economics and pesticides

The majority of farmers felt that the profitability of their crops was satisfactory or above in most crops and regions in the study year (1994). However, for wheat in Hannover and apples in S E France and Trentino, the majority of farmers were dissatisfied with their profitability.

Anticipated levels of profitability for a given crop had no influence on product choice or use for the great majority of farmers.

The chemical sector contributing the most to profitability was seen by the majority of farmers as fungicides in all crops and regions except for apples in the Lerida (E) where insecticides were nominated. Farmers were divided as to the sector contributing the least in wheat and potatoes though in apples and vines this was identified as herbicides.

The majority of farmers in all crops and regions felt that no reduction in chemical use would be possible without reducing profitability. However, among those that did feel it was possible, fungicides were most proposed in apples and vines with insecticides also featuring in apples.

Consumer demand for blemish-free quality produce, particularly in potatoes and apples and by processors in potatoes, makes growers of these crops particularly risk-averse.

5.1.5 Pesticides and the environment

Product labelling

In all regions, a large majority of farmers believed that label restrictions on handling and the environment were important or very important with regard to their choice and use of products. In some sectors, local specialists felt that these responses were not genuine, particularly with regard to the environment.

Environmental factors influencing product choice

Consideration for environmental factors when choosing pesticides was not high on the agenda of most farmers. Among wheat farmers, greatest attention was paid to these factors in Hannover and Piemonte for ground water considerations. In the potato growing areas, most attention to these factors was paid by farmers in Lüneburg, where a wide range of factors was considered. In the apple regions, only farmers in Trentino demonstrated reasonable consideration for factors of soil protection, ground and surface water. Similarly for vines, farmers in the Verona area showed the greatest attention, in this case for soil protection.

5.1.6 Alternative crop protection systems

Aspects of Integrated Crop Management (ICM), Integrated Pest Management (IPM) and Organic Production (OP) methods were put to farmers. Replies were unsatisfactory as terminology appeared to be interpreted differently or not understood by respondents, despite definitions being supplied (see crop appendices).

Though ICM or IPM techniques were practised, or under development, to some degree in all crops and regions, this was particularly the case in apples and vines.

In apples, Trentino is renowned for its local IPM/ICM protocol which can be seen to be working when the region is compared to others in this study. In vines, local trials in Rioja have shown that better adherence to advisory/warning systems can halve the number of fungicide applications.

There is undoubted scope for these systems to be more widely introduced. However, they need commitment and technical awareness on the part of the farmers and growers as well as considerable support from the extension network.

5.1.7 Opportunities to reduce chemical loads

Given the foregoing summary across crops, the following opportunities for chemical load reduction are suggested for the main chemical sectors.

Seed treatment

This is a low dose environmentally sound way of plant protection which, with recent technological innovations and chemicals, now offers enhanced protection. It can reduce the need for early field applications of fungicides and insecticides.

Pre-storage treatment of potatoes can be substantially reduced through use of cold storage techniques.

Herbicides

Dose rates are at a minimum in all crops. Opportunities for reduction in load in wheat are suggested through increased use of selective targeting of fields. This can be enabled by greater use of the newer postemergence chemicals available, increased use of mechanical weed control where soils permit in potatoes and continuing the move away from residual soil acting herbicides in favour of contact acting chemicals in apples and vines. Increased use of treatments along the crop rows would also have benefits in some vineyards.

Fungicides

Varieties differ considerably in their susceptibility to diseases. This factor, however, is of a secondary priority to suitability for the end-user and so choice is consumer driven. In potatoes particularly, the most dominant varieties are especially susceptible to disease. In the short term, reducing this dominance would help reduce fungicide requirements. In the longer term, newer breeding techniques may be able to marry up end-user demands with disease resistance. Influencing the consumer to accept some skin blemish would also help.

In all crops, increased use and continued development of disease warning systems would help to better target treatments and reduce load though certain of the systems under development are some way off practical application.

In apples and vines the optimisation of spray volumes would appear to offer additional opportunities for reducing unnecessary load.

Insecticides

As with fungicides, increased use of local warning systems could tighten up use in all crops. Extension of IPM/ICM techniques, particularly in apples and vines, could also reduce load as would the optimisation of spray volumes.

CROP SUMMARIES

5.2 Wheat

Relative to the other crops in this study the chemical loads per hectare of crop grown in wheat were modest. Main sectors contributing to the loads were:

Table 5.2 Main sectors contributing to the chemical load in wheat

	Hannover (D)	East Anglia (UK)	North Central France (F)	Piemonte (I)
Average crop yields t/ha	7.7	6.5	7.2	4.4
Average chemical load per hectare of crop grown per farm kg ai/ha	4.5	4.6	3.8	2.1
Main sectors	% of average load			
Herbicides	38	36	44	69
Fungicides	27	24	29	8
Anti lodging agents	28	26	15	4
Others	7	14	12	19

Herbicides provided most to the loads in all regions with fungicides also substantial in the three northerly regions. In addition, anti-lodging agents were important in Hannover and East Anglia.

5.2.1 Main agronomic variables affecting the chemical sectors

Herbicides

Chemicals and dose rates:

In the three northern regions considerable experimentation has taken place with dose rates. In practice this has resulted in 20 - 30% reductions from registered rates. Variations in load were largely due to the difference between use of older low activity (heavier dose) chemicals compared to use of the more modern higher activity (lower dose) chemicals which tend to be applied post emergence and can therefore be more targeted to appropriate areas of infestation. Dose rate reduction was judged to be at its maximum in these regions. Piemonte was just starting this process.

Part-crop spraying:

Targeted spraying of selected parts of the crop was undertaken by 40 - 50% of farmers in the three intensive regions and 24% in Piemonte. This suggests a selective approach to herbicide use where practised. In Piemonte the smaller farm units probably make this less applicable.

Fungicides

Diseases:

In the three intensive regions disease pressure appeared similar though varying in spectra between regions. Piemonte had little disease.

Varieties:

Varieties differ in their disease susceptibility/resistance but this is a secondary priority for the farmer (and breeder) whose aim is to provide good yields of quality produce for the intended end-use.

Chemicals and dose rates:

As in herbicides, dose rates used were 20 - 30% lower than registered rates.

Part-crop spraying:

Spot and partial crop spraying was undertaken to a varying degree (35% of farms in Hannover - 23% of farms in East Anglia). This may be a symptom of lack of a selective attitude or widespread disease infestation.

Decision support and disease management:

Considerable research is being undertaken in all three intensive regions towards managing the diseases rather than eradicating them and on better decision support systems. These latter are not yet fully developed.

Seed treatment:

Seed treatment technology is developing fast and was seen in all regions as being able to reduce the need for some early fungicide treatments as well as early insecticide applications.

Anti-lodging agents

Risk and use:

Risk of lodging is high in all three intensive regions. Anti-lodging agent use was widespread ranging from about half the crop in North Central France to near total use in Hannover. They are seen as cheap and protecting the investment made in the crop.

Varieties:

Varietal resistance is available but, as with disease resistance, it is a secondary consideration to yield and quality. Varieties, local conditions and practice induce considerable variation in dose rates.

5.2.2 Effect of pesticides on profitability

The wheat crop was regarded as profitable by a majority of farmers in all regions except Hannover.

The chemical sectors contributing the greatest and least to profitability were seen as the following:

Greatest effect:

Fungicides were regarded by farmers in Hannover and East Anglia as having the greatest effect on profitability while herbicides were indicated in North Central France and Piemonte. Specialists disagreed with farmers in France and suggested fungicides.

Least effect:

Opinion was more divided as to the sector having the least effect on profitability.

The majority of farmers in all regions felt that it would not be possible to reduce their level of pesticide use without lowering profitability. Least sure in this area were the farmers in Hannover.

5.2.3 Environmental aspects

The majority of farmers in all regions felt that handling and environmental restrictions on the label were important.

Concerning the environmental considerations farmers took into account when choosing chemicals, these ranged widely though ground water considerations were prominent in Hannover and Piemonte.

5.2.4 Alternative crop protection systems

It was difficult to obtain adequate responses on questions concerning awareness and attitude to alternative crop protection systems, as understanding of the terms varied considerably. The systems reviewed were Integrated Crop Management (ICM), Integrated Pest Management (IPM) and Organic Production (OP). Definitions were supplied and can be found in the individual cross regional crop appendices.

Greatest interest in developing the systems was demonstrated in North Central France for ICM (85%) though it is understood that this is interpreted as 'following locally advised practice'. In Hannover both ICM and IPM received support from just over 40% of the farmers. Elsewhere support was weaker.

5.2.5 Opportunities to reduce pesticide load

Few possibilities are seen that are not already being worked upon. Opportunities in the main chemical sectors are:

Seed treatments:

> An environmentally and toxicologically sound way of using pesticides which, with recent technological advances, can help reduce early field applications of fungicides and insecticides.

Herbicides:

> Dose rates have been reduced to a minimum for satisfactory weed control and may have to increase. It is suggested that greater targeted spraying of portions of the crop offers opportunities.

Fungicides:

In addition to seed treatments, further development of the holistic approach to disease management and the spray decision support systems in process in all the intensive regions should offer opportunities for reduction. However, these are still some way off practical application.

Insecticides:

In addition to seed treatments, further development of work on infestation thresholds, crop monitoring and greater use of official warning systems should reduce or better target insecticide use.

Anti-lodging agents:

Specialists in the three northern regions where these products are employed felt that there was no justification for reducing their use.

5.3 Potatoes

Fungicides dominated the chemical load as may be seen from Table 5.3.

Table 5.3 Main sectors contributing to the chemical loads in potatoes

	Lüneburg (D)	Flevoland (NL)	East Anglia (UK)	N E France (F)
Average chemical load per hectare of crop grown per farm kg ai/ha	9.8	12.6	13.1*	32.0
Main sectors	% of average load			
Fungicides	67	67	60	87
Herbicides	15	12	13	8
Insecticides/Nematicides	10	9	19	1
Desiccants	3	10	2*	2
Others	5	2	6	2

Yields are not compared owing to different crop type mixes.

* Ignores additional desiccant use of sulphuric acid at an estimated 115 kg ai/ha on 47% of crop.

5.3.1 Main agronomic variables affecting the chemical sectors

Fungicides

All potatoes must be protected from *Phytophthora infestans* (late blight) throughout the season. A programme of contact protectant fungicides is the basis of treatments to which may be added systemic, partially curative chemicals. The difference in fungicide load was largely a result of the number of applications modified by the inherent activity (dose rate) of the chemical employed. The main variables affecting this were:

Crop type:

The ware crop tends to be in the ground longer than the other two crop types (seed, starch) and therefore requires longer protection. Flevoland and N E France had the highest proportion of ware in the crop-type mix and received similar numbers of applications. The difference in

fungicide load resulted from Flevoland using a more modern lower dose chemical.

Varieties:

Varieties are chosen for their marketability but vary widely in their tolerance of *Phytophthora*. The variety Bintje is particularly sensitive and dominated the regions of Flevoland and N E France accounting for about half the area in each case. Similarly in East Anglia, Maris Piper, also regarded as sensitive to *Phytophthora*, was grown on over 40% of the sampled area.

Climatic region:

The more maritime climates of Flevoland, East Anglia and N E France tend to induce greater disease incidence compared to Lüneburg.

Soil/irrigation:

Organic and clay soils tend to create a micro-climate favouring *Phytophthora*. Sandy soils require more irrigation than other soil types which in turn favours *Phytophthora*. In Lüneburg, however, it was claimed that irrigation induced greater resistance to the disease by encouraging crop growth.

Fertiliser use:

Excess nitrogen can increase incidence of blight. However all regions appeared to have refined this use.

Spray timing:

Farmers at present use a mix of plant stage and weather to determine when to start spraying. Official warning systems exist but appeared only well used in the Lüneburg region. Better spray decision support systems are being developed in all regions but are still some way off practical use.

Part-crop spraying:

Farmers spraying parts of their crop with a given treatment were highest in Flevoland (27%) and lowest in N E France (7%). While this will relate to the crop and variety mix on farms it is understood that some farmers tend to time their fungicide rounds by the needs of the most susceptible variety.

Herbicides

The main factors affecting variation in herbicide use were:

Weed flora:

> Broadly similar across regions though individual field flora obviously differ.

Control levels sought by farmers:

> Considerable variation between farmers and regions. Lüneburg and Flevoland appear satisfied with lower levels of weed control than the other two regions.

Proportion of the regional crop sprayed:

> This varied from 100% in Lüneburg and N E France to 90% in Flevoland and 78% in East Anglia.

Mechanical weed control:

> Weed control is a mix of herbicide use and mechanical hoeing. The latter was practised most in East Anglia (65% of farms) and least in Flevoland (27% of farms). The practice was encouraged most in East Anglia though not all soil types are suitable. Results tend to show that, where practised, the herbicide load was lower.

Chemicals used and dose rates:

> The mixture of active ingredients used across the regions varied considerably. Herbicide load was lightest in Lüneburg and heaviest in N E France. This reflects:

Soil type	-	lightest in Lüneburg
Crop type	-	highest starch content in Lüneburg with lower inputs
Chemicals	-	heavier dose chemicals in N E France. In Lüneburg, Flevoland and N E France dose rates had been cut substantially over recent years using a strategy of split treatments (pre and post emergence) and mixtures. In East Anglia there has been a trend for increase.

Part-crop spraying:

Farmers selectively spraying portions of their crop were highest in Lüneburg 40% and lowest in Flevoland 10%. This appears largely to be linked to the proportion of different crop types on a farm.

Insecticides and nematicides

Mainly of importance in East Anglia, Lüneburg and Flevoland, variation in use was largely a consequence of:

Pests:

Myzus persicae (aphids) were seen as important in all areas. *Globodera spp* (nematodes) were regarded as a problem in East Anglia (65% of crop) and to a lesser degree in Lüneburg (25 % of crop). Aphid treatments dictated the most widespread use of insecticides though nematode treatments used high dose rates where employed.

Crop types:

Seed crops require complete freedom from aphids while the starch and ware crops can withstand limited populations before requiring treatment.

Seed crops were least represented in N E France and most in East Anglia correlating with insecticide use.

Varieties and nematicides:

Some varieties have in-bred resistance to one nematode species though, in East Anglia at least, a species to which there is very little in-bred resistance (*G pallida*) is increasing. In all regions, except N E France where nematodes do not appear to be a problem, it was felt that nematicide levels had been reduced to a minimum and an increase in use was inevitable.

Chemicals and dose rates:

> The variation in inherent activity was a factor in the chemical loads.
>
> For aphids, the chemicals employed tended to favour the heavier dose chemicals. A specific aphicide, pirimicarb, was widely used in all regions. In addition, low dose pyrethroids were more present in N E France than elsewhere.
>
> Heavy dose nematicides were used most in East Anglia accounting for the chemical load there.

Part-crop spraying:

> Highest in Lüneburg at 46% of farms and lowest in N E France at 11% this is obviously determined largely by crop type (seed requiring greater attention).

Desiccants

Desiccants are used to burn off the foliage to prevent ingress of disease to the tubers and to facilitate harvesting.

Proportion of regional crops treated:

> This varied from 59% in Lüneburg to 98% in Flevoland.

Varieties:

> Varieties differ in the volume of their foliage and, as a consequence, the necessity for desiccation.

Chemicals and dose rates:

> Dose rates were modest but conditions varied requiring 1 - 5 applications. East Anglia presented a particular case where 47% of the crop was treated with sulphuric acid at very high volumes/dose rates.

5.3.2 Effect of pesticides on profitability

A substantial majority of farmers in all regions were satisfied with crop profitability in the study year. The chemical sectors contributing the greatest and least to profitability were seen as:

Greatest effect:

Fungicides were regarded in each region as having the greatest effect on profitability.

Least effect:

Opinion was divided.

The great majority of farmers felt that it was not possible to reduce pesticides without reducing profitability. Farmers in Flevoland were least adamant on this point.

5.3.3 Environmental aspects

A substantial majority of farmers in all regions regarded handling and environmental restrictions on the label as important.

Farmers in Lüneburg showed the most attention to environmental considerations when choosing chemicals. Ground water aspects were mentioned frequently. This was supported by the fact that 27% claimed to be in restricted water catchment areas. In the other regions, environmental considerations featured at low levels. Specialists felt that farmers would think that governmental departments should evaluate products and permit use of only those that were environmentally sound.

5.3.4 Alternative crop protection systems

Awareness of and interest in developing the three alternative systems (ICM, IPM and OP) was investigated but suffered from poor interpretation of the definitions.

Greatest interest was shown in ICM across all regions with farmers in N E France providing greatest support. However as already stated their interpretation of ICM was very broad.

Specialists in all regions stressed that potato production was a high risk

enterprise and that farmers were very risk-averse.

5.3.5 Opportunities to reduce pesticide load

Opportunities to reduce the pesticide load in potatoes are seen as:

Seed treatment:

An environmentally sound and efficient low dose means of disease control. No reductions in use seem necessary for pre-sowing treatments. The necessity for pre-storage treatments can be substantially reduced by cold storage.

Herbicides:

Low dose or split dose regimes, where practised, appear to have reached their minimum and may have gone too far in Lüneburg and N E France. Mechanical weed control is limited by soil type and risk of damage to the crop but can reduce herbicide demand. Work in East Anglia and Flevoland is in progress to optimise this.

Fungicides:

Varietal susceptibility to disease is of secondary importance to the farmer compared to marketability. Future breeding technologies may be able to link these more closely. Meanwhile with the present chemicals available, a prophylactic spray strategy is fundamental. Warning systems to help time these applications are available but are not fully satisfactory and only seem to have a reasonable following in the Lüneburg region. Better decision support systems are under development but are some way off practical use.

Insecticides/nematicides:

Aphid control offers little opportunity for reduction except possibly through better use of the warning systems.

Nematicide use had been reduced substantially in Lüneburg and Flevoland. In these regions and in East Anglia there was felt to be little chance of a reduction indeed, rather the reverse given the threat of increasing populations.

Desiccants:

Cultural techniques including varietal choice can minimise the need for desiccation. This process, however, is important and specialists see little room for reduction. Non-chemical techniques have been tried but

have not proved satisfactory.

5.4 Apples

Fungicides also dominated the chemical load in apples as evident from Table 5.4.

Table 5.4 Main sectors contributing to the chemical load in apples

	Provence/Languedoc /Rhone Alps (F)	Trentino (I)	Lerida (E)
Average chemical load per hectare of crop grown per farm kg ai/ha	41.4	33.7	27.4
Main sectors	% of average load		
Fungicides	79	82	40
Insecticides/acaricides	11	5	23
Herbicides	5	2	5
Plant growth regulators	4	1	1
Spray oils	2	10	30
Others	-	-	-

The reduced importance of insecticides/acaricides in Trentino is of interest given that region's particular emphasis on their Integrated Crop Management protocol.

5.4.1 Main agronomic variables affecting the chemical sectors

Fungicides

Diseases:

Apples have to be protected from two main diseases - *Venturia inaequalis* (scab) and *Podosphaera leucotricha* (powdery mildew). Differences in fungicide load between regions were largely as a result of differences in the relative importance of these diseases and the chemicals used to combat them.

In Provence/Languedoc/Rhone Alps and Trentino, *Venturia* was regarded as more important than *Podosphaera* while in the drier Lerida region the reverse was the case.

Varieties:

The Golden Delicious group dominated all regions from 56% of the sample area in Lerida to 77% in Trentino. Disease resistance has been good but there are signs that this is reducing.

Chemicals used and dose rates:

Traditional high dose contact protectant fungicides were used for *Venturia* control with regional differences on choice. For *Podosphaera* control, sulphur was widely used at high doses as well as low dose systemic fungicides. Some of these latter are active against both main diseases and were used most in Lerida. Disease resistance management dictates against too many applications of systemics.

Applications volumes and dose rates:

Volumes of spray applied increase throughout the season as the leaf canopy develops. Average application volumes centred around 1000 l/ha in the French and Spanish regions and 1500 l/ha in Trentino. Wide variations were recorded around these averages. With fungicide dose rates given as concentration per volume of spray, variation in application volume leads to variation in chemical dose per hectare. Differences in planting density and training architecture influence the spray volume requirements. Given the range of application rates, however, it is suspected that some unnecessary use of chemical may be occurring.

Part-crop spraying:

Farmers appeared to target their spraying to a greater degree in the French region (16% of farmers) and Spanish region (13% of farmers) than in Trentino (3% of farmers). This may also be linked to the size of crop holding or disease incidence (variety mix).

Application timing:

Farmers used a selection of factors to determine their spray timing. Some of these are not related to the disease such as date or plant stage, others are closely linked to the disease such as disease stage, weather etc. Official warning systems exist for timing *Venturia* sprays and are an established part of ICM or IPM programmes. These were followed to a greater degree in Trentino and Lerida than in the French region.

Insecticides/acaricides

A substantial list of pests was noted in each region but *Carpocapsa pomonella*

(codling moth), Aphids (various) and *Panonychus ulmi* etc (spider mites) were regarded as important in all regions though to varying degrees. *Quadraspidiotus perniciosus* (San Jose Scale) was also important in Lerida.

Mites were least widespread in Trentino possibly reflecting the success of their ICM/IPM protocol.

Other factors creating variability were:

Chemicals used:

> A very wide selection of chemicals was used in all areas. Improvement in timing has reduced codling moth treatments in all regions and specific aphicides and acaricides were also used in all regions. Trentino, following its ICM/IPM protocol, used no pyrethroids which are known to cause mite resurgence due to their effect on beneficial predators. These were most widely used in the French region.
>
> High dose petroleum oils were used most widely in Lerida (36% of sampled area treated) and least in the French region (3% of sampled area treated).

Application volumes:

> As insecticides are often applied in tank mixes with fungicides, application volumes vary correspondingly. This lead one to believe that some waste of insecticides may be occurring.

Spray timing:

> Warning systems are available in each region particularly for timing *Carpocapsa* treatments. Good use was made of them in Trentino and Lerida though in the French region there was widespread use of date for triggering applications with farmers unwilling to run risks of an uncontrolled attack.

Part-crop spraying:

> This was only undertaken by a limited number of farmers in all regions.

Herbicides

Herbicide loads were low compared to other main chemical sectors. Almost all the crop (98%) was treated in Lerida while 90% and 82% respectively were treated in the French region and Trentino. Mechanical weed control was rarely practised. Variations in load were due largely to:

Chemicals used:

There has been a move away from residual soil acting chemicals towards contact treatments. The change was most apparent in Trentino while in Lerida and the French region farmers were still using substantial quantities of residual herbicides.

Herbicide placement:

The great majority of farmers applied herbicides only to the tree rows. The area between the rows being mowed.

Part-crop spraying:

Some farmers treated their orchards selectively applying chemicals to certain areas. This was most employed in Lerida (22% of farms) and least in Trentino (4% of farms) but, as commented earlier, the low figure in Trentino may be due to the small size of holdings.

5.4.2 Effect of pesticides on profitability

Only a minority judged their profits to be satisfactory or above in the French region and Trentino for the study year (1994). In Lerida just over half felt their profits had been satisfactory or above.

The chemical sectors contributing the greatest and least to profitability were seen as:

Greatest effect:

Fungicides in the French region and Trentino. Insecticides in Lerida.

Least effect:

The great majority answering this indicated that herbicides had the least influence.

In all regions a majority of farmers felt that they could not reduce pesticide use without reducing profitability. However, particularly in Lerida and Trentino, there was a substantial body (ca 40%) who felt that there were possibilities. Fungicides and insecticides were mostly mentioned.

5.4.3 Environmental aspects

Handling and environmental restrictions on the label were regarded as important by the great majority of farmers in all regions.

Concerning the environmental considerations taken into account when choosing pesticides, only a minority paid attention to these in the French region and Lerida. However in Trentino there was a higher proportion (up to 58%) who considered environmental factors. Soil protection, ground water and surface water appeared to be considered most. This evidently reflected the local ICM/IPM protocol.

5.4.4 Alternative crop protection systems

Farmers appeared generally well aware of the alternative crop protection systems though the differences between ICM and IPM may have been confused. They also expressed interest in developing them on their own farms. This latter point conflicted with specialist experience in the case of Lerida.

5.4.5 Opportunities to reduce pesticide load

Opportunities to reduce the pesticide load in apples are seen as:

Herbicides:

> Herbicides were predominantly sprayed only along the tree rows and so limited further reduction in load appears possible from wider use of this technique. Continued reduction of soil acting residual chemicals in favour of contact herbicides will help reduce load and permit increased use of targeted spraying of portions of the orchards.

Fungicides:

> Specialists felt there was little scope for reduction. However it is suggested that increased use of the *Venturia* warning system might offer opportunities particularly in the French region.
>
> Attention to optimising application volumes may also reduce any unnecessary use of fungicides.

Insecticides/acaricides:

In Trentino, specialists confirmed that most growers were using ICM procedures. Though frequency of spray application was near to optimum, further fine tuning could lead to minor reductions in load. IPM/ICM techniques were less developed in the other regions. Improved use of the warning system and greater adoption of IPM/ICM procedures could lead to reduced use.

Plant growth regulators:

Market demand for blemish free fruit of optimum size determines the use of these products. The dominant variety (Golden Delicious group) needs both fruit thinning and russet control. Variety diversification and consumer education could reduce the need for this sector.

5.5 Vines

The relative importance of the main chemical sectors in vines is given in Table 5.5. Fungicides dominate the picture in all regions.

Table 5.5 Main sectors contributing to the chemical load in vines

	Bordeaux (F)	Rioja (E)	Verona (I)
Average chemical load per hectare of crop grown per farm kg ai/ha	45.0	16.8*	33.6*
Main sectors	% of average load		
Fungicides	90	61*	95*
Insecticides/acaricides	2	27	3
Herbicides	8	11	3
Others	-	1	-

* It was suggested by local specialists that use of sulphur had often been under reported which, if added in, brings the load up to the level in Bordeaux (see Table 5.1).

5.5.1 Main agronomic variables affecting the chemical sectors

Fungicides

Diseases:

Two main diseases *Plasmopara viticola* (downy mildew) and *Uncinula necator* (powdery mildew) dictate the necessity to protect vines throughout the season. Other diseases, particularly *Botrytis cinerea* (grey mould) are also of importance.

The relative importance of the two main diseases varies by region:

Plasmopara - more prevalent in Bordeaux and Verona.

Uncinula - more prevalent in Rioja.

Chemicals used:

Disease control relies on a succession of prophylactic treatments. These may be contact or systemic in action. The variation in chemical load results from a mix of number of applications and dose rate of the chemicals employed. Contact fungicides tend to be used at heavy doses and systemic chemicals at lower doses. Disease resistance management, however, dictates against too frequent use of systemics.

Bordeaux and Verona used a greater proportion of contact fungicides while Rioja used more systemics, which tend to have greater activity on the main disease there - *Uncinula* .

Application volumes and dose rates:

Volumes of spray applied increase as the season progresses and the leaf canopy develops. Seasonal average application volumes were lowest and varied least in Bordeaux and Rioja. In Verona, volumes were highest and varied most between farms. Dose rates are given in concentrations per hectolitre of spray rather than on a hectare basis in Italy and Spain. In France in vines this is less practised. Where this occurs, dose rate per hectare varies with spray volume. While size and architecture of the vines influences the spray volume required, the extent of variation suggests that some waste of chemical may be occurring.

Application timing:

Farmers used a number of factors to determine the start of fungicide applications. These include date, plant stage, weather and the local warning system. In Bordeaux and Rioja more attention was paid to the local warning system than in Verona.

Part-crop spraying:

The proportion of farmers spraying parts of their crop selectively was highest in Rioja (24%) and lowest in Verona where the practice was not used probably due to the small size of holdings.

Insecticides and acaricides

Pests:

A large number of insects and mites can attack vines. The main pests were:

Grape berry moths	(*Clysia ambiguella*) (*Lobesia botrana*)	Present in all areas and the main pests.
Leaf hopper	(*Empoasca flavescens*)	Present mainly in Bordeaux and to a lesser extent in Verona.
Spider mites	(various)	Present in Bordeaux and Rioja though understood to be less of a problem than growers claimed.

Proportion of regional crop treated:

Over 95% of the crop was treated in Bordeaux and Rioja while only around 60% was treated in Verona. An average of 2 applications were made in Verona rising to 3.7 in Rioja.

Chemicals used:

IPM was practised to some degree in all regions. Product mixes however varied.

Bordeaux - tended to use more sophisticated chemicals with a strong acaricidal bias.

Rioja - largely used traditional insecticides with heavy use of sulphur and parathion ethyl + petroleum oil. This accounted in large part for the higher load than in the other regions.

Verona - the selection of chemicals used indicated greater reliance on IPM techniques than in the other two regions.

Application volumes:

Variation in dose per hectare follows variation in spray volumes and, as with fungicides (tank mixes), suggests some unnecessary use.

Part-crop spraying:

About 20% of farmers in Rioja and Verona and 30% in Bordeaux sprayed their crops selectively.

Application timing:

Responses were inconclusive as to the factors taken into account to time applications. For the main pests, the grape berry moths, growers in Bordeaux and Rioja used the warning system together with monitoring the pest. In Verona few growers appeared to use this method despite the greater use of products applicable to IPM regimes.

Herbicides

Proportion of regional crop treated:

Herbicides were used over 80% of the crop in Bordeaux and Rioja and only on half in Verona.

Chemicals used and dose rates:

Contact and soil acting residual chemicals were used in all regions though in different proportions. In Rioja and Bordeaux substantial use was made of the soil acting residuals while in Verona use was practically all contact chemicals. Dose rates for all chemicals and in all regions were at the lower end of the registered range with Bordeaux below this.

Herbicide placement:

Herbicides were either applied over the entire vineyard surface (overall), along the vine rows or just spot treated. ‘Overall’ treatment was highest in Rioja (55% of farms) and lowest in Verona (13% of farms). Where spraying along the rows is practised the soil area covered ranges between 25 - 30% of the vineyard area. This method leads to substantial load reduction compared to overall treatments. Spot treatment, which accounts for the lowest herbicide load when used as the only technique, was most widely practised in Verona.

Mechanical weed control:

Mechanical cultivation (not always for weed control) was practised on the following proportion of farms:

Rioja	90%
Bordeaux	75%
Verona	57%

Given the wide use of herbicide treatment along the rows and the fact that some mechanical passes were more for soil aeration purposes than weed control, no relationship could be found to exist between mechanical cultivation and herbicide load.

Part-vineyard spraying:

The proportion of growers selectively treating parts of their vineyards was high ranging from 19% in Verona to 44% in Bordeaux suggesting a well targeted approach.

5.5.2 Effect of pesticides on profitability

A substantial majority of growers in all regions estimated the profitability of their vines as satisfactory or above.

The chemical sectors judged to contribute the greatest and least to profitability were clearly nominated by a majority in all regions:

Greatest effect - fungicides.

Least effect - herbicides.

A majority of farmers in all regions felt that no reduction in chemical use could be made without affecting profitability. However, between 26% in Verona and 38% in Bordeaux felt that it might be possible. There was overwhelming agreement across all regions that it was in the fungicide sector where reductions might be made. In Rioja, 29% of the growers questioned felt this to be the case and mirrors the local specialists' findings that well targeted fungicide applications could halve the number of treatments.

5.5.3 Environmental aspects

Handling and environmental restrictions on the labels were regarded as important by the great majority of growers. Specialists in Bordeaux and Rioja, however, felt that growers were being ‘polite’ in their answers on environmental aspects. They intimated that environment meant little to growers when choosing a chemical to use.

This latter point is borne out when reviewing the specific environmental considerations influencing choice of chemical. In Bordeaux and Rioja very few farmers indicated that they paid attention to specific environmental considerations. Verona provided the highest score with 42% of farmers taking ‘soil protection’ into consideration.

5.5.4. Alternative crop protective systems

As with other crops, questions on alternative crop protection systems were confused by lack of clear understanding of the terms.

Awareness of all systems (IPM, ICM, OP) was greatest in Bordeaux.

Growers in Bordeaux were most interested in developing ICM though the understanding of the term there is believed to be ‘following advised practice’. In the other regions some interest was indicated in IPM, for example, in Rioja this was expressed by several larger growers who represented 47% of the crop area.

Grower responses did not correspond well with specialist opinion. In Rioja the local specialists indicated that there was little interest in IPM/ICM. In Verona, where little interest was demonstrated by the growers, specialists reported that elements of IPM/ICM had been practised for many years - a fact borne out by the insecticides used.

5.5.5 Opportunities to reduce pesticide load

Opportunities to reduce the pesticide load in vines are seen as:

Herbicides:

Soil acting residual chemicals which by their nature tend to be used prophylactically were still used in some vineyards and regions. A move away from these to the contact herbicides would enable more

targeted/spot spraying to be undertaken. ‘Overall’ treatment is still practised by 55% of farms in Rioja and 32% in Bordeaux and does appear to offer some scope for reduction.

Fungicides:

Fungicides dominated the chemical load and general opinion seems to recognise that better adherence to advisory/warning systems (ICM) could reduce use. In some areas this could be substantial (Rioja).

It is suggested that some increased targeted spraying of portions of the crop and optimisation of the application volumes could also help.

Insecticides/acaricides:

IPM was practised to a greater or lesser degree in all regions but most in Verona. Wider use of the official warning systems in association with IPM/ICM techniques would appear to offer possibilities for reduction.

As with fungicides, it is suggested that increased targeted spraying of portions of the crop and optimisation of application volumes should also help reduce load.

6.0 CONCLUSIONS

Pesticide use and pesticide loads varied widely across the crops and regions surveyed. Pesticide load has been measured by weight of ai/ha. It must be appreciated that differences in the inherent activity of individual chemicals account for a substantial degree of the variability in load.

The principal load sectors and suggested opportunities for use reduction are highlighted below:

Wheat

- Herbicides were the most important sector accounting for approximately 40% of use in the Northern European regions and 69% in Piemonte.
- A continued reduction in dose rates over recent years has resulted in a significant lowering of herbicide load. Scope for further reduction appears limited.
- For fungicides, a holistic approach to disease management is developing in all intensive regions (Northern Europe). This approach, coupled with the development of improved decision support systems, offers scope for fungicide reduction in the future.

Potatoes

- Fungicides accounted for around two-thirds of the total chemical load and large regional variations were demonstrated by use of chemicals with different inherent activity.
- Varietal susceptibility to disease is a major factor influencing fungicide use. This was exaggerated in some regions by the widespread use of popular varieties with poor disease resistance.
- The prospect of better decision support systems offers a way forward for improved disease targeting and load reduction.

Apples

- Fungicides dominated, particularly in France and Italy, and scope for reduction is limited due to the consumer demand for unblemished fruit.
- Trentino, through its IPM/ICM protocol, is a good demonstration of insecticide/ acaricide use restriction. This technique offers potential for wider adoption in other regions.

Vines

- The heavy pesticide load was dominated by fungicides although insecticides were also important in Rioja. Season long protection is required to prevent loss of crop and a very wide range of chemicals were used including traditional products such as copper salts and sulphur.

- Specialists indicated that improved application timing, through greater use of advisory/warning systems, could result in significant reductions.

- IPM/ICM was practised to some degree in all regions - most extensively in Verona. Wider application of these techniques appears to offer possibilities for further use reduction.

REPORT FOR THE COMMISSION OF EUROPEAN COMMUNITIES
DUTCH MINISTRY FOR THE ENVIRONMENT

REGIONAL ANALYSIS OF USE PATTERNS OF PLANT PROTECTION PRODUCTS IN SIX EU COUNTRIES

PES - A/PHASE 2

A COMPARISON OF AGROCHEMICAL USE ON WINTER WHEAT IN FOUR REGIONS IN EUROPE

Hannover, Germany
East Anglia, UK
North Central France
Piemonte, Italy

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WHEAT - CROSS REGIONAL REVIEW

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WINTER WHEAT - CROSS REGIONAL REVIEW

SUMMARY

The study was conducted in mid 1995 on practices employed on the crop harvested in 1994. Four regions were reviewed, Hannover (D), East Anglia (UK), North Central France and Piemonte (I). These were covered by farmer surveys and discussions with key specialists in the regions.

General

The three northern regions, Hannover, East Anglia and North Central France, comprised high-input commercial enterprises, technically well advanced, and utilising all the available means of controlling weeds, diseases and insects, and of regulating growth. They are very well supported with advice from both official and private agencies, and respond to new developments.

The most strikingly different region amongst the four in this study is Piemonte. It is a region of low-input, small farms, mostly managed by an older age group which is technically unaware. With a drier climate the region does not suffer serious disease nor insect pest attack. Specialist advisers appear to have limited impact. In retrospect it would have been better to have selected Emilia Romagna.

Chemical load

The average volumes of active ingredients applied per hectare of crop grown by the samples are given below. They obviously ignore differences in inherent activity of the chemicals used.

		Average	(Range)
East Anglia (UK)	-	4.6 kg ai/ha	(0 - 10.1 kg ai/ha)
Hannover (D)	-	4.5 kg ai/ha	(0.08 - 8.5 kg ai/ha)
North Central France (F)	-	3.8 kg ai/ha	(0.7 - 13.7 kg ai/ha)
Piemonte (I)	-	2.1 kg ai/ha	(0.02 - 7.2 kg ai/ha)

Seed treatment

Farmers were not always aware of the seed treatments used hence this area is believed to be under-reported. Specialists in all regions considered seed treatment to be a highly desirable crop protection practice, being effective, well controlled, and toxicologically and environmentally safe. Besides protecting the seed, some treatments reduce the need for foliar insecticide and fungicide sprays to the growing crop.

Weed control - herbicides

The highest loads of active ingredient, both between regions and between farms within a region, were the result of the use of low activity herbicides which therefore required high rates of use. These tend to be older products which also offer broad spectrum control. Many of them are applied to the soil before the weed has emerged and are therefore prophylactic and tend to be applied to the whole crop area.

New active ingredients have been recently introduced which are post-emergent low dose (more active) and many are specific to particular weed species. They are replacing to a large extent the older products, particularly in the three northern regions. The whole strategy of weed control has thus changed, farmers now having an arsenal of different specific herbicides to use as and when they are needed. Within this scenario there appear to be differences between the three northerly regions.

In North Central France the definition of the dose for each herbicide for a range of weeds has been worked on in detail and was being widely recommended by advisers. Farmers in Hannover appeared also to be well advised, based on local trials, but some doses may be too low for the vagaries of practical use, and specialists were concerned about poor results. In East Anglia the new post-emergence herbicides were well established, but dose rates, though well below recommended rates, were still considerably higher than in the other two northern regions. There could be climatic reasons for this.

The use of this post-emergence weed control strategy allows for the most environmentally beneficial tactic - the possibility of spraying only the area of crop where a particular weed occurs - spot or partial spraying. This was being practised most widely in East Anglia.

The use of post-emergence specific herbicides demands technical awareness, field inspections and ability to spray possibly during a narrow window of suitable weather. The average farmer in Piemonte would appear to be unlikely to be capable of this at the moment.

Disease control - fungicides

There was no significant disease problem in Piemonte. The situation in the other three regions in terms of fungicide use was relatively uniform, one to three sprays being applied. In all three regions the doses used were about 70 to 80% of that recommended, and the range of active ingredients used was similar.

There were no factors apparent from this study which suggested that disease control in one region or on one set of farms was more efficient than another. The risk of fungicide resistance has forced all regions to closely analyse their use of fungicides for several years. There were no practices which were being carried out uniquely in one place which might have relevance elsewhere, although more spot or partial spraying occurred in Hannover (35% of farms) than in North Central France (25%) and East Anglia (23%).

A holistic approach is now being taken for the treatment of diseases, in which all aspects and their interactions are being considered together, including the use of disease resistant varieties. The research approach in East Anglia is to manage the crop canopy rather than to try to specifically control diseases, and it is one which will require great technical awareness on the part of farmers, and close contact with advisers throughout the season. The latter aspect, contact between advisers and farmers, is one which appears to be better developed in Hannover than the other regions. Research continuing in all three northern regions should eventually produce sets of recommendations which will be backed up by warning systems constantly assessing on a daily basis the necessity for spraying or not.

As the skill develops in allowing disease to exist in the crop, there should be an increase in spot or partial spraying.

Insect pest control - insecticides

Two species of aphid (*Macrosiphum avenae* and *Rhopalosiphum padi*), the latter particularly important as a virus vector, are the main pests in all four regions with the addition of *Hylemia coarctata*, the wheat bulb fly, in East Anglia and North Central France, *Sitodiplosis dactylidis* in East Anglia and *Agriotes*, a beetle, in Piemonte. There are therefore different pests to control in each region, requiring different insecticides. Nevertheless aphid control is by far the most important operation.

Unlike fungicides and herbicides where dose rate cutting was normal, for insecticides it was not - all regions maintaining the recommended label rate. In each region the heaviest loads were those where low activity active ingredients had been used.

In all regions it is important that farmers make frequent inspections of the crop to identify the incidence and level of intensity of aphid attack. This was carried out by farmers in Hannover and East Anglia and, to a lesser extent, in North Central France. In Piemonte, however, they appeared only to note incidence and not take into account the population density. A consequence was that more insecticide use than was necessary probably occurred in Piemonte, although only 14% of farmers sprayed. Warning systems can aid farmers in deciding whether to spray and the system in Hannover was well used - those in East Anglia and North Central France were less so. Field monitoring enables farmers to spray only those parts of the crop which are infested, and the highest proportion of farmers doing this was in East Anglia (34%). It is believed that there is scope to encourage this practice in all regions.

Miscellaneous pests - molluscicides

The only miscellaneous pests mentioned in all regions were slugs. These were most important in North Central France (46% of the crop area treated), and East Anglia (24% of the crop area treated). Treatments were only applied to the area where the pests were found. Specialists did not see any room to reduce usage.

Other agrochemicals - plant growth regulators (PGRs)

PGRs, applied to minimise the risk of lodging, were used on virtually all the crop in Hannover, about three-quarters in East Anglia, about half in North Central France but only 3% in Piemonte where the risk of lodging is very low. They are cheap and protect the full season's investment from damaging weather. Specialists felt there was no reason to minimise the use of these products, in fact those in East Anglia and North Central France felt there was less than optimal use, due to the fact that there had not been a bad season which might cause lodging for several years.

Trends in pesticide use

There were thought not to be any major changes in agrochemical/pesticide use over the last five years. However, it was agreed that there had been a slight reduction in herbicide use in Hannover and Piemonte, and from 1993 an increase in foliar insecticide use in East Anglia due to a new pest (*Sitodiplosis dactylidis*). There was concern expressed in East Anglia and in North Central France about the influx of weed seed from set-aside land. A positive impact of new seed treatments in reducing insecticide use was anticipated in all regions.

Farmers' main concerns in choosing new products were better control and economics, i.e. 'cost-efficacy', but in answer to several questions concerning development in new products and in the agrochemicals market, they expressed a very high level of satisfaction.

Label restrictions concerning product handling influenced farmer's choice and use of products more than those concerning the environment, although the difference was not large. The farmers of Piemonte, who basically only applied herbicides, considered these restrictions most important.

Profitability and pesticides

In East Anglia and North Central France a few more farmers felt that their wheat crops were satisfactorily profitable in 1994 than five years before. In Hannover substantially fewer farmers felt they were profitable in 1994 than five years before. In Piemonte there was little difference.

Farmers' attitudes to the influence that anticipated profits would have on their usage of agrochemicals varied - the least influence would occur in East Anglia and the most in Hannover.

The more northerly the region the more fungicides were considered to be the main influence on profitability while the more southerly the region the more it was herbicides that were seen to play the major role.

Alternative crop protection systems

Farmers were questioned on their awareness of three alternative crop protection/production systems that might be as equally profitable as conventional systems. The systems proposed were Integrated Crop Management (ICM), Integrated Pest Management (IPM) and Organic Production (OP). Definitions were supplied (see Wheat Appendix I) but there were varying levels of interpretation according to region.

Farmers in North Central France demonstrated the highest awareness of ICM and its potential profitability though it was felt that they understood this to be judicious use of pesticides as locally recommended. IPM methods were most recognised as profitable in Hannover and East Anglia.

Awareness of OP methods was greatest in East Anglia where a majority felt they might be profitable. Interest in developing the techniques was expressed most for ICM in North Central France followed by Hannover. IPM in Hannover received interest with some support in East Anglia, OP was mainly of interest to 20% in Hannover.

Environmental issues

Environmental considerations affected the choice of agrochemicals. The most outstanding cases were in Hannover and Piemonte. In the former there was a generally high level of concern, particularly with regard to ground water, soil protection and surface water as well as produce quality. This can be traced to the high-level concern expressed through government channels concerning ground water contamination by both nitrates and agrochemicals, and the consequent legislation enforcing almost nil residue levels.

In Piemonte a similar high profile official campaign, as a result of both nitrates and urea herbicide derivatives in ground water of the Po valley, has created awareness amongst the wheat growers of this study. Of most concern in East Anglia was produce quality, flora and fauna. The level of environmental concern in North Central France was the lowest of the regions.

Conclusion

The comparisons between regions and the analyses of the heaviest and lightest loads in each region have highlighted some interesting differences. Ignoring Piemonte, because of the unique socio-economic basis of wheat production there, the level of technological advancement in the other regions was high and broadly similar. Technically few possibilities are seen for reduction in agrochemical use that are not already being worked on.

All the lines of study aimed at rationalising agrochemical use have three consequences:

- an element of increased risk through lack of control of the pests,
- a major requirement for increased technical awareness, including the use of technologically advanced tools for monitoring and production,
- the need for year-round commitment.

There is therefore the requirement in each region for a detailed understanding of farmer attitudes, their level of technical ability, and the corresponding creation of the most appropriate back-up advisory and technical assistance facility. From an examination of the 'information sources' quoted in this study, this may have to have a different structure in each region.

1.0 THE REGIONS, METHODOLOGY AND SAMPLES

1.1 The regions

The regions were selected as being moderately high users of agrochemicals in winter wheat relative to the average for the country. The regions chosen were:

- Germany - Hannover
- United Kingdom - East Anglia, (Cambridgeshire, Norfolk, Suffolk)
- France - North Central (Eure, Eure et Loire, Loire et Cher, Loiret, Oise, Yonne)
- Italy - Piemonte

(In hindsight it would have been better to have selected Emilia Romagna in Italy where wheat growing is more developed than in Piemonte.)

1.2 Methodology

The format followed consisted of one group discussion held in Norfolk, East Anglia to determine broad parameters followed by farmer surveys in the four regions using a questionnaire of approximately one hour in length. Fieldwork was conducted in mid 1995 and questions related to agrochemical use in the previous season, 1994. Results having been obtained and partially analysed, were used as a basis for interviews with local specialists in the regions to discuss the findings and broaden the discussion.

1.3 The survey samples

The objective of the farmer survey was not only to ascertain current agrochemical practices in the region but also to identify differences in agronomic practice between farms.

Patterns of crop distribution by farm in all regions showed the typical pattern of the largest area of crop concentrated in the hands of relatively few larger units.

When designing the sample prior to commencement of research the causal factors of any variation are not fully known. It is often found, however, that one of the more common bases for variation in practice is enterprise size.

Budgetary restraint limited the sample sizes to around 60 per region. It was decided that in order to expose variation a sample with as far as practically possible adequate numbers of farms across the crop size distribution profile should be represented.

The statistics for the regions are presented in the individual regional reviews but are so different in make up that they are not easily compared. The samples resulting were the following:

Table 1.3 Farm survey samples

Wheat area per farm - ha	Hannover (D)		East Anglia (UK)		North Central (F)		Piemonte (I)	
	Farms %	Area %	Farms %	Area %	Farms %	Area %	Farms %	Area %
1 < 2	-	-	-	-	-	-	12	1
2 < 5	-	-	-	-	-	-	29	10
5 < 10	-	-	-	-	-	-	22	15
10 < 20	38	15	18	3	22	8	22	28
20 - 50	37	33	36	15	55	44	14	39
50+	25	52	46	82	23	48	2	9
Total No. ha	60	1,956	61	4,627	65	2,603	59	563
Average - ha	-	33	-	76	-	40	-	9.5
Regional average - ha	-	15	-	44	-	32	-	2.5

The average crop areas for the samples are compared above with the average for the region as a whole. From this it may be seen that the average areas in the samples were larger than for the regions as a whole, a consequence of spreading the sample as evenly as possible across the profile.

2.0 GENERAL RESEARCH FINDINGS

2.1 Farming demographics

2.1.1 Land tenure

Table 2.1.1 Land tenure

Region	Hannover (D)	East Anglia (UK)	North Central (F)	Piemonte (I)
Number of farms	60	61	65	59
Total crop area - ha	1,956	4,627	2,603	563
Tenure category	Farms %			
>60% owned	47	56	14	68
40 - 60% owned	25	12	6	9
<40% owned	28	32	80	23

North Central France was clearly different in land tenure, the majority of farmers renting land for their wheat crop. Most of these were medium sized farms. In the >60% owned category, smaller farms predominated in Hannover and Piemonte, but larger farms in East Anglia.

2.1.2 Occupational status

Table 2.1.2 Occupational status

Region	Hannover (D)	East Anglia (UK)	North Central (F)	Piemonte (I)
Number of farms	60	61	65	59
Occupational status	Farms %			
Full-time	86	98	85	86
Part-time	5	2	2	12
No reply	9	0	14	2

Part-time farmers generally farmed the smaller farms.

2.1.3 Farming enterprises

Table 2.1.3 Farming enterprises

Region	Hannover (D)	East Anglia (UK)	North Central (F)	Piemonte (I)
Number of farms	60	61	65	59
	Farms %			
Crops				
small grain cereals	100	100	100	100
maize	38	2	49	78
sorghum	2	0	0	2
soya beans	3	0	0	5
sugar beet	65	85	18	22
oilseed rape	42	21	54	3
sunflowers	2	2	42	15
peas	2	39	55	7
field vegetables	2	34	6	12
top fruit	0	4	0	10
soft fruit	2	0	0	2
temporary grass	10	18	25	14
permanent grass	25	36	45	41
Animals				
dairy	37	0	25	24
beef	18	4	23	15
veal	2	0	0	15
pigs	33	4	0	3
poultry	7	2	5	19
Other				
tourism	0	2	0	0

2.2 Crop agronomy

2.2.1 Varieties

Table 2.2.1 Varieties of winter wheat

Hannover (D)	East Anglia (UK)	North Central (F)	Piemonte (I)
Crop area 1,956 ha	Crop area 4,627 ha	Crop area 2,603 ha	Crop area 563 ha
Main varieties Area %			
Contra 15	Riband 36	Soisson 35	Centauro 33
Ritmo 14	Hunter 12	Thesee 11	Golia 7
Astron 12	Brigadier 12	Sideral 10	Eureka 6
Toronto 10	Soisson 9	Scipion 8	Marius 6
Pepital 10	Hereware 8	Rossini 6	Tommaso 4
Zentos 8	Hussar 3	Recital 4	Aquileia 4

There were significant differences amongst the varieties in each region concerning their susceptibility to diseases, and this in turn influenced the need for, and intensity of, fungicide application. The situation is complex with each variety having different levels of susceptibilities to each of a wide range of important diseases. For example, in Hannover, Contra, Ritmo and Toronto are susceptible to *Fusarium* in the ear, but are more resistant to other diseases whilst Zentos is particularly susceptible to *Puccinia recondita*, brown rust. In East Anglia, Riband is susceptible to *Puccinia* spp and *Septoria tritici*, whilst Brigadier and Soisson are susceptible to *Septoria nodorum*. Similar situations exist in North Central France and Piemonte.

Whilst characteristics of disease susceptibility do influence to some extent the application of fungicide to the crop, and breeders do attempt to select for resistance to the main diseases, the over-riding parameters for the farmer and hence for the breeder is yield and the suitability of the resultant crop for its intended use - for bread making, biscuit making, animal feed and so on. An example is the increasing popularity of Tremie in North Central France which yields about one tonne per hectare more than other varieties yet has lower levels of disease resistance. Many farmers sow more than one variety, often in a patchwork as a strategy to minimise the risk of fungicide resistant strains developing and spreading. Varieties sown in Piemonte were generally less disease resistant than in the other regions because disease pressure appears low.

2.2.2 Soil types

Table 2.2.2 Soil types - main constituents

Region	Hannover (D)	East Anglia (UK)	North Central (F)	Piemonte (I)
Crop area - (ha)	1,956	4,627	2,603	563
	Area %			
Sand	19	7	3	19
Silt	44	35	41	15
Clay	11	21	39	53
Organic	4	22	3	2
Other	23	15	14	11

Only in Piemonte was it suggested that soil type can have some effect on agrochemical usage. Here it was said that, for reasons of accessibility of the fields, where there was a preponderance of clay there was a tendency to use pre-emergence herbicides rather than post. Most of the reference to clay in Piemonte was in reality clay-loam, and in North Central France clay-silt.

2.2.3 Climate and irrigation

Climate and irrigation generally have an effect on the growth of plants and hence of weeds, the appearance of diseases and insects. There are complex warning systems for disease and insect attacks partly based on weather patterns. It is outside the scope of a study such as this to identify differences between the four regions. There was a small amount of supplementary irrigation in dry years in East Anglia but in other regions there was no significant area irrigated.

2.2.4 Crop rotations

Table 2.2.4 Crop rotations

Region	Hannover (D)	East Anglia (UK)	North Central (F)	Piemonte (I)
No. of farms	60	61	65	59
Wheat per length of rotation - years	Farms %			
1 : 1	5	2	-	15
3 : 4	-	7	5	2
2 : 3	18	11	5	-
4 : 6	2	-	-	-
3 : 5	3	2	-	-
1 : 2	58	15	55	30
2 : 4	20*	33*	18*	3*
3 : 7	2	-	-	-
2 : 5	5	8	2	-
1 : 3	75	16	42	25
2 : 7	2	-	-	-
1 : 4	13	11	31	12
1 : 5	5	7	3	-
No answer	-	-	-	13

* Where two wheat crops are grown either in successive years or alternate years separated by different crops.

The total of the rotations may come to >100% due to several rotations being practiced on the same farm.

There remain as good reasons now as there always have been not to sow wheat on the same land year after year. Soil and seed-borne diseases build up in the soil. The shortness of the wheat rotation depends on the availability of profitable alternatives which are suitable for growing in the area. In Hannover and East Anglia sugar beet was the principle alternative, whilst in North Central France these were oilseed rape, maize and sunflowers.

2.2.5 Fertiliser use

Table 2.2.5 Fertiliser use

Region		Hannover (D)	East Anglia (UK)	North Central (F)	Piemonte (I)
Crop area - (ha)		1,956	4,627	2,603	563
Constituent	Specification kg/ha	Area %			
Nitrogen					
high	>250	1	14	1	4
medium	150 - 250	92	54	85	24
low	1 - 150	3	27	14	50
nil	0	4	2	0	23
no answer			4		
Phosphorus					
high	>120	4	4	3	4
medium	70 - 120	38	39	69	14
low	1 - 70	21	13	16	58
nil	0	37	44	12	25
no answer					
Potassium					
high	>200	5	5	0	4
medium	100 - 200	39	27	43	36
low	1 - 100	23	19	46	37
nil	0	33	50	11	24
no answer					

Fertiliser levels are known to influence the occurrence of weeds and some diseases, usually increasing their incidence and severity. *Septoria* spp, however, are worse under low nitrogen conditions. Farmers are quite sophisticated in determining the crop's requirements and the conclusion is that in wheat there was no significant effect of fertiliser levels enhancing the use of agrochemicals.

Nitrogen

Nitrogen is essential for the production of high quality, grain protein. Levels of nitrogen in Hannover were the highest amongst the regions, specialists saying that the norm was about 250kg/ha - the top of the 'medium' range. Quantities applied in East Anglia have reduced during the past few years because of fears of nitrates in the ground water. These were generally within the medium level, although a significant minority still used 'high' levels. The lower levels applied in Piemonte were supplemented by applications of organic nitrogen in farmyard manure.

Phosphorus and potassium

Levels of application were much lower than for nitrogen, and on clay soils there may often be no need for potassium. In Piemonte and Hannover the use of farmyard manure occurred on some farms.

2.2.6 Average yields

Table 2.2.6 Average yields

Region	Hannover (D)	East Anglia (UK)	North Central (F)	Piemonte (I)
Number of farms	60	61	65	59
Yield t/ha	Farms %			
2	2	7	0	5
3	0	10	0	7
4	0	0	0	42
5	0	3	3	22
6	5	12	17	20
7	30	40	38	0
8	40	20	29	0
9	23	3	12	0
10	0	5	0	0
Average	7.7	6.5	7.2	4.4

2.3 Commercial issues

2.3.1 Destination of produce

Table 2.3.1 Destination of produce

Region	Hannover (D)	East Anglia (UK)	North Central (F)	Piemonte (I)
Number of farms	60	61	65	59
Destination	Farms %			
Flour	68	67	94	72
Animal feed	43	65	43	5
Seed - own use	23	2	46	3
Seed - for sale	13	3	8	23

The larger farmers had more than one destination for their wheat crop. The proportion destined for flour is higher if considered on the basis of total crop production. The high figure for 'seed for sale' in Piemonte conflicted with the ideas of local specialists who claimed that none was produced.

2.3.2 Contracts agreed in advance

Table 2.3.2 Contracts agreed in advance

Region	Hannover (D)	East Anglia (UK)	North Central (F)	Piemonte (I)
Number of farms	60	61	65	59
	Farms %			
Yes	3	25	15	10
Sometimes	5	10	6	15
No	90	59	75	69
No answer	2	7	3	4
Restriction on pesticides	2	8	3	5

The figures overstate the proportion of the crop area grown under an advance contract. Usually only part of a farm is concerned.

Contracts with agrochemical restrictions

Only a very small proportion of advance contracts included restrictions on agrochemical usage. Most written contracts containing agrochemical usage restrictions were with specialist food producers such as ‘health’ food or baby food manufacturers. The restrictions varied but included chemicals used in storage, herbicides and fungicides. These were believed to be for the purpose of ensuring nil residues in the grain.

3.0 PESTICIDE USE

3.1 Summary of chemical use

3.1.1 General

There was surprisingly little difference between three of the regions in the overall pattern of agrochemical use and the quantities applied, although there were differences within these totals which are examined in the appropriate section. The obviously different region was Piemonte where the social and economic basis of wheat production dictated a lower intensity of use.

Herbicides were the sector of highest volume use in all four regions followed closely by fungicides, except in the case of Piemonte.

3.1.2 Seed treatment

The recommended dose rates for seed treatment were used hence the main determinant of the volume of seed treatment used per hectare was the seed rate. Hannover averaged 200 kg/ha, East Anglia 191 kg/ha, and North Central France 160 kg/ha, but Piemonte averaged 245 kg/ha. However, the level of activity of the active ingredients used also affects average volumes of active ingredient per hectare. Farmers were not fully aware of what treatments had been applied by the seed merchant or original seed producer and so the amounts reported in this study may understate the true situation.

3.1.3 Herbicides

All the regions had widespread infestations of weeds which were acknowledged to be difficult to control. The main difference between farms using high loads of active ingredient and those using low loads was similar in all regions - the use or otherwise of active ingredients which have high or low levels of activity, in other words of low dose rate or high dose rate. There was less ‘spot’ or spraying of only parts of the farm in Piemonte compared with the other regions, possibly explained by the smaller farm size there and the impracticality of spraying a smaller area than that covered by a complete spray tank.

3.1.4 Fungicides

In the three northern regions >90% of the crop was treated while in Piemonte there was little disease pressure and only 20% of the crop was treated with fungicides. In the other regions the variability amongst farms was mainly due to the number of sprays applied. Adding to this was the inherent level of activity of the active ingredients used. In all three regions dose rates were below those recommended. Up to a third of farmers in Hannover and a quarter in East Anglia and North Central France at times sprayed only parts of their farm dependant on the location of the disease.

3.1.5 Insecticides

In the regions of Hannover, East Anglia and North Central France, aphids were the key pest and because of their ability to vector plant viruses most of the crops were treated. However, in Piemonte where aphid-transmitted virus appears less important, only 19% of the area was treated. It is of interest that in all three northern regions dose rates were maintained around the recommended level. In East Anglia a higher proportion of farmers than the other regions selectively sprayed parts of their crop following inspections.

3.1.6 Miscellaneous pesticides

The only other pests mentioned were slugs and snails. North Central France was treated most followed by East Anglia and Hannover. Treatment was negligible in Piemonte. Treatments were mostly targeted at specific parts of the crop in all regions.

3.1.7 Other agrochemicals

Chemicals were applied which reduce the risk of lodging. (Lodging is when stems become broken as a result of inclement weather, and it usually occurs after the ears have filled and the head becomes heavy towards harvest time.) Some varieties are particularly resistant to lodging, especially short straw varieties, and they require no treatment. Most treatments were applied in Hannover followed by East Anglia, North Central France and Piemonte. Dose rates and numbers of treatments varied widely due to varieties, soil type and local factors.

Table 3.1 Summary of chemical use

	Hannover (D)			East Anglia (UK)			North Central (F)			Piemonte (I)		
Area grown ha	1,956			4,627			2,603			563		
	Proportion of crop treated %	Average volume of active ingredient kg/ha		Proportion of crop treated %	Average volume of active ingredient kg/ha		Proportion of crop treated %	Average volume of active ingredient kg/ha		Proportio n of crop treated %	Average volume of active ingredient kg/ha	
		on crop treated	on crop grown		on crop treated	on crop grown		on crop treated	on crop grown		on crop treated	on crop grown
Seed treatment	78	0.184	0.144	92	0.156	0.144	78	0.230	0.180	46	0.396	0.181
Fungicides	98	1.258	1.230	96	1.154	1.097	92	1.181	1.090	20	0.821	0.163
Herbicides	80	2.136	1.709	95	1.724	1.638	99	1.697	1.650	91	1.522	1.426
Insecticides	94	0.131	0.124	85	0.378	0.321	73	0.081	0.059	19	0.651	0.122
Other pesticides	6	0.835	0.047	20	0.760	0.152	46	0.488	0.223	4	2.364	0.084
Other agchems	96	1.416	1.275	65	1.851	1.202	36	1.580	0.569	8	1.000	0.083
All sectors	100	*	4.529	100	*	4.554	100	*	3.771	93	*	2.061

* Treatments were not necessarily applied to the same area of crop in each sector of chemicals so no total is provided for this column.

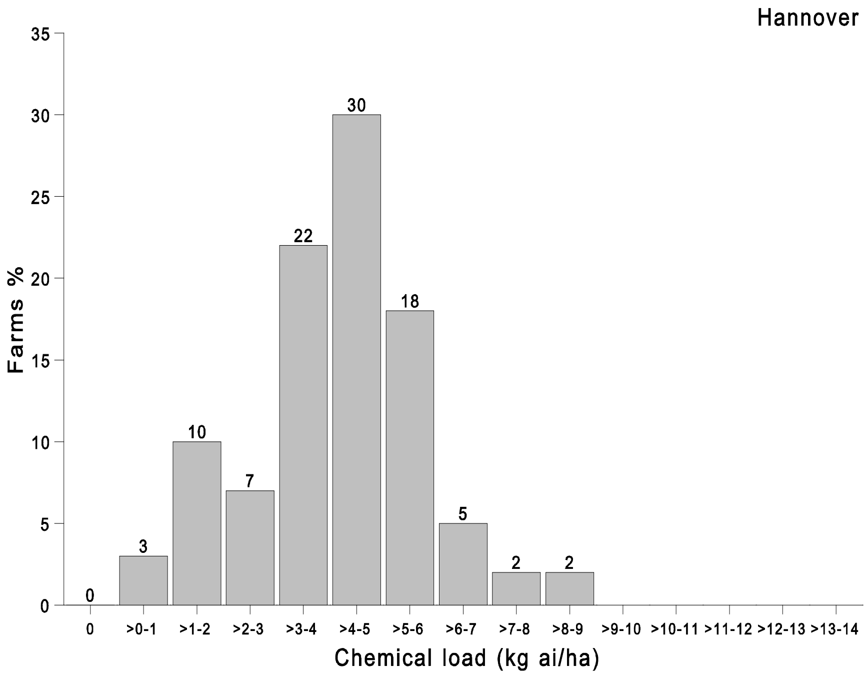
Seed treatment is believed to be underestimated in all regions because purchased seed was often treated by seed producers or merchants and the seed treatments applied were not known to all farmers.

3.2 Variation in chemical load between farms and regions

Table 3.2 Variation in chemical load between farms and regions

Region	Hannover (D)	East Anglia (UK)	North Central (F)	Piemonte (I)
Number of farms	60	61	65	59
Chemical load kg ai/ha	Farms %			
0	0	3	0	5*
>0 - 1	3	3	3	32
>1 - 2	10	11	14	31
>2 - 3	7	11	25	17
>3 - 4	22	16	23	7
>4 - 5	30	13	12	5
>5 - 6	18	20	8	0
>6 - 7	5	7	8	0
>7 - 8	2	5	0	2
>8 - 9	2	7	5	
>9 - 10	2	5	0	
>10 - 11		2	0	
>11 - 12			2	
>12 - 13			0	
>13 - 14			2	
Range kg ai/ha	0.08 - 8.5	(0) 0.7 - 10.1	0.7 - 13.7	0.02 - 7.3

* No answer.



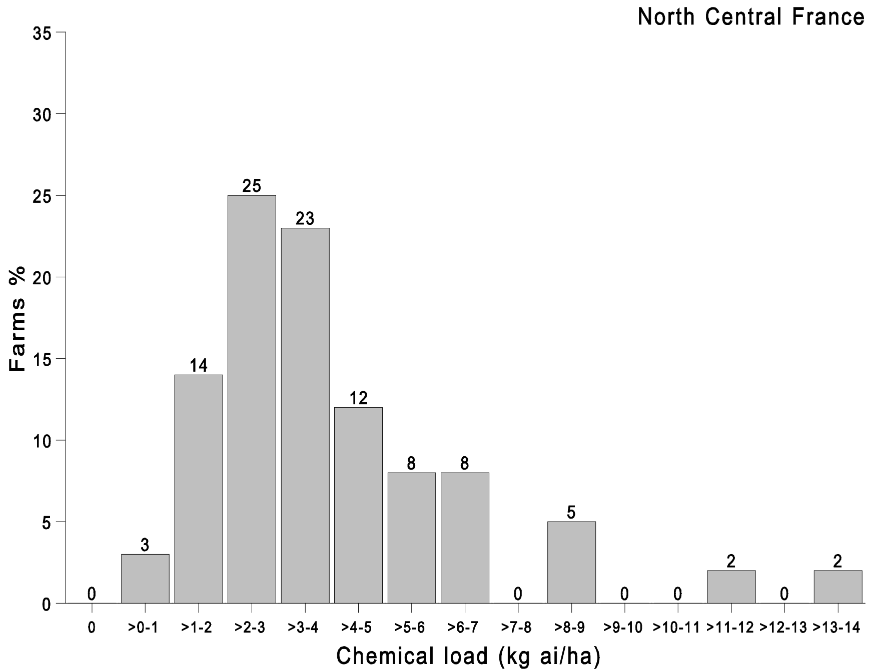
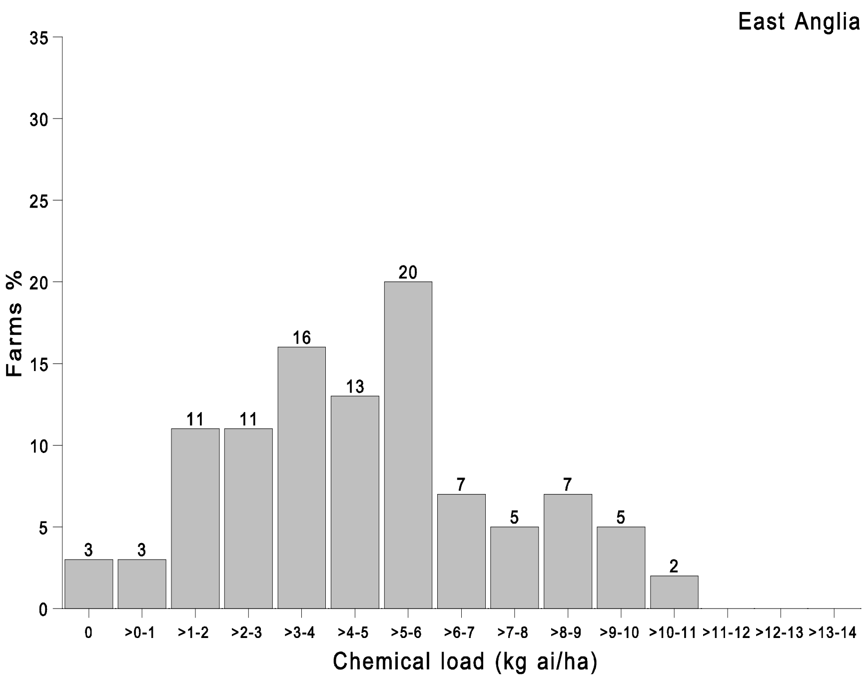
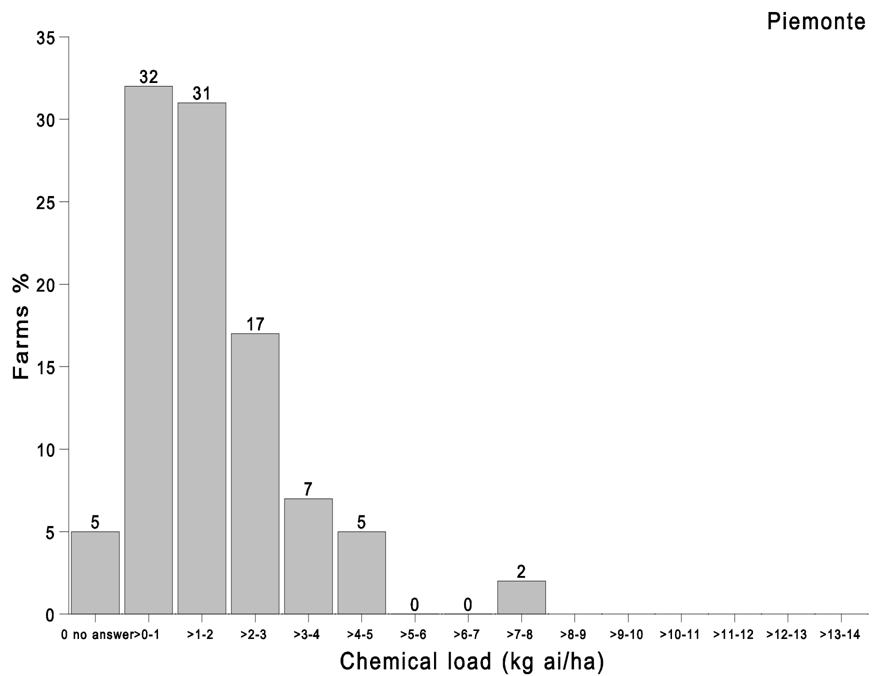


Chart 3.2 Variation in chemical load between farms and regions


East Anglia
Farms %
35
30
25
20
15
10
5
0
3
3
11
11
16
13
20
7
5
7
5
2
0
>0-1
>1-2
>2-3
>3-4
>4-5
>5-6
>6-7
>7-8
>8-9
>9-10
>10-11
>11-12
>12-13
>13-14
Chemical load (kg ai/ha)


Piemonte
Farms %
35
30
25
20
15
10
5
0
5
32
31
17
7
5
0
0
2
0 no answer
>0-1
>1-2
>2-3
>3-4
>4-5
>5-6
>6-7
>7-8
>8-9
>9-10
>10-11
>11-12
>12-13
>13-14
Chemical load (kg ai/ha)

3.3 Chemical load related to average farm yield

Chemical load was plotted against average farm yield. No relationships were apparent in any of the regions.

4.0 SEED AND SEED TREATMENTS

4.1 Seed sources

Table 4.1 Seed sources

Region	Hannover (D)	East Anglia (UK)	North Central (F)	Piemonte (I)
Crop area - ha	1,956	4,627	2,603	563
	Area %			
Purchased only	22	74	7	96
Farm-saved or purchased	72	15	81	5
Farm-saved only	5	9	11	0

Smaller farmers tended only to purchase seed in Piemonte and Hannover.

4.2 Background to seed treatment

Table 4.2 Pest targets - farmer responses (f) with specialists rankings (s)

Region	Hannover (D)		East Anglia (UK)		North Central (F)		Piemonte (I)	
Number of farms	60		61		65		59	
	Farms %							
Target	f	s	f	s	f	s	f	s
Diseases								
Tilletia	75	1	38	1	74	3	24	3
Ustilago	57	3	31		34		27	4
Fusarium spp	53	2	25	2	20	1	8	1
Cochliobolus	20	4						5
Erysiphe	7	5	20		82		6	
Pseudocercosporella	2						11	
Puccinia striiformis	3		13		25		20	
Septoria			16		18	2		2
Puccinia recondita			5		15			
Ophiobolus			2					
Helminthosporium			2					
Insects								
Agriotes	2		3		8	s+		
Zabrus	2				12	s+		
Oscinella frit			2		6	s+		
Hylemia coarctata			39		5	s+		
Birds	2	5			69			

Notes:-

f = farmer replies
s = specialists estimate of importance
s+ = specialists in France agreed with the list but felt the level of importance suggested by farmers was too low.

In all regions specialists said that all seed purchased from merchants or seed producers was treated by them. Farmers were therefore often not aware of the current targets for seed treatment. The same factor compromises the accuracy of answers concerning the treatments applied, in Section 4.4.

4.3 Proportion of seed treated and who treats it

Table 4.3 Proportion of seed treated and who treats it

Region	Hannover (D)	East Anglia (UK)	North Central (F)	Piemonte (I)
Crop area - ha	1,956	4,627	2,603	563
Proportion of seed treated	Area %			
All	88	97	94	85
Some	5	2	3	0
None	1	2	0	12
Don't know	5	2	3	2
The treater of the seed	Area %			
Original seed grower	22	25	30	61
Merchant	68	66	12	11
Farmer	30	5	54	23
Mobile operator	2	16	4	2

All seed was treated by the original seed grower or merchant. Sometimes it was additionally treated by the farmer who also treated most of his farm-saved seed. Specialists in North Central France, where there was still a high proportion treated by the farmer, commented that there was a rapid trend towards treatment by producer or merchant and away from treatment by farmers. This was associated with the recent introduction of very highly active fungicides and insecticides which require more specialised treatment machinery to achieve an adequate distribution.

4.4 Seed treatment - active ingredient use

Table 4.4 presents the active ingredients used per region. With a substantial part of the crop not being treated by the farmer, they were not asked to give the dose rates of products used. Recommended rates were taken.

Table 4.4 Seed treatment - active ingredients used

Region	Hannover (D)		East Anglia (UK)		North Central (F)		Piemonte (I)	
Crop area - ha	1,956		4,627		2,603		563	
Active ingredients	Part of crop treated %	Ave dose g ai/ha	Part of crop treated %	Ave dose g ai/ha	Part of crop treated %	Ave dose g ai/ha	Part of crop treated %	Ave dose g ai/ha
Fungicides								
bitertanol	24	160	1	38				
carbendazim							9	37
carboxin	26	213	32	157	1	303	26	152
cuprous-oxide			1	62				
fenfuram	5	35						
fenpiclonil	1	42	8	40				
fludioxonil					4	8		
fuberidazole	29	9	24	8				
guazatine	22	130	15	104			9	142
imazalil	14	11	7	7			2	12
mancozeb							<1	277
maneb					<1	264	31	286
oxine-copper	1	96			70	44		
prochloraz	18	42					<1	54
propiconazole	1	2						
thiabendazole			32	18				
thiram							7	197
thiophanate-							2	76
methyl	4	68	24	68			2	31
triadimenol								
Insecticides			4	46				
chlorfenvinphos					37	169		
endosulfan			16	208				
fonofos					59	71		
lindane								
Bird repellant	4	140			58	86		
anthraquinone								

Only half the farmers in Piemonte were able to report which seed treatment products had been used.

There are certain differences to be pointed out.

- The very high usage of oxine-copper in North Central France, reputedly because of its wide spectrum of activity. The strong commercial position of the manufacturer in France is also a possible reason. In the season since the survey it is understood that fludioxonil has replaced a considerable amount of oxine-copper in the market.

- Birds were clearly a particular problem in North Central France. Specialists commented that 90 to 95% of seed was treated with a repellant. The use of anthraquinone also has the benefit of deterring birds from consuming seed which is treated with insecticides or fungicides which may be toxic to them.

- Insect pests appeared to be a significant target for seed treatment mainly in North Central France and to a lesser extent East Anglia. This is one of the factors leading to the use of anthraquinone in North Central France, mentioned above.

- Chemicals used in Piemonte, especially maneb, were mostly old types and of low activity. Thus although seed treatment was certainly no higher than in the other regions the average volume of active ingredient used was higher. Specialists there reported that newer products were now entering the market.

- Seed rates vary and lead to variation in seed treatment rates per hectare.

  The average seed rates and their variation were:

Region	Average seed rate kg/ha	Variation %
Hannover	189	63 - 148
East Anglia	183	33 - 137
North Central France	163	55 - 147
Piemonte	245	39 - 122

4.5 Opportunities to reduce seed treatment load

In all the regions surveyed in the study specialists emphasised the value of seed treatments. They were regarded as an environmentally and toxicologically safe way of utilising pesticides which resulted in very low quantities of active ingredient being used per unit area of land. The trend has accelerated in recent years because of the extremely high levels of activity of the new active ingredients being commercialised. This means that for the first time an adequate loading per seed can be achieved, often of products which are systemic and can provide protection for several weeks into the growth of the plant. The seed can thus be invested at relatively low cost and under controlled ‘factory’ conditions with many protective features, some of which may obviate the need for one or more field treatments.

5.0 WEEDS AND WEED CONTROL

5.1 Target weeds

Table 5.1 Main target weeds

Region	Hannover (D)	East Anglia (UK)	North Central (F)	Piemonte (I)
Number of farms	60	61	65	59
	Farms %			
Dicotyledons				
Galium	85	64	63	5
Matricaria	63	46	49	51
Stellaria	63	43	12	+
Papaver		21		59
Veronica	43	34	34	10
Polygonum	40	23	34	+
Cirsium	27	34	32	5
Viola	42	11	11	10
Chenopodium	12	41	15	14
Raphanus			9	15
Convolvulus		16	18	+
Galeopsis	8	16		s
Ranunculus			+	12
Sinapsis		23	8	+
Capsella	12			+
Bifora				14
Monocotyledons				
Alopecurus	60	54	74	27
Avena	3	62	57	58
Apera	87		+	+*
Agropyron	13	5	26	24
Poa	12	21	12	7
Lolium	5		40	20*
Bromus	2	s		

+ = limited cases mentioned by farmers
s = specialists mention * = specialists believe is more important than stated

The similarity in dicotyledon weed spectrum in Hannover, East Anglia and North Central France was striking and quite different from Piemonte. In the three former regions the weed spectra were typical of intensive cereal growing regions with weeds that are more difficult to control such as *Galium, Matricaria, Stellaria* etc. This makes its consequential demand on herbicides.
Similarities between regions were less marked amongst the monocotyledons.

Alopecurus was less of a problem in Piemonte, *Avena* was no problem in Hannover, whilst *Apera* was peculiarly a problem there. All the monocotyledons make particular demands on herbicides.

5.2 Weeds claimed to be resistant to herbicides

In each region several farmers claimed to have experienced problems of herbicide resistance. Specialists refuted all of these, except one, as being cases of poor application or the use of inherently inactive and inappropriate chemicals. The one case which was agreed across all regions was the resistance of black grass, *Alopecurus myosuroides*, to isoproturon, and in East Anglia to fenoxaprop-ethyl as well.

5.3 Levels of weed control sought

Table 5.3 Levels of weed control sought

Region	Hannover (D)	East Anglia (UK)	North Central (F)	Piemonte (I)
Number of farms	60	61	65	59
Control sought	Farms %			
<70%	0	0	0	2
71 - 80%	2	0	6	14
81 - 90%	30	15	31	44
91 - 100%	47	84	51	37
No answer	22	2	12	3

Herbicide doses had been reduced in all the regions in the study but specialists remarked in Hannover and Piemonte that, because of this, a lower level of control sometimes resulted which farmers had grown accustomed to. It was noted in North Central France that it was the larger farmers who expected the highest levels of weed control, a situation mirrored in East Anglia where most farms were large.

5.4 Herbicide use by active ingredient

5.4.1 Hannover

Table 5.4.1 Herbicide active ingredients used in Hannover

Active ingredient	Activity	% of crop treated (Base area 1,956 ha)	No. of applications		Cumulative dose on crop receiving that ai g ai/ha		
			Range per farm	Ave per ha treated	min	max	ave
isoproturon	ppoc	89	1 - 2	1.4	119	2,668	976
fluroxypyr	pob	69	1 - 2	1.1	36	216	102
MCPA	pob	32	1	1.0	360	1,000	668
MCPP-P	pob	27	1	1.0	300	1,200	620
bifenox	ppoc	22	1 - 2	1.1	132	580	313
2,4-DP	pob	12	1	1.0	600	1,014	705
MCPP	pob	12	1	1.0	200	1,800	663
metsulfuron-m	ppob	11	1	1.1	1.4	10	3
diflufenican	poc	7.5	1 - 2	1.5	25	94	59
ioxynil	pob	7	1	1.0	100	192	112
2,4-DP-P	pob	6	1	1.0	300	900	624
chlorotoluron	ppoc	6	1 - 2	1.3	490	1,400	823
thifensulfuron-m	ppob	6	1	1.0	14	55	39
tribenuron-	pob	4	1	1.0	7	7	7
methyl	pob	3	1	1.0	15	22	17
amidosulfuron	pob	3	1	1.0	520	520	520
bentazone	saf	2	1	1.0	22	30	27
fenchlorazole-e	pog	2	1	1.0	90	120	110
fenoxaprop-e	pc	2	1	1.0	400	800	755
pendimethalin	pob	<1	1	1.0	470	470	470
bromoxynil	syn	<1	1	1.0	120	120	120
flurenol							

Key to abbreviations:

p = pre-emergence
po = post-emergence
b = broad leaf weeds
g = grass weeds
c = cross spectrum (b + g)
saf = safener for winter wheat, used in mixture with fenoxaprop-ethyl
syn= synergist for herbicides, formulated in mixture with ioxynil and MCPP.

5.4.2 East Anglia

Table 5.4.2 Herbicide active ingredients used in East Anglia

Active ingredient	Activity	% of crop treated	No. of applications		Cumulative dose on crop receiving that ai g ai/ha		
		(Base area 4,627 ha)	Range per farm	Ave per ha treated	min	max	ave
metsulfuron-m	ppob	58	1 - 2	1.2	2.7	12	4.5
fluroxypyr	pob	53	1 - 6	1.7	100	400	166
fenoxaprop-e	pog	37	1 - 2	1.0	30	240	112
isoproturon	ppoc	34	1	1.0	944	5,000	2,177
thifensulfuron-m	ppob	16	1	1.0	27	41	35
glyphosate	poc	14	1 - 2	1.3	180	1,680	865
MCPA	pob	14	1	1.0	500	2,500	975
ioxynil	pob	13	1	1.0	63	250	115
bromoxynil	pob	13	1	1.0	75	83	131
fenoxaprop-p-e	pog	7	1	1.0	22	250	35
diflufenican	poc	6	1	1.0	25	125	77
MCPP-P	pob	6	1	1.0	600	1,200	1,049
trifluralin	pc	5	1	1.0	479	1,464	727
sethoxydim	pog	5	1	1.0	386	386	386
MCPP	pob	5	1	1.0	570	2,394	1,274
pendimethalin	pc	4	1	1.0	943	943	943
benazolin	pob	3	1	1.0	24	75	60
flamprop-m-i	po/Av	1	1	1.0	440	600	522
chlorotoluron	ppoc	1	2	2.0	7,000	7,000	7,000
triallate	ppi/g	1	1	1.0	1,700	1,700	1,700
imazamethabenz	pog	1	1	1.0	494	494	494
oil	adj	<1	1	1.0	2,000	2,000	2,000
tralkoxydim	pog	<1	1	1.0	350	350	350
paraquat	poc	<1	1	1.0	800	800	800
triasulfuron	poc	<1	1	1.0	2	2	2
simazine	pec	<1	1	1.0	167	167	167
amidosulfuron	pob	<1	1	1.0	19	19	19
diclofop-methyl	pog	<1	1	1.0	566	566	566

Key to abbreviations:

ppi = pre-plant incorporated
p = pre-emergence
po = post-emergence
adj = adjuvant
Av = *Avena fatua*
b = broad leaf weeds
g = grass weeds
c = cross spectrum (b + g)

5.4.3 North Central France

Table 5.4.3 Herbicide active ingredients used in North Central France

Active ingredient	Activity	% of crop treated (Base area 2,603 ha)	No. of applications: Range per farm	No. of applications: Ave per ha treated	Cumulative dose on crop receiving that ai g ai/ha: min	max	ave
isoproturon	ppc	31	1-2	1.1	400	1,994	1,129
chlorotoluron	pob	25	1-2	1.1	300	2,403	1,564
fluroxypyr	pob	24	1	1.0	40	600	158
fenoxaprop-e	pog	24	1	1.0	21	83	50
ioxynil	pob	24	1	1.0	27	322	170
metsulfuron-m	ppb	21	1-2	1.1	1	7	4
bifenox	ppc	16	1	1.0	89	1,049	472
MCPA	pob	15	1-2	1.1	120	859	639
diflufenican	poc	14	1	1.0	31	189	138
MCPP	pob	13	1	1.0	194	1,500	658
MCPP-P	pob	12	1	1.0	77	910	438
cloquintocet	saf	12	1	1.0	5	17	11
clodinafop	pog	12	1	1.0	20	70	45
chlorsulfuron	ppc	11	1	1.0	6	17	16
methabenzthiazuron	poc	11	1	1.0	875	2,450	2,282
clopyralid	pob	11	1	1.0	9	80	60
thifensulfuron-m	ppb	10	1	1.0	27	41	34
amidosulfuron	pob	9	1	1.0	7	37	16
2,4-D	pob	5	1	1.0	69	1,080	669
picloram	pob	3	1	1.0	2	38	22
diuron	pec	2	1	2.0	3,600	3,600	3,600
aclonifen	pec	2	2	2.0	2,400	2,400	2,400
triasulfuron	ppb	1	1	1.0	10	15	13
isoxaben	pb	1	1	1.0	71	71	71
prosulfocarb	ppc	1	1	1.0	4,000	4,000	4,000
bromoxynil	pob	1	1	1.0	100	125	114
oil	adj	1	1	1.0	1,000	1,000	1,000
pendimethalin	pc	1	1	1.0	500	1,000	810
flupoxam	ppb	1	1	1.0	125	125	125
fluazifop-p-butyl	pog	1	1	1.0	50	50	50
fluoroglycofen-e	ppc	1	1	1.0	40	40	40
2,4-DP	pob	1	1	1.0	875	875	875
propaquizafop	pog	1	1	1.0	40	40	40
imazamethabenz	pog	1	1	1.0	625	625	625
diclofop-methyl	pog	1	1	1.0	1,260	1,260	1,260
benzoylprop-ethyl	po/*Aven*	<1	1	1.0	700	700	700
linuron	ppb	<1	1	1.0	500	500	500
flamprop-m-i	po/*Aven*	<1	1	1.0	104	104	104
simazine	peb	<1	1	1.0	75	75	75
2,4-DP-P	pob	<1	1	1.0	775	775	775
dinoterb	pog	<1	1	1.0	380	380	380

Key to abbreviations:

p	=	pre-emergence	*Aven*	=	*Avena fatua*
po	=	post-emergence	b	=	broad leaf weeds
adj	=	adjuvant	g	=	grass weeds
			c	=	cross spectrum (b + g)

5.4.4 Piemonte

Table 5.4.4 Herbicide active ingredients used in Piemonte

Active ingredient	Activity	% of crop treated	No. of applications		Cumulative dose on crop receiving that ai g ai/ha		
		(Base area 563 ha)	Range per farm	Ave per ha treated	min	max	ave
MCPA	pob	24	1 - 2	1.2	236	1,201	619
MCPP	pob	23	1	1.0	381	1,664	783
ioxynil	pob	23	1	1.0	162	474	246
tribenuron-m	pob	22	1	1.0	7.5	19	12
methabenz-thiazuron	poc	18	1	1.0	1,750	2,170	2,002
diflufenican	poc	17	1	1.0	66	223	113
trifluralin	ppoc	16	1	1.0	814	1,484	833
linuron	ppob	15	1	1.0	352	450	431
isoproturon	ppoc	13	1	1.0	319	1,435	1,235
pendimethalin	pc	13	1	1.0	799	800	799
bromoxynil	pob	12	1	1.0	204	445	274
fenchlorazole-e+	saf	11	1	1.0	20	35	33
fenoxaprop-e	pog	11	1	1.0	83	140	135
chlorotoluron	ppoc	10	1	1.0	872	1,308	1,022
2,4-D	pob	6	1	1.0	236	620	359
dicamba	pob	3	1	1.0	26	72	34
terbutryn	pc	2	1	1.0	1,164	1,164	1,164
diclofop-methyl	pog	2	1	1.0	546	819	621

Key to abbreviations:

p = pre-emergence
po = post-emergence

b = broad leaf weeds
g = grass weeds
c = cross spectrum (b + g)

5.4.5 Herbicide active ingredients used - commentary

The weed control strategy of all four regions was to apply a cross-spectrum herbicide in the autumn followed in the spring with post-emergence products more specific to the weed species found.

The major difference between the regions was again between the group of Hannover, East Anglia and North Central France on the one hand and Piemonte on the other. In Piemonte there were none of the new specific herbicides used. The list of active ingredients was shorter than in the other regions, particularly North Central France, because of this. The new herbicides are in general for post-emergence use, and thus there has been a definite trend away from pre-emergence treatments to post-emergence in the three northerly regions. An indication of the result of this is that in Piemonte there was significantly less spot or partial spraying of farms than in the other regions. See Section 5.5. The use of specific post-emergence herbicides demands a higher level of technical awareness than is necessary for cross-spectrum products. Specialists in Piemonte said this trend was just starting there, but the ageing population of farmers involved in wheat growing has slowed its implementation.

The long list in North Central France is particularly striking. This is the result of a deliberate official policy of determining the lowest effective rate of every active ingredient for each of the main weed species. The strategy is to use only the most cost-effective active ingredient on a species-by-species basis. If there are several species present, a mixture of active ingredients may need to be used. Recommendations are made available to farmers to enable them to do this. It is interesting, however, that the dose rates actually used in North Central France were frequently found to be higher than in Hannover, though generally lower than in East Anglia - the latter appearing to have the highest rates of the four regions. This policy in North Central France is reflected in the high number of active ingredients used per farm, yet the low number used per hectare - see Table 5.5.

In East Anglia the dose rates used were at or just below recommended rates, compared with North Central France where they generally varied between about half to three-quarters, and with Hannover where they were generally slightly lower still. Rates in Piemonte were generally between 75% and the recommended rates.

5.5 Herbicide use parameters

Several average figures were calculated to shed more light on regional differences.

Table 5.5 Herbicide applications

On farms using herbicides	Hannover (D)	East Anglia (UK)	North Central (F)	Piemonte (I)
No. of active ingredients used/farm	4.5	4.5	4.7	2.6
No. of active ingredients used/ha	3.2	3.0	3.3	2.4
No. of product applications/ha	2.9	2.6	2.1	1.4
Proportion of farmers spraying parts of their crop	45%	50%	40%	24%
Average volume of active ingredients kg ai/ha	2.14	1.72	1.70	1.52

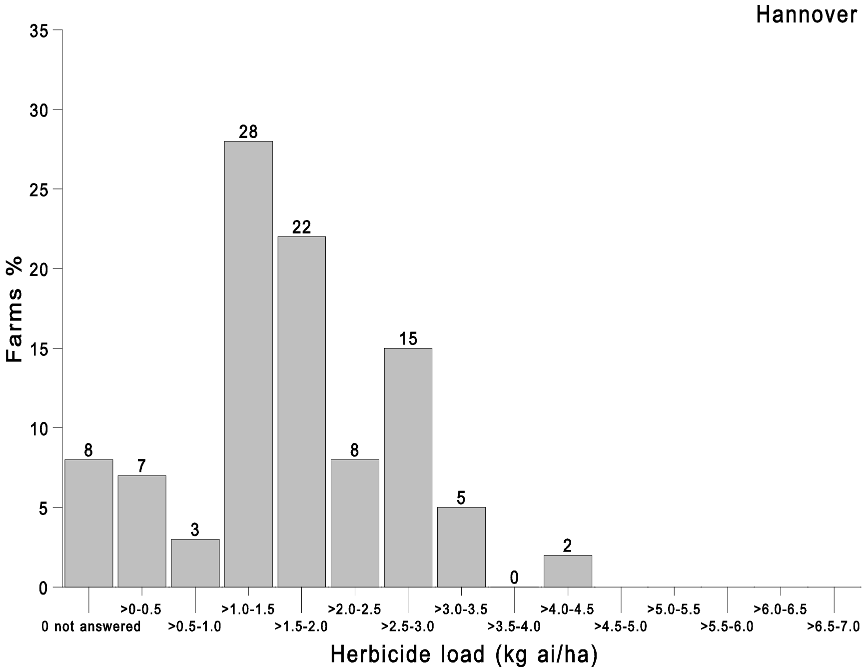
The proportion of farmers spraying parts of their crop for any given treatment was very similar in the three northerly regions and demonstrates a targeted approach to weed control. The smaller proportion in Piemonte reflects the farm sizes as well as the less developed approach.

5.6 Herbicide load per farm

Table 5.6 Herbicide load per farm

On farms using herbicides	Hannover (D)	East Anglia (UK)	North Central (F)	Piemonte (I)
Number of farms	60	61	65	59
Chemical load kg ai/ha	Farms %			
0	8†	2(+3*)	0	7†
>0 - 0.5	7	25	8	12
>0.5 - 1.0	3	8	18	32
>1.0 - 1.5	28	20	34	20
>1.5 - 2.0	22	13	15	12
>2.0 - 2.5	8	0	6	10
>2.5 - 3.0	15	7	8	0
>3.0 - 3.5	5	11	6	2
>3.5 - 4.0	0	2	2	0
>4.0 - 4.5	2	2	2	5
>4.5 - 5.0		2	0	
>5.0 - 5.5		2	0	
>5.5 - 6.0		2	0	
>6.0 - 6.5		2	0	
>6.5 - 7.0				
Range kg ai/ha	0.1 - 4.2	0.03 - 6.1	0.05 - 4.0	0.01 - 4.5

† Not answered
* Farmers applied treatments but could not provide information (contractors)



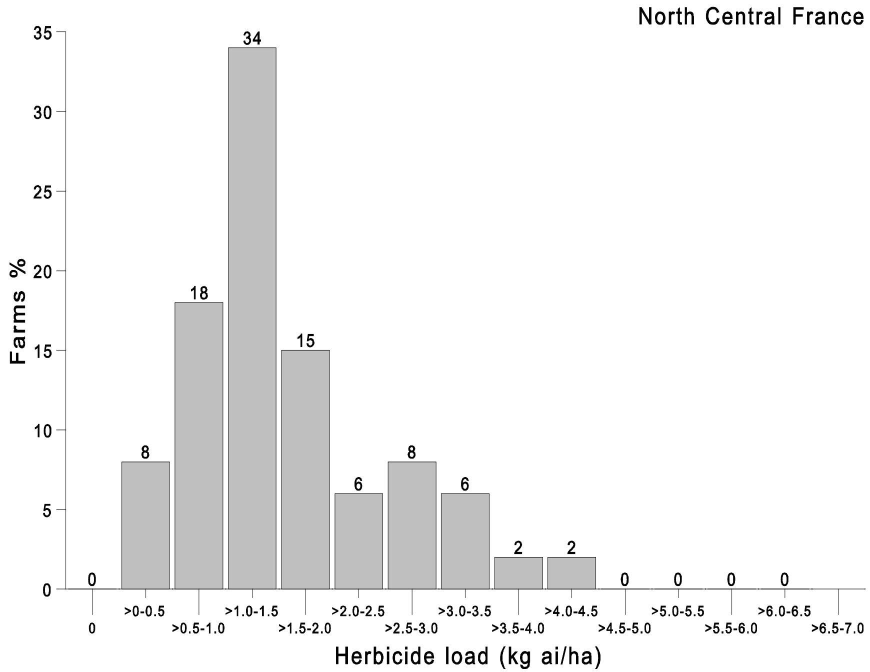
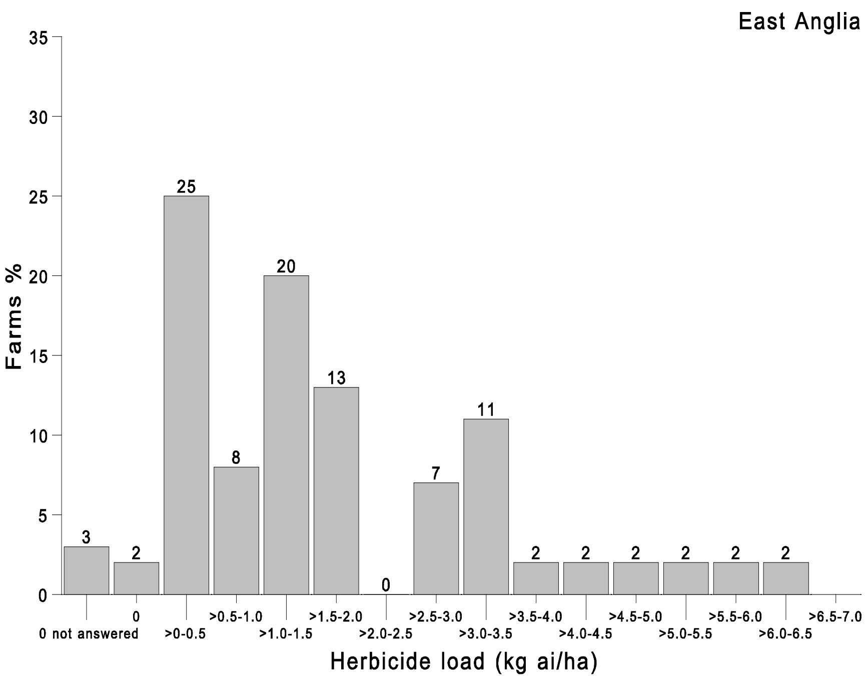
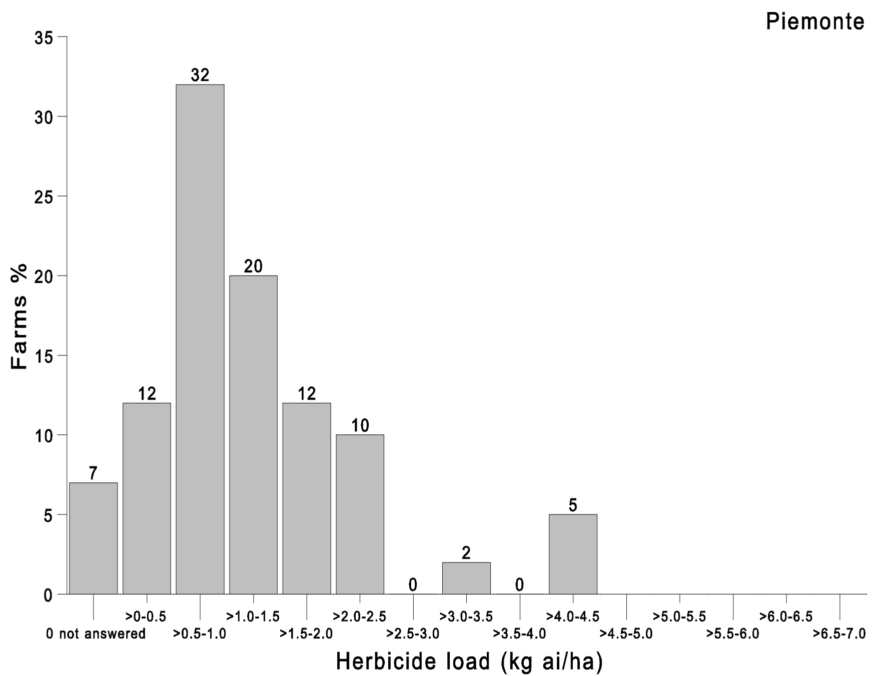


Chart 5.6 Herbicide load per farm



East Anglia
Farms %
Herbicide load (kg ai/ha)
0 not answered
0
>0-0.5
>0.5-1.0
>1.0-1.5
>1.5-2.0
>2.0-2.5
>2.5-3.0
>3.0-3.5
>3.5-4.0
>4.0-4.5
>4.5-5.0
>5.0-5.5
>5.5-6.0
>6.0-6.5
>6.5-7.0



Piemonte
Farms %
Herbicide load (kg ai/ha)
0 not answered
>0-0.5
>0.5-1.0
>1.0-1.5
>1.5-2.0
>2.0-2.5
>2.5-3.0
>3.0-3.5
>3.5-4.0
>4.0-4.5
>4.5-5.0
>5.0-5.5
>5.5-6.0
>6.0-6.5
>6.5-7.0

An analysis of the variability between farms within each of the regions was carried out. The heaviest loads in all four regions were the result of farms using the older less active herbicides such as isoproturon. These farmers also tended to use rates which were higher than the average - though not necessarily higher than recommended. In East Anglia there was also a tendency for the higher loads to comprise more products than average for East Anglia. Spot or partial spraying was carried out by farmers applying both light and heavy loads.

Farmers whose herbicide loads were the lightest were those who used modern highly active herbicides such as the sulfonyl-ureas. This was true across all four regions. This means that they were generally using a post-emergence weed control strategy, a strategy which offers the opportunity of spot or partial spraying. In East Anglia this opportunity was used slightly more than in the other regions. See Section 5.5.

5.7 Mechanical weed control

Mechanical weed control was practised by only a few farms - 3% in Hannover, 7% in East Anglia, 0% in North Central France, and 22% in Piemonte. In no region was there any relationship between the use or otherwise of mechanical weed control and the amount of herbicide load applied. Two reasons were advanced for this - one in East Anglia, that soil tillage allows weed seeds to germinate, thus requiring more herbicide use, and the other from Piemonte, that farmers planning to use mechanical methods will tend to use the older high dose rate herbicides. Specialists generally did not consider wheat an appropriate crop for mechanical methods but there is some official effort going into developing new equipment in East Anglia.

5.8 Herbicide load relative to crop yield

No relationship was found between the amount of herbicide used and crop yield in any region.

5.9 Herbicide use in the study year (1994) compared with an average year

Region	Hannover (D)	East Anglia (UK)	North Central (F)	Piemonte (I)
Number of farms	60	61	65	59
Herbicide use	Farms %			
Lower use	88	92	100	80
Greater use	2	7	0	17
No answer	10	2	0	4

The low usage in 1994 was said by specialists to be the result of dry weather in early spring and summer. The trend over a period of years, according to specialists in North Central France, was upward. This was due they maintained to set-aside land providing a reservoir of weed seed. Use in 1995 was apparently considerably higher than 1994.

5.10 Opportunities to reduce herbicide load

There has been a trend over several years, which is continuing, to utilise specific active ingredients for each weed species and to apply these post-emergence rather than to use broad-spectrum herbicides often prophylactically. Generally this concerns the second application in the early spring or summer, but where land is known to harbour a particular weed spectrum from previous seasons it can also apply to the autumn application. This means that farmers will only spray for the known and observed occurrence of a particular weed species, rather than apply a broad-spectrum herbicide.

The consequences are :

- that broad-spectrum herbicides, which generally have high rates of application, will be replaced by specific herbicides, which are generally far more active and the doses of which will have been specifically determined for each weed.

- that there will be a tool in the farmers hands encouraging him to apply only to the parts of the farm where particular weeds exist, thus reducing the area treated.

- an unavoidable consequence is that the number of active ingredients used per farm and per hectare will probably rise considerably.

These developments point to a much more intelligent, risky (because accurate timing may be needed) and demanding weed control strategy, which requires farmer education and support. This has been accepted and introduced into the three northerly regions to varying degrees, but due to social, economic and climatic factors is only now starting to penetrate Piemonte.

From the point of view of environmental protection, although loads of active ingredient per hectare are declining, and will continue to do so, the true criteria will be whether the new active ingredients at the doses being used have any more or less effect on the environment than previously, and whether the areas being sprayed are reducing as a result of spot or partial spraying.

Dose rates have been pared down a great deal. Some specialists in Hannover believe this has gone too far in that direction because levels of control now being achieved are sometimes leading to an unacceptable degree of competition with the crop. There is still some potential, probably in East Anglia and possibly in Piemonte as the newer herbicides are introduced, to shave the rates of use.

The most effective technique to reduce herbicide loads, however, is the increasing use of spot or partial spraying, a practice well established in East Anglia. A significant threat to this is the spread of weed seed from set-aside land.

6.0 DISEASES AND FUNGICIDES

6.1 Target diseases

The main target diseases appear in Table 6.1.

Table 6.1 Target diseases

Region	Hannover (D)		East Anglia (UK)		North Central (F)		Piemonte (I)	
Number of farms	60		61		65		59	
	Farms %							
Target diseases	f	s	f	s	f	s	f	s
Erysiphe graminis	92		81	d	69	e	23	s
Septoria nodorum	82		24		34			+
Puccinia striiformis	63		68	e	42	b	18	-
Pseudocercosporella	60		40	c	48	c		
Septoria tritici	62	+	21	b	58	a	2	-
Fusarium	32		19		45	d	22	s
Rhizoctonia sp			7					
Puccinia recondita		+			40			+
*Gaumannomyces graminis**		+		a	28			
Don't know							45	

* = *Ophibolus graminis*

Key to abbreviations:

f = farmer responses
s = specialists views

s = general agreement
\+ = should be higher
\- = should be lower
specialists rankings a - e (where a is most important)

6.2 Diseases claimed to be resistant to fungicides

Several farmers in each region believed they had cases of fungicide resistance -

Hannover - 17%

East Anglia - 7%

North Central France - 21%

Piemonte - 5%

Specialists refuted virtually all these claims. The only cases which were accepted were *Pseudocercosporella* resistance to several fungicide types particularly the benzimidazoles (carbendazim (MBC) and other MBC generators). Specialists in North Central France also agreed with farmer reports of resistance by *Septoria* to tebuconazole.

6.3 Levels of disease control sought

Table 6.3 Levels of disease control sought

Region	Hannover (D)	East Anglia (UK)	North Central (F)	Piemonte (I)
Number of farms	60	61	65	59
Control sought	Farms %			
<70%	3	0	3	0
71 - 80%	2	0	11	7
81 - 90%	20	13	35	22
91 - 100%	50	87	46	42
No answer	22	0	5	29

Acceptance of less than perfect levels of control seems to be most developed in North Central France although specialists thought a greater percentage wanted higher levels than they claimed. In East Anglia, specialists were strongly pursuing a strategy of disease control named “canopy management”, in which the objective is to relate the health of the canopy rather than levels of disease, to variations in yield. It requires continuous field assessment of levels of disease pressure, related to appropriate warnings from research stations. The objective is to delay or possibly eliminate sprays, and to encourage farmers to accept disease in the crop in appropriate circumstances. It appears from this study that few farmers in that region are yet inclined to accept less than substantial control.

6.4 Fungicide use by active ingredient

6.4.1 Hannover

Table 6.4.1 Fungicide active ingredients used in Hannover

Active ingredient	Activity	% of crop treated	No. of applications		Cumulative dose on crop receiving that ai g ai/ha		
		(Base area 1,956 ha)	Range per farm	Ave per ha treated	min	max	av
fenpropimorph♦	s/*Ery*+*Pu*	82	1 - 3	1.7	62	2,954	537
prochloraz	*c*	64	1 - 3	1.3	39	719	332
epoxiconazole♣	s/*Psc*+*Sep*	51	1 - 3	1.2	20	252	87
triadimenol	s/b	50	1 - 3	1.3	16	675	130
carbendazim	s/*Ery*+*Pu*	46	1 - 2	1.1	17	270	94
tebuconazole♣	*c*	44	1 - 2	1.1	32	650	196
anilazine	s/b	42	1	1.0	120	1,920	633
cyproconazole♣	s/b	28	1 - 2	1.0	21	95	48
propiconazole♣	c/b	27	1 - 3	1.1	2	262	93
tridemorph♦	s/b	13	1 - 3	1.3	93	787	214
difenoconazole♣	s/b	11	1	1.0	74	150	92
flusilazole♣	s/*Ery*+*Pu*	8	1	1.0	125	375	266
chlorothalonil	*c*	4	1	1.0	67	750	309
aldimorph	s/b	3	3	3.0	450	450	450
iprodione	s/b	3	1	1.0	34	34	34
guazatine	p/*Sept*	2	1	1.0	80	80	80
fenpropidin♦	a	1	1	1.0	112	112	112
	p/*Sept*						
	p/*Till*						
	s/*Sept*						

Key to abbreviations:

s = systemic — *Ery* = *Erysiphe* (Mildew)
c = contact — *Puc* = *Puccinia* (Rusts)
p = protectant — *Psc* = *Pseudocercosporella* (Eye spot)
a = additive — *Sept* = *Septoria*
b = broad-spectrum — *Till* = *Tilletia*

♦ = morpholines
♣ = triazoles

6.4.2 East Anglia

Table 6.4.2 Fungicide active ingredients used in East Anglia

Active ingredient	Activity	% of crop treated (Base area 4,627 ha)	No. of applications: Range per farm	No. of applications: Ave per ha treated	Cumulative dose on crop receiving that ai (g ai/ha): min.	max	ave
triadimenol	s/*Ery*+*Puc*	51	1 - 2	1.5	47	416	149
tebuconazole♣	s/b	45	1 - 2	1.2	62	500	218
carbendazim	s/b	42	1 - 2	1.6	74	625	216
chlorothalonil	p/*Sep*	22	1 - 2	1.4	125	1,829	602
fenpropimorph♦	s/*Ery*+*Puc*	20	1 - 2	1.7	93	1,500	921
propiconazole♣	s/b	20	1 - 2	1.8	45	400	164
tridemorph♦	s/*Ery*+*Puc*	19	1 - 2	1.8	30	1,800	402
cyproconazole♣	s/b	18	1 - 2	1.2	35	80	60
flutriafol	s/b	17	1 - 2	1.2	58	305	117
flusilazole♣	s/b	16	1 - 2	1.7	100	300	222
prochloraz	s/*Pse*+*Sep*	11	1 - 2	1.1	225	804	346
fenpropidin♦	s/*Sep*	7	1 - 2	1.3	225	750	405
maneb	p/b	7	1 - 2	1.5	320	1,600	1,082
mancozeb	p/b	6	1 - 2	1.1	200	3,200	1,295
triadimefon	s/*Ery*+*Puc*	6	1 - 2	1.5	125	250	192
sulphur	p/*Ery*	1	1	1.0	8,000	8,000	8,000

Key to abbreviations:

s	=	systemic	b	=	broad-spectrum
c	=	contact	*Ery*	=	*Erysiphe* (Mildew)
p	=	protectant	*Puc*	=	*Puccinia* (Rusts)
a	=	additive	*Psc*	=	*Pseudocercosporella* (Eye spot)
			Sep	=	*Septoria*

♦ = morpholines

♣ = triazoles

6.4.3 North Central France

Table 6.4.3 Fungicide active ingredients used in North Central France

Active ingredient	Activity	% of crop treated (Base area 2,603 ha)	No. of applications		Cumulative dose on crop receiving that ai g ai/ha		
			Range per farm	Ave per ha treated	min	max	ave
fenpropimorph♦	s/*Ery+Puc*	54	1 - 3	1.3	84	2,623	399
epoxiconazole♣	s/b	46	1 - 3	1.6	31	500	182
fenpropidin♦	s/*Sep*	37	1 - 3	1.3	28	1,010	202
prochloraz	s/*Pse+Sep*	24	1 - 3	1.2	135	1,350	445
tebuconazole♣	s/b	25	1 - 3	1.2	74	750	298
chlorothalonil	p/*Sep*	23	1 - 3	1.2	250	3,240	941
carbendazim	s/b	23	1 - 3	1.4	70	2,250	318
hexaconazole♣	s/*Ery+Puc*	21	1 - 2	1.1	75	250	161
cyprodinil	s/b	15	1 - 3	1.6	450	1,125	706
cyproconazole♣	s/b	15	1 - 2	1.1	63	199	87
flusilazole♣	s/b	9	1 - 2	1.4	125	440	248
fenbuconazole♣	s/b	8	1	1.0	30	68	54
propiconazole♣	s/b	7	1 - 3	1.3	25	375	142
tetraconazole♣	s/b	6	1	1.0	94	300	136
metconazole♣	s/b	5	1	1.0	60	90	76
difenoconazole♣	s/b	4	1	1.0	62	125	107
bitertanol*	s/b	2	1	1.0	100	100	100
tridemorph♦	s/*Ery+Puc*	2	1	1.0	65	187	158
mancozeb	p/b	2	1	1.0	300	3,200	1,207
thiophanate-m*	s/b	1	1	1.0	360	360	360
sulphur	p/*Ery*	1	1	1.0	1,600	1,600	1,600
flutriafol	s/b	1	3	3.0	352	352	352
copper*	p/*Sep*	1	1	1.0	100	100	100

Key to abbreviations:

s = systemic
c = contact
p = protectant
a = additive

Ery = *Erysiphe* (Mildew)
Puc = *Puccinia* (Rusts)
Pse = *Pseudocercosporella* (Eye spot)
Sep = *Septoria*
b = broad-spectrum

♦ = morpholines
♣ = triazoles

* = not registered for use on cereals in France

6.4.4 Piemonte

Table 6.4.4 Fungicide active ingredients used in Piemonte

Active ingredient	Activity	% of crop treated	No. of applications		Cumulative dose on crop receiving that ai g ai/ha		
		(Base area 563 ha)	Range per farm	Ave per ha treated	min	max	ave
carbendazim	s/b	12.2	1	1.0	122	592	389
fenpropimorph♦	s/*Ery*+*Puc*	10.7	1 - 2	1.3	367	1,590	702
triadimenol	s/*Ery*+*Puc*	8.2	1	1.0	294	294	294
prochloraz	s/*Psc*+*Sep*	1.8	1	1.0	452	452	452
propiconazole♣	s/b	1.2	2	2.0	250	250	250
benomyl	s/*Psc*+*Rhy*	0.5	2	2.0	1,500	1,500	1,500
maneb	p/b	0.2	1	1.0	1,800	1,800	1,800
thiophanate-m	s/b	0.2	1	1.0	420	420	420

Key to abbreviations:

s = systemic
p = protectant

b = broad-spectrum
Ery = *Erysiphe* (Mildew)
Puc = *Puccinia* (Rusts)
Psc = *Pseudocercosporella* (Eye spot)
Sep = *Septoria*
Rhy = *Rhynchosporium*

♦ = morpholines
♣ = triazoles

6.4.5 Fungicide active ingredients used - general commentary

The backbone of winter wheat disease treatment were two classes of active ingredients - the broad spectrum triazoles (♣ in Tables 6.4.1 - 6.4.4), and the very effective *Erysiphe* fungicides, the morpholines (♦ in Tables 6.4.1 - 6.4.4).
In the three northerly regions disease pressure is constant and requires a programme of sprays. This may commence in the autumn with treatment to control stem base diseases such as *Pseudocercosporella* and *Fusarium*. The two main periods of treatment, however, are early spring and late spring/early summer, to control these stem base diseases and the leaf diseases, *Erysiphe, Septoria* spp and *Puccinia* spp. Treatments applied during these two periods are likely to be broad-spectrum. A final treatment may be warranted in the late summer to control *Septoria nodorum* or *Puccinia hordei.* Seed treatments may have been applied to control some of these together with some seed-borne diseases such as *Ustilago nuda* and *Tilletia caries,* which may obviate the need for some foliar sprays. Two or three sprays may be applied per season.

Disease pressure in Piemonte was low. Only 19% of farmers applied treatments in 1994. Specialists recommend that a single treatment is made if there are signs of *Puccinia recondita* or *Erysiphe graminis* observed.

Dose rates used by farmers in the three northerly regions were lower than recommended. The average rate used was about 70 - 80 % of the recommended rate. There was remarkable similarity in the amount of reduction in all three regions. There were almost no farmers who used higher than the recommended rates. This applied to products which were only introduced the previous year.

Products which contain mixtures of active ingredients were popular particularly in North Central France. Here 64% of the 50 products mentioned were mixtures, compared with 59% of 22 in Hannover, 50% of eight in Piemonte, and 38% of 48 in East Anglia.

6.5 Fungicide use parameters

Table 6.5 Fungicide applications

On farms using fungicides	Hannover (D)	East Anglia (UK)	North Central (F)	Piemonte (I)
No. of active ingredients used per farm	5.9	3.9	4.9	1.6
No. of active ingredients used per ha	4.8	3.1	3.3	0.4
No. of product applications per ha	3.4	3.6	3.6	1.2
Proportion of farmers spraying parts of their crop	35%	23%	25%	9%
Average volume of active ingredient kg ai/ha	1.26	1.15	1.18	0.82

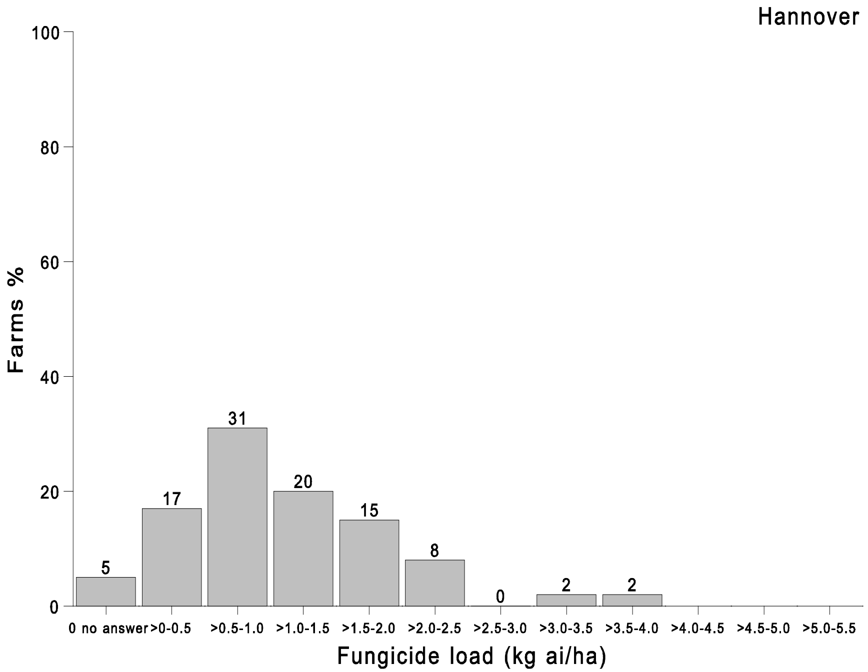
The greatest number of active ingredients per hectare were used by farmers in Hannover. Targeted spraying of parts of the crop was most developed in Hannover.

6.6 Fungicide load per farm

Table 6.6 Fungicide load per farm

Region	Hannover (D)	East Anglia (UK)	North Central (F)	Piemonte (I)
Number of farms	60	61	65	59
Chemical load kg ai/ha	Farms %			
0	5*	2(+5*)	6*	81
>0 - 0.5	17	23	17	5
>0.5 - 1.0	31	34	29	8
>1.0 - 1.5	20	10	22	3
>1.5 - 2.0	15	10	11	0
>2.0 - 2.5	8	10	5	2
>2.5 - 3.0	0	5	3	
>3.0 - 3.5	2	2	3	
>3.5 - 4.0	2	0	2	
>4.0 - 4.5		2	0	
>4.5 - 5.0			2	
>5.0 - 5.5			2	
Range kg ai/ha	0.2 - 3.4	0.08 - 4.0	0.1 - 5.1	0.2 - 2.2

* These farmers could not answer.



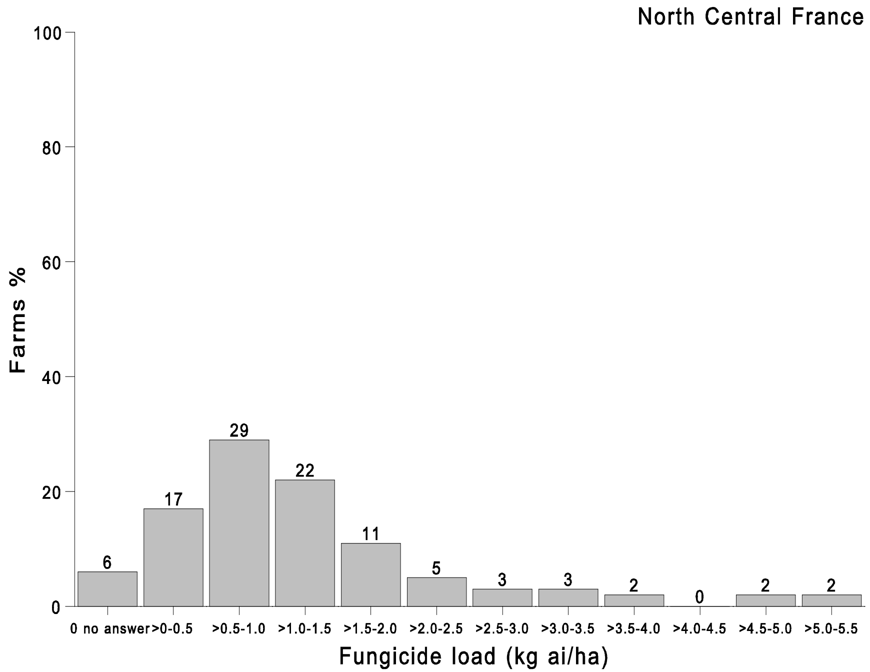
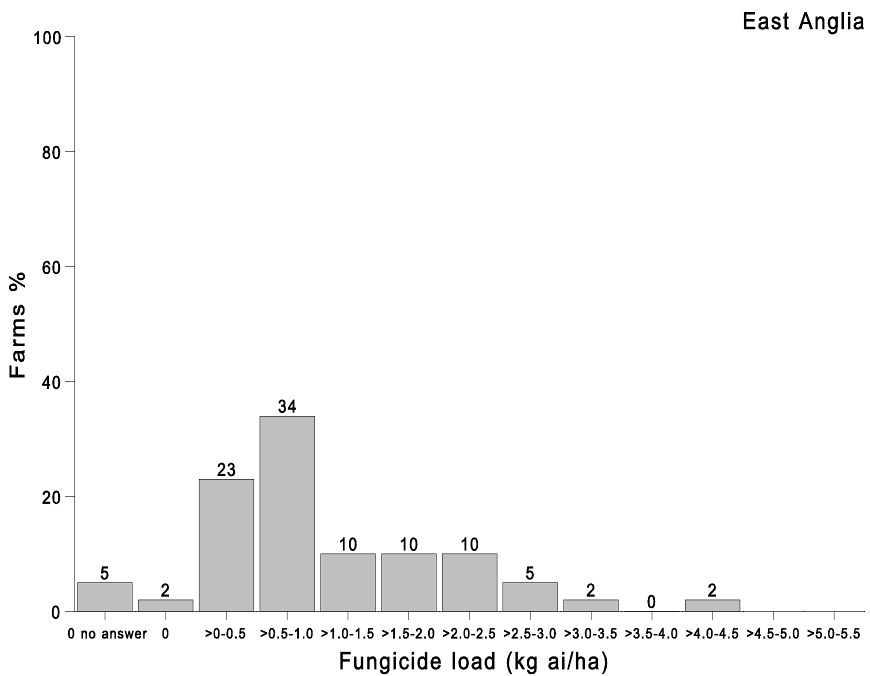
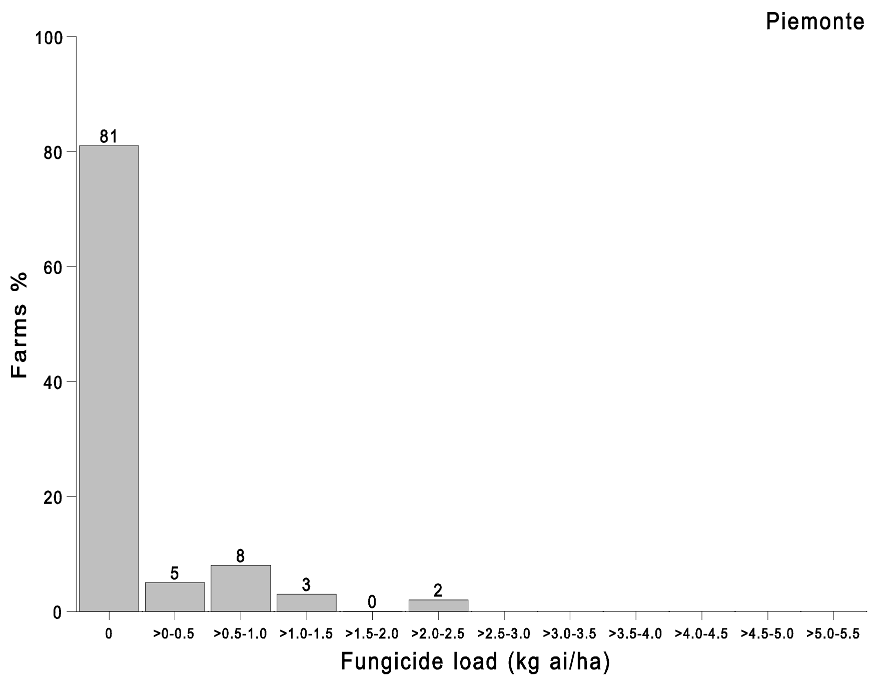


Chart 6.6 Fungicide load per farm


East Anglia
Farms %
100
80
60
40
20
0
5
2
23
34
10
10
10
5
2
0
2
0 no answer
0
>0-0.5
>0.5-1.0
>1.0-1.5
>1.5-2.0
>2.0-2.5
>2.5-3.0
>3.0-3.5
>3.5-4.0
>4.0-4.5
>4.5-5.0
>5.0-5.5
Fungicide load (kg ai/ha)


Piemonte
Farms %
100
80
60
40
20
0
81
5
8
3
0
2
0
>0-0.5
>0.5-1.0
>1.0-1.5
>1.5-2.0
>2.0-2.5
>2.5-3.0
>3.0-3.5
>3.5-4.0
>4.0-4.5
>4.5-5.0
>5.0-5.5
Fungicide load (kg ai/ha)

Heaviest loads

The range of loads used in Hannover was the narrowest of the four regions. Farmers who applied the highest loads applied at recommended rates whereas the majority used rates lower than recommended. These farmers also applied older, low activity chemicals.

Dose rate was not a factor responsible for the extremes of loads in any of the other regions.

In East Anglia high loads were solely caused by farmers making more applications than others. There was no difference in any other aspect. It could be assumed that this represents normal variation in the need to spray for disease control.

The same reason occurred in North Central France, where high load farms received more applications, but in addition these farms also used more of the lower activity (high dose) fungicides.

No common reason could be found for the higher loadings in Piemonte. There was generally too little fungicide application.

Lightest loads

Farms receiving the lightest loadings in East Anglia, North Central France and Piemonte commonly applied at least some of the treatment to only part of the farm. This was the single most important factor. In North Central France a contributory factor was the use of lower doses than the average for the region and the use of higher activity active ingredients.

The lightest loads in Hannover were the result of the use of fewer product applications.

6.7 Fungicide load per farm related to average yield

No relationship could be found for any region between the fungicide load per farm and yields of wheat.

6.8 Fungicide use in the study year (1994) compared with an average year

Table 6.8 Fungicide use in the study year (1994) compared with an average year

	Hannover (D)	East Anglia (UK)	North Central (F)	Piemonte (I)
Number of farms	60	61	65	59
Fungicide use	Farms %			
Lesser use	26	5	10	7
Greater use	5	8	8	4
The same	67	80	80	13
No answer	2	7	2	76

Hannover had a higher proportion than the other regions of farmers using less fungicide in 1994 compared with average. The average fungicide load of this region was the highest of all and it would appear therefore that in an average year it will be even higher.

Specialists in East Anglia commented that there was generally little change from year to year except in the use of morpholines, which vary according to the intensity of *Erysiphe* attack.

6.9 Factors determining the start of fungicide application

Table 6.9 Factors determining the start of fungicide application (Farms %)

Factor	Date				Plant stage				Disease stage				Weather				Warning system				Don’t know				No disease			
Region	H	E	N	P	H	E	N	P	H	E	N	P	H	E	N	P	H	E	N	P	H	E	N	P	H	E	N	P
Disease																												
Pseudocercosporella	17	4	5	-	40	27	48	-	17	21	26	-	25	9	8	-	40	5	12	-	2	2	2	12	3	32	6	88
Rhizoctonia	2	6	6	-	5	14	14	-	7	12	6	-	2	6	6	-	3	2	6	-	10	6	14	12	35	54	11	88
Fusarium spp	5	2	6	-	13	22	28	2	22	18	31	8	18	10	18	3	18	4	6	-	5	4	-	12	17	41	5	73
Septoria tritici	3	2	8	-	13	25	45	3	27	12	29	5	13	12	15	2	15	4	6	-	9	4	-	10	18	38	8	81
Erysiphe graminis	15	4	5	2	15	31	32	2	57	34	42	12	23	15	22	8	32	4	11	2	2	1	-	8	-	11	8	68
Septoria nodorum	22	4	12	-	38	14	23	-	18	16	23	7	18	12	11	-	25	5	11	-	2	2	3	12	2	47	18	81
Puccinia spp	12	3	9	10	17	30	31	8	25	35	17	14	18	15	8	14	23	5	11	3	7	2	-	2	5	11	18	47

Region abbreviations: H = Hannover, E = East Anglia, N = North Central France, P = Piemonte

In all three northern regions, 'plant stage' and 'disease stage' were the most important factors used for determining when to apply fungicides. The indications were the same in Piemonte where fewer farmers answered those questions because they did not have the diseases. This was in agreement with the opinions and policies of the specialists in each region. Only in Hannover did 'warning systems' appear important. Specialists in East Anglia felt that the answers concerning 'weather' as a trigger supported their view that this factor is very unsatisfactory as a component of a spray decision support system. A relatively high proportion of farmers in East Anglia claimed their wheat had not suffered attack by certain diseases (in 1994), which, as for Piemonte, influences the totals recorded for the various factors.

6.10 Opportunities to reduce fungicide load

A significant amount of resource is being expended in the three northern regions on optimising the cost-efficacy of disease control. In all three the farmers are technically well-educated and are served by well established official and private extension services. If the tools were available to reduce fungicide loads, it would appear that, although farmer attitudes require compelling arguments, their receptivity is good and the communication pathway effective.

Dose rates have been reduced from label rates and it is believed there is no more scope in this area in the conventional use of fungicides.

Varietal resistance to diseases is of great significance, and is particularly strongly promoted in East Anglia, partly as a means of minimising the need for fungicide treatment but also as a means of reducing the threat of fungicide resistant diseases.

Disease management has however developed into a holistic approach ('canopy management' in East Anglia) where varietal tolerance to disease, selection of active ingredient, selection of dose rate, level of disease pressure at the time of spraying, spectrum of diseases present, time of season and the weather, are all involved. Scientists in all three regions are working to create spray-decision support systems including all these variables. The availability of computers in the farmhouse linked to a central advisory office, with access to programmes based on masses of scientific data makes the possibility of success much higher than only a few years ago.

Several programmes have been tested on a commercial scale during recent years and some are currently being tested. Conclusions generally are that the systems are still not sophisticated enough to deal reliably with the weather and its hugely variable impact, the range of potential diseases and all the other components of the system. The results in practical terms were that the efficiency of fungicide sprays had been improved but that there had been no significant reduction in the amount of fungicidal units (i.e. disregarding the level of activity of the active ingredient) applied.

A result which is increasingly occurring, even though a fully fledged system is still some years away, is that of more spot- or partial-spraying taking place.

7.0 INSECTS AND INSECTICIDES

7.1 Target insects

Table 7.1 Target insects

Region	Hannover (D)	East Anglia (UK)	North Central (F)	Piemonte (I)
Number of farms	60	61	65	59
	Farms %			
Macrosiphum avenae (bird cherry aphid)	42	15	73	37
Rhopalosiphum padi (grain aphid)	88	34	59	1
Hylemia coarctata (wheat bulb fly)	22	28	40	-
Sitodiplosis dactylidis (orange wheat-blossom midge)	3	22	11	-
Agriotes (wireworm)	-	-	-	4

Macrosiphum avenae may transmit Barley Yellow Dwarf Virus (BYDV) but it infests the crop in the spring during flowering and ear-filling and its importance lies more in its direct feeding which debilitates the crop and reduces grain quality.

Rhopalosiphum padi infests the seedling crop in the autumn and can transmit BYDV.

Hylemia coarctata eggs are laid in the soil during the summer particularly on bare soil or in crops with open foliage, such as potatoes. The eggs hatch during the winter and the maggots infest the central shoot of the wheat seedling, which will eventually die. In early spring the growing maggot migrates to other tillers of the seedling and it is at this time when control must be achieved to prevent serious damage. *H. coarctata* infestations tend to be localised. Specialists in East Anglia believed it is increasing probably due to set-aside land.

Agriotes is a beetle and the damaging stage is the larva which is found in the soil. The larval stage lasts for several years, each summer feeding on the seedlings. It has declined in most of northern Europe over the past thirty years.

In North Central France specialists mentioned a new pest *Psammotettix alienus* which is the vector of ‘nanisme’, a stunting disorder.

7.2 Insects exhibiting resistance

A few farmers in each of the samples claimed to have found insect resistance but local specialists discounted all of them, the real cause being inappropriate insecticides or poor application.

7.3 Level of insect control sought

Table 7.3 Level of insect control sought

Region	Hannover (D)	East Anglia (UK)	North Central (F)	Piemonte (I)
Number of farms	60	61	65	59
Control sought	Farms %			
71 - 80%	12	3	9	3
81 - 90%	22	10	31	14
91 - 100%	55	87	49	42
No answer	12	-	11	40

Specialists in Hannover and in North Central France said they would prefer levels of control to be about 100%, in order to prevent BYDV transmission. Response levels in East Anglia were considered suitable by the specialists. In Piemonte there was a general acceptance of lower levels of control for all crop protection inputs - in line with the low input nature of wheat cultivation in this region.

7.4 Insecticide use

7.4.1 Hannover

Table 7.4.1 Insecticide active ingredients used in Hannover

Active ingredient	Activity	% of crop treated (Base area 1,956 ha)	No. of applications		Cumulative dose on crop receiving that ai g ai/ha		
			Range per farm	Av per ha treated	min	max	ave
pirimicarb	sf/aph	48	1 - 2	1.1	50	400	148
fenvalerate♣	c/b	46	1 - 2	1.1	13	100	29
lambda-cyhalothrin♣	c/b	23	1	1.0	2.5	25	9
parathion-e	c/b	22	1 - 3	1.4	100	300	152
deltamethrin	c/b	15	1 - 2	1.2	2.5	10	5
alphacypermethrin♣	c/b	4	1	1.0	7	10	9
oxydemeton-methyl	sc/aph	3	1	1.0	120	120	120

Key to abbreviations:

c = contact   aph = aphids
s = systemic   b = broad spectrum
f = fumigant

♣ = pyrethroids

7.4.2 East Anglia

Table 7.4.2 Insecticide active ingredients used in East Anglia

Active ingredient	Activity	% of crop treated (Base area 4,627 ha)	No. of applications		Cumulative dose on crop receiving that ai g ai/ha		
			Range per farm	Ave per ha treated	min	max	ave
dimethoate	s/b	34	1 - 3	1.3	149	1,000	411
pirimicarb	sf/aph	30	1 - 2	1.3	69	1,050	238
cypermethrin♣	c/b	21	1	1.0	20	30	25
chlorpyrifos-ethyl	c/b	9	1	1.0	240	720	375
deltamethrin♣	c/b	5	1-2	5.8	5	124	49
			(11,13)				
fenvalerate♣	c/b	5	*	1.0	18	174	147
chlorfenvinphos	soil/b	3	1	1.0	279	551	426
fonofos	soil/b	3	1	1.0	100	139	103
heptenophos	sf/b	2	1	11.8	1,672	1,976	1,800
demeton-s-methyl	sc/b	1	11,13	1.0	115	202	121
bifenthrin♣	c/b	1	1	1.0	5	5	5
oxydemeton-methyl	sc/aph	<1	1	1.0	121	121	121
			1				

Key to abbreviations:

c	=	contact	aph	=	aphids
s	=	systemic	b	=	broad-spectrum
f	=	fumigant			

♣ = pyrethroids

* Deltamethrin was applied by two farmers in low doses mixed with heptenophos 11 and 13 times respectively. Specialists could not explain this, if it was true. Such a spray strategy is used for aphid control on potatoes.

7.4.3 North Central France

Table 7.4.3 Insecticide active ingredients used in North Central France

Active ingredient	Activity	% of crop treated	No. of applications		Cumulative dose on crop receiving that ai g ai/ha		
		(Base area 2,603 ha)	Range per farm	Ave per ha treated	min	max	ave
lambda-cyhalothrin♣	c/b	28	1 - 2	1.2	4	15	8
pirimicarb	sf/aph	16	1 - 2	1.1	40	130	100
deltamethrin♣	c/b	14	1 - 2	1.1	4	20	8
esfenvalerate♣	c/b	11	1 - 2	1.6	6	20	10
bifenthrin♣	c/b	11	1	1.0	16	59	20
thiometon	s/aph	9	1 - 2	1.1	60	168	86
tau-fluvalinate♣	c/b	7	1	1.0	21	95	50
endosulfan	c/b	6	1 - 2	1.1	200	500	246
beta-cyfluthrin♣	c/b	5	1	1.0	1.6	7.5	4
cypermethrin♣	c/b	5	1 - 2	1.5	25	139	40
oxydemeton-methyl	sc/aph	4	1	1.0	50	100	91
tralomethrin♣	c/b	2	1	1.0	8.6	8.6	8.6
cyfluthrin♣	c/b	1	1 - 2	1.6	12	20	16
parathion-methyl	cf/b	1	1	1.0	200	200	200

Key to abbreviations:

c	=	contact	aph	=	aphids
s	=	systemic	b	=	broad spectrum
f	=	fumigant			

♣ = pyrethroids

7.4.4 Piemonte

Table 7.4.4 Insecticide active ingredient used in Piemonte

Active ingredient	Activity	% of crop treated (Base area 563 ha)	No. of applications		Cumulative dose on crop receiving that ai g ai/ha		
			Range per farm	Ave per ha treated	min	max	ave
pirimicarb	sf/aph	10	1	1.0	209	244	217
dimethoate	s/b	8	1	1.0	599	764	746
deltamethrin♣	c/b	8	1	1.0	22	23	23
phosalone	c/b	7	1	1.0	479	527	496
lindane	c/b	<1	1	1.0	450	450	450

Key to abbreviations:

c = contact aph = aphids
s = systemic b = broad-spectrum
f = fumigant

♣ = pyrethroids

7.4.5 Insecticide active ingredients used - general commentary

In each region the list of active ingredients was as expected by specialists. In all regions the majority of active ingredients were suitable for aphid control, and in East Anglia and Piemonte there were also obvious soil insecticides listed, chlorfenvinphos and fonofos, and lindane respectively. The latter is not in fact registered for use on winter wheat in Piemonte. The pyrethroids (♣ in Tables 7.4.1 - 7.4.4) may be used for aphid and *Hylemia coarctata* control, and chlorpyrifos-ethyl is also particularly suitable for the latter.

Pirimicarb is a specific aphicide which has no effect on other or beneficial insects, and its widespread use was gratifying to the specialists. Lambda-cyhalothrin is also particularly suitable for virus-transmitting aphids due to its rapid effect of causing aphids to withdraw their mouthparts from plants and cease feeding thus preventing virus transmission.

In East Anglia two farmers had apparently adopted a spray strategy used for controlling aphids on potatoes but one which was not recommended on cereals. This entailed frequent low dose sprays of a mixture of deltamethrin and heptenophos, explaining the 11 and 13 sprays in Table 7.4.2.

Specialists in Piemonte were surprised at the extent of insecticide use, even though only 14% of farmers applied treatments.

Unlike herbicides and fungicides, insecticide dose rates were not cut, the majority of farmers used the recommended rate. There was evidence in Hannover of farmers using the correct rate within a range which was dependant on air temperature at the time of spraying. The general analysis is that of rational and intelligent use of insecticides in all regions in the study. Possibilities for reducing usage are discussed in Section 7.7.

7.5 Insecticide use parameters

Table 7.5 Insecticide applications

On farms using insecticides	Hannover (D)	East Anglia (UK)	North Central (F)	Piemonte (I)
No. of active ingredients used per farm	1.8	1.6	1.9	1.6
No. of active ingredients used per hectare	1.6	1.1	1.2	0.3
No. of product applications per hectare	1.7	2.0	1.2	1.3
Proportion of farmers spraying parts of their crop	15%	34%	27%	12%
Average volume of active ingredient kg ai/ha	0.13	0.38	0.08	0.65

Over a third of the farmers in East Anglia and a quarter in North Central France sprayed distinct parts of their crop depending on the incidence and pressure of pests. Fewer appeared to do this in Hannover and Piemonte.

7.6 Insecticide load per farm

Table 7.6 Insecticide load per farm

Region	Hannover (D)	East Anglia (UK)	North Central (F)	Piemonte (I)
Number of farms	60	61	65	59
Insecticide load kg ai/ha	Farms %			
0	3	3(+2*)	20	86
>0 - 0.025	28	3	40	0
>0.025 - 0.05	15	0	14	0
>0.05 - 0.075	7	3	9	0
>0.075 - 0.10	5	5	6	0
>0.10 - 0.15	17	7	10	0
>0.15 - 0.20	8	7	0	2
>0.20 - 0.25	8	7	0	2
>0.25 - 0.30	2	5	0	0
>0.30 - 0.35	3	20	0	0
>0.35 - 0.40	3	8	3	0
>0.40 - 0.45	0	0	0	2
>0.45 - 0.50	0	8	0	0
>0.5 - 1.0		10	2	8
>1.0 - 1.5		3	0	0
>1.5 - 2.0		0	0	0
>2.0 - 2.5		3	0	0
Range kg ai/ha	0.002 - 0.37	0.005 - 2.1	0.002 - 0.7	0.19 - 0.85

* Farmers applied treatments but were unable to provide information (contractors etc).

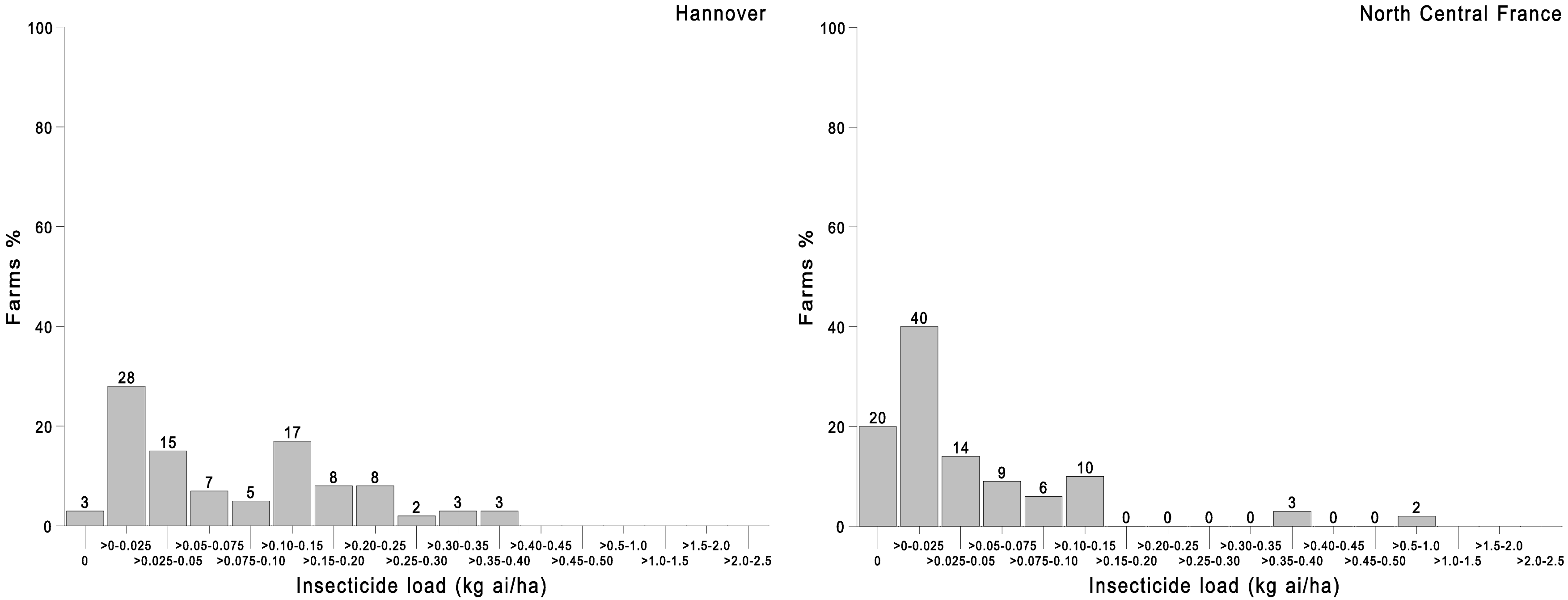
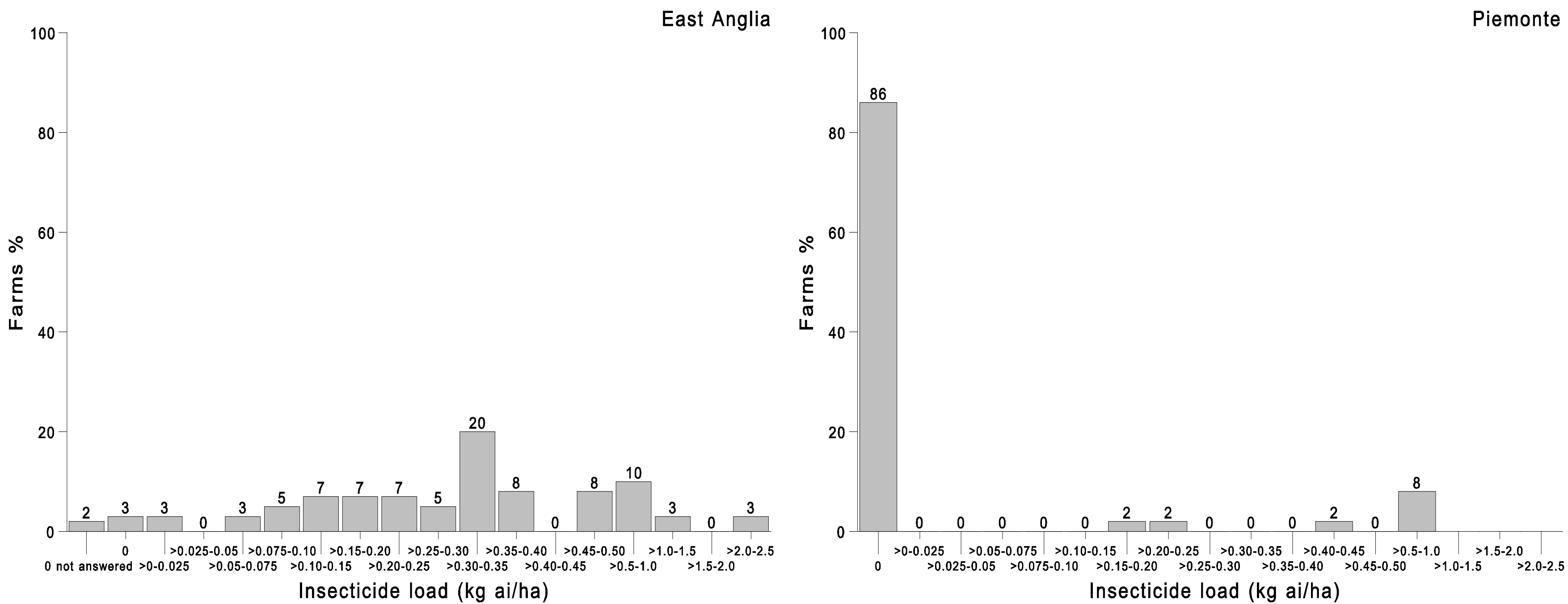


Chart 7.6 Insecticide load per farm



East Anglia
Farms %
100
80
60
40
20
0
2
3
3
0
3
5
7
7
7
5
20
8
0
8
10
3
0
3
0 not answered
0
>0-0.025
>0.025-0.05
>0.05-0.075
>0.075-0.10
>0.10-0.15
>0.15-0.20
>0.20-0.25
>0.25-0.30
>0.30-0.35
>0.35-0.40
>0.40-0.45
>0.45-0.50
>0.5-1.0
>1.0-1.5
>1.5-2.0
>2.0-2.5
Insecticide load (kg ai/ha)
Piemonte
Farms %
86
0
0
0
0
0
2
2
0
0
0
2
0
8
0
>0-0.025
>0.025-0.05
>0.05-0.075
>0.075-0.10
>0.10-0.15
>0.15-0.20
>0.20-0.25
>0.25-0.30
>0.30-0.35
>0.35-0.40
>0.40-0.45
>0.45-0.50
>0.5-1.0
>1.0-1.5
>1.5-2.0
>2.0-2.5
Insecticide load (kg ai/ha)

East Anglia and Piemonte stand out as having the highest loads per farm. The principle reason for this was the high use of dimethoate, an active ingredient of low activity. In the other regions the highly active synthetic pyrethroids were used at the expense of dimethoate. The dose rate of pirimicarb in both East Anglia and Piemonte was also higher.

The heaviest loads in Hannover especially were characterised by the use of pirimicarb which is also of relatively low activity compared with the synthetic pyrethroids. None of these farms had been partial or spot sprayed. In East Anglia the heaviest loads, ignoring the aberrant deltamethrin/heptenophos multiple applications, were the result of dimethoate used at above the recommended rate or the use of chlorpyrifos for *Hylemia coarctata* control, also used at above the recommended rate.

A similar situation existed in North Central France where the heavy loads were explained by the use of the low activity insecticides endosulfan and thiometon, and again by farmers using rates above recommended levels.

The lightest loads in all regions were the result of farms being spot or partially sprayed, and also of using the highly active synthetic pyrethroids.

7.7 Insecticide use in the study year (1994) compared with an average year

Table 7.7 Insecticide use in the study year (1994) compared with an average year

Region	Hannover (D)	East Anglia (UK)	North Central (F)	Piemonte (I)
Number of farms	60	61	65	59
Insecticide use	Farms %			
Lesser use	18	5	7	8
Greater use	0	18	12	3
The same	77	70	63	14
No answer	5	6	15	75

Weather was seen as the determinant of seasonal variability. The only suggestion of any change was the increase in *Sitodiplosis dactylidis* and of *Hylemia coarctata* in East Anglia, the former suddenly in 1993 and the latter slowly over several years.

7.8 Factors determining the start of insecticide applications

Table 7.8 Factors determining the start of insecticide applications (Farms %)

Factor	Date				Plant stage				Insect stage				Insect pressure				Warning system				Don't know				No answer			
Region	H	E	N	P	H	E	N	P	H	E	N	P	H	E	N	P	H	E	N	P	H	E	N	P	H	E	N	P
Insect																												
Aphids	3	7	9	0	25	7	18	2	37	37	15	10	55	38	20	3	32	7	6	6	0	4	9	25	0	0	2	59
Hylemia	5	15	9	-	12	17	5	-	3	33	6	-	15	22	8	-	8	5	6	-	10	8	17	-	47	0	49	-

Region abbreviations: H = Hannover, E = East Anglia, N = North Central France, P = Piemonte

Aphids

Farmers in Hannover and East Anglia monitored the crop for aphid attacks and based their decisions on the aphid stage and pressure. This is the system advised by officials. In addition, those in Hannover utilised a warning system. In North Central France there was some reticence in responding to the question but, of those who answered, a high proportion inspect their crop for aphids. Specialists in Piemonte expressed their opinion that too much insecticide spraying had occurred in 1994. The results in Table 7.8 agree with their comments. Farmers were not assessing pressure and sprayed on the basis of presence or absence of aphids in the crop. Specialists commented that because there was no problem of aphid transmission of BYDV in Piemonte considerable aphid populations could be supported by the crop without economic damage.

Hylemia

This pest is most important in East Anglia and specialists commented that farmers tended to adopt a more prophylactic approach to its control. Spray timing is difficult to determine and the optimum time can easily be missed.

It was commented in East Anglia and North Central France that the newer active ingredients being introduced for seed treatment will reduce the need for sprays for both aphid and *Hylemia* control.

7.9 Opportunities to reduce insecticide load

It is inappropriate to consider reducing the dose rate of insecticides. When a spray is necessary it must kill the insects, and judging by the responses in this study farmers and specialists concur on this.

The opportunities lie in three areas.

1 Seed treatment. Insecticides such as imidacloprid and tefluthrin are being introduced for seed treatment. These insecticides will control the autumn populations of the most important virus transmitting aphid, *Rhopalosiphum padi*, and thus minimise the over-wintering population. There could therefore be a very significant reduction in the need for autumn sprays and a reduction in the need for early spring sprays. The exact importance and potential benefits of this development on a regional scale have not yet been determined and will not be so for a year or two.

   The impact of the new seed treatments on *Hylemia* is less certain particularly in respect of tefluthrin.

2 More information linking the timing and level of aphid infestation to economic damage. Specialists in East Anglia were particularly interested in this area. If seed treatments reduce aphid levels, the possibility to avoid spraying will increase and information on these factors is essential if maximum benefit is to be gained from the seed treatment.

3 Monitoring of the crop. Encouragement to farmers to continually monitor the occurrence and levels of aphids and *Hylemia* is an essential pre-requisite to more sophisticated management of pest control. At the very least it will enable farmers to spray only the parts of their crop which are infested. There is considerable scope for reduced usage through this means in all the regions. Already in East Anglia 34% of farmers at some time sprayed only part of their crop. Specialists in Piemonte were convinced of the value of crop monitoring to assess insect pressure but were disappointed that few farmers did it.

4 Warning systems. The warning system in Hannover appears to have most practical use. That in North Central France exists but information dissemination is reportedly too slow to give farmers the confidence to use it. A well developed system exists in East Anglia but it appears from this study that few farmers find it of relevance.

8.0 MISCELLANEOUS PESTS AND PESTICIDES

8.1 Target pests and their control

The main target pests in this section were slugs and snails which affected all the regions. Farmers only treated those parts of the crop affected. Additional treatments were mentioned aimed at pre/post harvest weed control.

Table 8.1 Slug and snail infestations which were treated

	Hannover (D)		East Anglia (UK)		North Central (F)		Piemonte (I)	
Number of farms/area ha	60	1,956	61	4,627	65	2,603	59	563
	Farms %/Area %							
Infestations treated	11	6	31	17	65	46	-	-

8.2 Miscellaneous pesticide use

8.2.1 Hannover

Table 8.2.1 Miscellaneous pesticide active ingredients used in Hannover

Active ingredient	% of crop treated (Base area 1,956 ha)	Average no. of applications per ha treated	Cumulative dose on crop receiving that ai g ai/ha		
			min	max	ave
Molluscicides					
methiocarb	3.2	1.0	100	1,500	1,274
metaldehyde	2.1	1.0	39	600	263

All farmers who controlled slugs used a single application, but only one treated his whole crop. For those who used a molluscicide, the average proportion of the crop which was treated was 31%.

8.2.2 East Anglia

Table 8.2.2 Miscellaneous pesticide active ingredients used in East Anglia

Active ingredient	% of crop treated (Base: 4,627 ha)	Average no. of applications per ha treated	Cumulative dose on crop receiving that ai g ai / ha		
			min	max	ave
Molluscicides					
methiocarb	10	1.5	108	440	318
metaldehyde	7	1.2	59	900	518
Others					
glyphosate	4	1.0	1,260	1,440	1,437
dimethoate	2	1.0	340	340	340

17% of the crop was treated for molluscs and a small proportion with glyphosate for pre/post harvest weed control. The target for dimethoate in this context is uncertain.

8.2.3 North Central France

Table 8.2.3 Miscellaneous pesticide active ingredients used in North Central France

Active ingredient	% of crop treated (Base area 2,603 ha)	Average no. of applications per ha treated	Cumulative dose on crop receiving that ai g ai/ha		
			min	max	ave
Molluscicides					
metaldehyde	28	1.2	179	900	451
methiocarb	17	1.1	59	1,199	148
thiodicarb	1	1.3	120	400	213
bensultap	0.4	1.0	150	150	150
Others					
glyphosate	7	1.0	108	1,259	867

This region presented a similar picture to East Anglia though with an increased use of molluscicides.

8.2.4 Piemonte

Table 8.2.4 Miscellaneous pesticide active ingredients used in Piemonte

Active ingredient	% of crop treated (Base area: 563 ha)	Average no. of applications	Cumulative dose on crop receiving that ai g ai/ha		
			min	max	average
glyphosate	3	1.0	2,199	2,119	2,119
MCPA	3	1.0	575	575	575
glufosinate	<1	1.0	480	480	480

Glyphosate and MCPA were applied as a formulated mixture.

8.3 Miscellaneous pesticide use in the study year (1994) compared with an average year

Table 8.3 Miscellaneous pesticide use in the study year (1994) compared with an average year

	Hannover (D)	East Anglia (UK)	North Central (F)	Piemonte (I)
Number of farms	60	61	65	59
	Farms %			
Lesser use	7	3	3	0
Greater use	5	13	22	3
The same	7	47	25	7
Don’t know	3	15	2	-
No answer	73	21	49	90

Specialists in North Central France agreed with farmers that slugs were becoming more of a problem. In other regions no trend was mentioned, infestations varying with the year and the weather.

8.4 Opportunities to reduce the load of miscellaneous pesticides

The main miscellaneous pesticides mentioned were molluscicides to control slugs and snails. Treatment of these is well targeted because populations are easily seen and they are not very mobile. Cleanliness of land between crops is important in keeping populations down, but no opportunity was seen to reduce the use of appropriate treatments when necessary.

9.0 OTHER AGROCHEMICALS

9.1 Other agrochemicals used - plant growth regulators (PGRs)

In all regions plant growth regulators were applied to minimise the risk of lodging.

Table 9.1 Other agrochemicals used - plant growth regulators

	Hannover (D)		East Anglia (UK)		North Central (F)		Piemonte (I)	
Number of farms/area ha	60	1,956	61	4,627	65	2,603	59	563
	Farms %/Area %							
Use of anti-lodging PGRs	92	96	70	65	46	36	3	8

9.2 Plant growth regulator active ingredient use

9.2.1 Hannover

Table 9.2.1 Plant growth regulator active ingredients used in Hannover

Active ingredient	% of crop treated (Base area 1,956 ha)	Average number of applications	Cumulative dose on crop receiving that ai g ai/ha		
			min	max	ave
chlormequat-chloride	88.5	1.8	41	4,185	1,412
ethephon	7.0	1.8	93	479	348

9.2.2 East Anglia

Table 9.2.2 Plant growth regulator active ingredients used in East Anglia

Active ingredient	% of crop treated (Base area 4,627 ha)	Average number of applications	Cumulative dose on crop receiving that ai g ai / ha		
			min	max	ave
chlormequat-chloride	62.4	1.3	434	3,220	1,816
choline-chloride	7.8	1.9	49	147	136
ethephon	5.5	1.5	155	310	253
mepiquat-chloride	5.5	1.5	305	609	499

Note: Choline-chloride always in mixture with chlormequat-chloride. Ethephon and mepiquat-chloride was a pre-mixed product.

9.2.3 North Central France

Table 9.2.3 Plant growth regulator active ingredients used in North Central France

Active ingredient	% of crop treated (Base area 2,603 ha)	Average number of applications		Cumulative dose on crop receiving that ai g ai/ha		
		Range	Ave	min	max	ave
chlormequat chloride	30	1 - 2	1.4	368	3,220	1,395
choline-chloride	14	1 - 2	1.4	69	1,600	739
trinexapac-e	5	1 - 2	1.1	25	250	110
ethephon	3	1 - 2	1.8	309	557	514
mepiquat-chloride	3	1 - 2	1.8	609	1,098	1,012
imazaquin	2	1	1.0	19	200	56

Note: Choline-chloride used in mixture with chlormequat-chloride. Ethephon and mepiquat-chloride was a pre-mixed product.

A number of farmers applied several active ingredients to the same area resulting in the proportion of crop treated at all being 36%.

9.2.4 Piemonte

Table 9.2.4 Plant growth regulator active ingredients used in Piemonte

Active ingredient	% of crop treated (Base area: 563 ha)	Average number of applications	Cumulative dose on crop receiving that ai g ai/ha		
			min	max	ave
chlormequat-chloride	8	1.0	812	2,472	999

9.2.5 Plant growth regulator active ingredients used - general commentary

The use of plant growth regulators was highest in the most northerly region and reduced towards the most southerly, Piemonte. In Hannover the use of anti-lodging PGRs was the norm, a range of concentrations being available to suit the need for a single or multiple applications, the differences in variety, soil type and field aspect. The cost of treatment is low and is considered a worthwhile insurance policy protecting the complete season's inputs.

Specialists in East Anglia recommended the use of PGRs to prevent lodging even for varieties which are resistant. They felt that there has not been a season for several years which has tested such varieties. Similar sentiments were expressed in North Central France. In Piemonte lodging was not regarded as a problem.

9.3 Opportunities to reduce the load of other agrochemicals

Specialists in the three northern regions felt there was no justification in principle for reducing the use of anti-lodging PGRs.

There was wide variation in cumulative dose in all regions. Inclement weather would show farmers what doses are effective and which varieties require less or perhaps no treatment, and there has not been such weather for several years.

10.0 TRENDS IN PESTICIDE USE

10.1 Variation in pesticide use in winter wheat over the last five years

Farmer responses are presented below:

10.1.1 Seed treatment

Table 10.1.1 Variation in seed treatment use over the last five years

	Hannover (D)	East Anglia (UK)	North Central (F)	Piemonte (I)
Number of farms	60	61	65	59
Usage	Farms %			
Increased	3	8	9	39
The same	92	72	83	54
Reduced	0	11	3	0
No answer	5	9	5	6

10.1.2 Herbicides

Table 10.1.2 Variation in herbicide use over the last five years

	Hannover (D)	East Anglia (UK)	North Central (F)	Piemonte (I)
Number of farms	60	61	65	59
Usage	Farms %			
Increased	3	26	11	28
The same	48	54	78	50
Reduced	45	16	9	16
No answer	3	3	2	5

10.1.3 Fungicides

Table 10.1.3 Variation in fungicide use over the last five years

	Hannover (D)	East Anglia (UK)	North Central (F)	Piemonte (I)
Number of farms	60	61	65	59
Usage	Farms %			
Increased	12	38	13	10
The same	57	41	72	28
Reduced	27	16	10	22
No answer	5	5	5	38

10.1.4 Foliar insecticides

Table 10.1.4 Variation in foliar insecticide use in the last five years

	Hannover (D)	East Anglia (UK)	North Central (F)	Piemonte (I)
Number of farms	60	61	65	59
Usage	Farms %			
Increased	17	26	14	11
The same	53	56	72	25
Reduced	18	8	7	34
No answer	12	10	7	28

10.1.5 Soil insecticides

Specialists in East Anglia commented that there had been an increase in the use of soil-applied insecticides for *Hylemia* control in recent years.

10.1.6 General commentary

Specialists in all four regions thought that there had not been any major change in usage over the last five years. However, there were slight changes which they believed had occurred.

All thought that there had been, and would continue to be, an increase in seed treatment and all except in Piemonte thought that this would result in some reduction in foliar, and possibly soil, insecticide use. In Piemonte there is such a small amount of insecticide use that no difference would be detected.

Herbicide use appears to have reduced in Hannover. In North Central France although it was believed that there had been a reduction in dose rates through refining the use of specific post-emergence herbicides, there was also concern over the influx of weed seed from neighbouring set-aside land - a concern shared with specialists in East Anglia.

Specialists in East Anglia did not agree with farmers that there was some increase in fungicide use (the responses mainly from smaller farms), but felt there had been a small increase in soil insecticide use as mentioned in Section 10.1.5, and in foliar insecticides to control *Sitodiplosis dactylidis.*

10.2 Plans to maintain or change pesticide use in winter wheat

Farmers were asked if they would maintain the same use of products next year.

Table 10.2i Plans to maintain or change pesticide use in winter wheat

Region	Hannover (D)	East Anglia (UK)	North Central (F)	Piemonte (I)
Number of farms	60	61	65	59
Usage	Farms %			
Will change	8	5	17	5
Possibly change	40	36	12	27
Will not change	45	46	69	59
Don't know	7	13	2	8

Opinion in North Central France was most clearly divided but in no region was there a strong desire for change.

Those farmers who indicated they would, or might, change were asked in which agrochemical sector change would be made and if so for what reason. The four possible reasons offered were

- better control
- distribution/availability
- economics
- environment

Hannover

The main sector for change was fungicides followed by herbicides, and the main reasons were ‘better control’ and ‘economics’.

East Anglia

The most important areas for change were the same as for Hannover - herbicides and fungicides equally, again with reasons of ‘better control’ and ‘economics’.

North Central

The most important sectors for change were herbicides, for the reason of ’better control’ and fungicides for the reason ‘economics’.

Piemonte

Only for herbicides was there any significant response, and farmers cited ‘better control’ followed by ‘environment’ as the main reasons for change. Specialists suggested that ‘better control’ was probably mentioned because some farmers had cut their doses too much resulting in poor weed control. ‘Environment’ was mentioned because of the knowledge of the serious problem of ground water contamination in the Po valley.

In general, ‘cost-efficacy’ was the main reason for willingness to change products, in both herbicides and fungicides. The wider influence of the news of environmental problems is of interest, although it should be said that the Po valley problem was acute and of practical and obvious importance. It necessitated water wagons being drawn around the towns and villages of that region as the water had been declared unfit to drink, and legal parameters on herbicide use were rigorously enforced.

10.3 Change in agrochemical use across all crops in the last five years

Questioned as to broad changes in agrochemical use across all their crops farmers gave the following replies:

Table 10.3 Change in agrochemical use across all crops in the last five years

	Hannover (D)	East Anglia (UK)	North Central (F)	Piemonte (I)
Number of farms	60	61	65	59
	Farms %			
More intensive	10	34	18	27
The same	47	36	58	42
Less intensive	40	20	15	25
No answer	3	10	8	6

In East Anglia it was the smaller farmers who expressed a wider range of opinion, suggesting that they were less consistent than larger ones. Similarly, the larger farmers in Piemonte said there had been no change.

11.0 PESTICIDE/AGROCHEMICAL GENERALITIES

11.1 Sufficiency in choice of products

Table 11.1 Farmers indicating satisfaction in choice of products

Region	Hannover (D)	East Anglia (UK)	North Central (F)	Piemonte (I)
Number of farms	60	61	65	59
	Farms %			
Herbicides	92	92	94	93
Fungicides	90	93	97	90
Insecticides	92	89	97	85
Molluscicides	23	-	85	78
Anti-lodging agents	33	75	85	32

The level of dissatisfaction in all regions was very low, and lowest of all in Piemonte.

The reason for any low levels of satisfaction recorded in Table 11.1 was generally that use of that chemical sector was low in the region. The exception to this was in Hannover for anti-lodging agents where these products were widely used.

11.2 Attitudes to developments in the pesticide market

Farmers were asked to comment on developments in the pesticide market with regard to availability of new products, increasing efficacy of products, ease of application and lowered residue levels. They responded as good, satisfactory or poor. Table 11.2 gives the result of the 'good and 'satisfactory' replies combined.

Table 11.2 Farmers expressing satisfaction with pesticide developments

Region	Hannover (D)	East Anglia (UK)	North Central (F)	Piemonte (I)
Number of farms	60	61	65	59
	Farms %			
Availability of new products	89	85	88	95
Increasing efficacy	90	87	80	76
Ease of application	93	91	83	99
Lower residues	66	78	56	76

There was a very high level of satisfaction expressed, particularly concerning ease of application. Specialists in East Anglia suggested this was the response to many new packaging ideas and more convenient formulations.

In general the proportion of the rating for satisfaction in Table 11.2 which was ‘good’ as opposed to ‘satisfactory’ was highest in Hannover, next highest in Piemonte, then East Anglia and lowest in North Central France.

The lower levels of satisfaction for ‘lower residues’ was felt by specialists to be the result of farmers being unaware of the actual residue situation with regard to the particular products they apply. Farmers rely on the authorities having explored the issue.

11.3 Attitudes to handling restrictions on the label

Farmers were asked how important handling restrictions on the label were on choice and use of products. They were offered three responses - very important, important and not important. Table 11.3 presents the two former answers.

Table 11.3 Attitudes to handling restrictions on the label

Region	Hannover (D)		East Anglia (UK)		North Central (F)		Piemonte (I)	
Number of farms	60		61		65		59	
Attitude	Farms %							
Importance	very	imp.	very	imp.	very	imp.	very	imp.
On **choice** of products	52	40	57	30	26	54	78	22
On **use** of products	50	40	59	30	40	48	75	25

Farmers in Piemonte were most emphatic in the importance of label restrictions. This must be coloured by the fact that most only applied herbicides. Those in North Central France seem least influenced.

11.4 Attitudes to environmental restrictions on the label

The same procedure was adopted as for 11.3.

Table 11.4 Attitudes to environmental restrictions on the label

Region	Hannover (D)		East Anglia (UK)		North Central (F)		Piemonte (I)	
Number of farms	60		61		65		59	
Attitude	Farms %							
Importance	very	imp.	very	imp.	very	imp.	very	imp.
On **choice** of products	42	52	44	43	43	42	73	25
On **use** of products	42	48	48	39	42	49	71	29

Piemonte farmers were the most emphatically influenced by environmental restrictions on the label. Farmers in North Central France accorded more importance to environmental restrictions than to handling restrictions. The reverse was true for those in Hannover and East Anglia.

It is interesting that in all regions there was no difference between ‘choice’ and ‘use’, yet an environmental restriction on the label would without doubt require a modification specifically with regard to the manner of the product’s use.

11.5 Sources of information

Farmers were asked to indicate their sources of information on agrochemicals and to attribute a score of 1 - 5, where 5 was most important.

Table 11.5 Information sources

Region	Hannover (D)		East Anglia (UK)		North Central (F)		Piemonte (I)	
Number of farms	60		61		65		59	
Information source	Farms %	Av score	Farms %	Av score	Fams %	Av score	Farms %	Av score
Co-op rep	40	2.3	3	4.5	69	3.7	58	4.8
Farming press	72	3.2	21	2.5	43	3.6	29	4.8
Manufacturer's rep	38	2.4	10	3.7	5	3.0	20	3.9
Merchant	42	3.3	56	3.8	29	3.6	53	4.3
Neighbour/colleague	50	3.0	7	3.0	12	3.5	12	2.9
Plant protect. advisor	67	3.2	20	3.7	25	3.7	2	4.0
Private consultant	48	2.9	28	4.7	5	3.7	7	4.8
Other	3	-	-	-	3	1.5	-	-

The information in Table 11.5 is relevant to any wish to influence farmer behaviour.

Scores can not be compared across regions as they will obviously reflect national characteristics. However, they provide interesting comparisons within a region.

As mentioned earlier in this report, official plant protection advisers in Hannover appeared to be very influential, together with the farming press.

In East Anglia merchants held most sway, but interestingly the information from co-operative representatives and private consultants was held in highest esteem by those who used them. Contrary to Hannover, manufacturers representatives were considered to provide sound information.

Co-operative representatives and the farming press were most important in North Central France and all sources seem to provide a similar level of satisfaction in the quality of the information, manufacturers representatives being lowest.

The frustration apparent in the responses of specialist plant protection advisors in Piemonte, to farmers not following recommended procedures, which has been noticed in this study, may be explained by the result in Table 11.5. Only a single farmer (2%) considered them to be a source of information.

12.0 PROFITABILITY AND PESTICIDES

12.1 Profitability of the winter wheat crop

Farmers were asked how they assessed the profitability of their winter wheat crop, last year (1994), and five years ago.

Table 12.1 Profitability of the winter wheat crop

Region	Hannover (D)		East Anglia (UK)		North Central (F)		Piemonte (I)	
Number of farms	60		61		65		59	
	Farms %							
Profitability of winter wheat	Last year 1994	5 years ago	Last year 1994	5 years ago	Last year 1994	5 years ago	Last year 1994	5 years ago
Very good	0	7	16	5	2	5	0	3
Good	17	43	41	46	42	30	36	41
Satisfactory	20	37	43	41	34	34	36	36
Total positive response	37	87	100	92	78	69	72	80
Poor	50	5	0	8	12	12	24	14
Very poor	10	2	0	0	2	2	0	0
No answer	3	7	0	0	9	17	5	7

Farmer attitudes on profitability of wheat growing showed a worse position in 1994 than five years ago in Hannover and Piemonte. In East Anglia and North Central France no major shift was apparent though a tendency for a move to profitability in 1994 compared with five years ago was evident.

12.2 Return and costs of production

Models of returns and costs are presented in the individual region reports. The details and terms used vary considerably. The models had to be drawn from different years and in one case, Piemonte, from the neighbouring region of Emilia Romagna.

While the data are not directly comparable, some comparisons can be attempted.

Table 12.2 Comparison of agrochemical costs

Agrochemical costs	Hannover (D) 1993	East Anglia (UK) 1993	North Central (F) 1995	Piemonte① (I) 1992
As proportion of variable costs %	36	48	55	30
As proportion of gross income %	11	12	23	6

① Emilia Romagna

The variable costs in Table 12.2 are generally the sum of the costs of seed, fertiliser and agrochemicals.

The most accurate comparative factor is believed to be agrochemical costs as a proportion of gross income.

12.3 Influence of anticipated profit on pesticide use

Farmers were asked to predict their reactions in terms of pesticide use when good or poor profitability was to be anticipated for the crop. A number of choices were offered.

Table 12.3 Influence of anticipated profit on pesticide use

Region	Hannover (D)		East Anglia (UK)		North Central (F)		Piemonte (I)	
Number of farms	60		61		65		59	
	Farms %							
Anticipated profit	good	poor	good	poor	good	poor	good	poor
Influence on pesticide use								
Price of product								
Use more expensive product	23	23	12	5	11	9	3	15
Use less expensive product	25	38	2	21	8	25	8	7
No influence	40	23	80	67	74	54	76	47
No answer	12	17	7	6	8	12	12	30
Dose rate								
Use higher dose	8	20	5	5	14	18	0	29
Use lower dose	43	27	8	20	6	19	14	2
No influence	40	27	84	67	71	52	73	44
No answer	8	27	4	8	9	11	14	25
Age of product								
Use newer product	2	12	13	10	12	8	0	35
Use older product	42	27	2	8	22	20	15	0
No influence	47	43	82	71	58	60	73	44
No answer	10	18	3	11	8	12	12	20

Table 12.3 shows some interesting regional differences in attitude.

One of the most striking differences was the degree of influence which profitability had on the farmers of Hannover. They showed by far the most susceptibility to this, even to the extent of taking more risks by reducing doses in a ‘good’ year. Curiously they would go for the less risky option of using older products in a good year.

Farmers of East Anglia would be least influenced by anticipated profit, particularly ahead of a ‘good’ year.

Piemonte was unique in that the response to an anticipated bad year would be to increase doses, use newer products and use more expensive ones. This appears to be a ‘belt and braces’ approach - “If it is going to be bad, make very sure that crop protection does not let me down.”

12.4 The effect of pesticides on profitability

Farmers were asked to identify the pesticide sector which, in their opinion, had the greatest and least effect on profitability.

Table 12.4i Effect of pesticides on profitability

Region	Hannover (D)		East Anglia (UK)		North Central (F)		Piemonte (I)	
Number of farms	60		61		65		59	
	Farms %							
Effect	greatest	least	greatest	least	greatest	least	greatest	least
Sector								
Seed treatment	22	7	13	7	32	8	34	8
Herbicides	13	20	26	8	34	9	54	0
Fungicides	38	3	30	0	18	3	0	25
Insecticides	-	17	5	18	5	6	2	8
PGRs	-	-	2	20	-	54	2	14
Molluscicides	-	-	13	15	-	9	0	34

The more northerly the region the more influence fungicides were believed to have on profitability. The more southerly the region the more influence herbicides had on profitability. These two groups were considered to have the greatest effect on profitability. Specialists in North Central France disagreed with the farmers and thought the most important sector there was fungicides.

Seed treatment was recognised in all regions as having a significant effect. It is interesting that even in Hannover and East Anglia insecticides were considered by only a few farmers to have the most effect on profitability. In North Central France, PGR’s were identified by just over half the farmers as having the least effect on profitability.

Following this, farmers were asked if it would be possible to reduce pesticide use without lowering profitability.

Table 12.4.2 Possibility to reduce pesticide use without lowering profitability

	Hannover (D)	East Anglia (UK)	North Central (F)	Piemonte (I)
Number of farms	60	61	65	59
Opinion	Farms %			
Yes	13	8	12	17
Possibly	32	16	14	19
No	50	72	62	46
No answer	5	2	12	19

Those in Hannover were most positive about the possibility, those in East Anglia least.

The farmers who had responded either 'yes' or 'possibly' were then asked in which pesticide sector might the reduction be possible. Though from very small samples the data are presented.

Table 12.4.3 Sector where reduction might be possible without afffecting profitability

	Hannover (D)	East Anglia (UK)	North Central (F)	Piemonte (I)
Number of farms	27	15	17	21
Sector	Farms %			
Seed treatments	3	7	18	5
Herbicides	28	47	41	62
Fungicides	39	40	65	19
Insecticides	11	27	24	10
Molluscicides	0	0	18	5
Anti-lodging agents	0	20	53	19

Specialists were dubious about the views expressed in answer to this question. In North Central France they did not believe significant reductions were possible in any sector, whilst in East Anglia they thought that if there were possibilities in any sector it would be in herbicides. In Piemonte, whilst specialists considered that from a technical point of view there were possibilities for reduction in all sectors, in practice given the level of technical awareness and agricultural sophistication in the area, there would be none.

13.0 ALTERNATIVE CROP PROTECTION SYSTEMS

13.1 Awareness of alternative systems

Farmers were asked if they were aware of any alternative system of crop protection in wheat which might be equally profitable to conventional methods. No prompts were given to them. Those not mentioning a system were then asked specifically if they were aware of Integrated Crop Management (ICM), Integrated Pest Management (IPM), or Organic Production (OP).

Definitions were given to farmers for the different regimes (see Appendix I) but local terms and understandings also played a role in these answers. The results need to be interpreted with care.

Table 13.1 Awareness of alternative crop protection systems that might be equally profitable

Awareness **Unprompted**	Hannover (D)	East Anglia (UK)	North Central (F)	Piemonte (I)
Number of farms	60	61	65	59
	Farms %			
ICM	33	38	78	12
IPM	33	44	8	27
OP	13	54	2	29
No answer	55	38	14	59
After prompting	Awareness amongst farms which had not mentioned the system **Proportion of total sample %**			
ICM	33	13	22	5
IPM	30	10	31	8
OP	27	30	78	14

The level of spontaneous awareness was highest in North Central France for ICM, and, after prompting, all farmers in the study in the sample said they were aware of ICM. Specialists commented that ICM (agriculture raisonée) is a very broad term in France meaning a variety of things to different people. To some it may be interpreted as following the recommendations of a crop protection programme, to limit agrochemical use for economic reasons, to optimally time operations, use warnings and adhere to modelling information from co-operatives or SRPV, etc..

As may be expected the level of awareness in Piemonte was low, even after prompting. These farmers were not aware of new developments and new technology.

East Anglian farmers were well aware of OP. Specialists said that they were also very well aware of IPM and ICM as most of them were practising them to some extent and had been for many years. It had become part of 'conventional' practice. They felt the greatest potential lay in ICM.

13.2 Interest in developing alternative systems

Farmers were asked for their level of interest in developing the various alternative systems discussed.

Table 13.2 Interest in developing alternative systems

	Hannover (D)	East Anglia (UK)	North Central (F)	Piemonte (I)
Number of farms	60	61	65	59
	Farms giving positive response %			
ICM	42	16	85	3
IPM	43	23	14	12
OP	20	5	9	3

Organic production had least interest for farmers. Specialists commented that it represents a complete change in farming, requiring a firm philosophical conviction in its value and faith that there was some commercial gain to be made. In wheat production this was likely in only a very small and specialised proportion of the crop.

Of the other two systems, IPM was already being practised by some farmers with regard to insecticide use.

As discussed, farmers in North Central France had a high level of interest in ICM - regardless of what each individual understood by the term. The majority did not see it as a means of gaining a commercial advantage. They did, however, appear to be open-minded to genuine advances in new technology - whether they were biological, chemical or mechanical.

Farmers in East Anglia appeared to be less interested in developing the systems although there were many who believed them to be practical. As specialists commented however, many of the farmers are already using components of IPM and ICM as part of what is now considered just good practice, and the data tend to understate the level of adoption.

Specialists in Piemonte felt there was no chance of introducing IPM or ICM in wheat unless there was a definite economic gain to be made from the sale of the produce. This is particularly unlikely in that area. It should also be mentioned that very little in the way of fungicides or insecticides were applied anyway.

14.0 ENVIRONMENTAL ISSUES

14.1 Farms in restricted areas

One farmer in each of East Anglia and North Central France farmed in a restricted water catchment area. They claimed that there were no implications for their use of agrochemicals.

The situation in Hannover was different. There 25% of farmers were in restricted water catchment areas and all these farmers commented that choice of agrochemicals was made difficult or very difficult.

14.2 Considerations influencing the choice of pesticides

Farmers were asked what environmental considerations they took into account when choosing their chemicals. A number of alternative choices were suggested.

Region	Hannover (D)	East Anglia (UK)	North Central (F)	Piemonte (I)
Number of farms	60	61	65	59
Consideration	Farms %			
Surface water	45	30	6	17
Ground water	60	25	14	42
Soil protection	50	33	12	32
Flora	37	41	29	3
Fauna	37	41	34	13
Produce quality	57	57	17	15
None of these	10	25	38	28
Don’t know	22	2	5	13

Ground water concerns figured strongly in Piemonte and Hannover. Farmers in the former being aware of the problems in the Po valley, and many farmers in the latter being themselves in restricted water catchment areas. It may be assumed that choice and use of fertilisers and herbicides would be affected by this.

Produce quality was of concern to farmers in Hannover and East Anglia. A consequence for farmers was being aware of the risks of residues in the grain exceeding permitted levels.

Soil protection in Hannover and flora and fauna in East Anglia also ranked highly. Specialists in North Central France were not surprised at the generally low level of environmental concern of farmers in this region.

APPENDIX I

DEFINITIONS AND CAVEAT

BACKGROUND

1 Ideally this study should have been conducted on an individual field basis. Economics and practical considerations, however, precluded this. Farmers were therefore asked about their treatments for the entire crop over their whole farm.

2 Typically fields were treated several times for any one pesticide sector (fungicides, insecticides, particularly). Occasionally on certain farms some fields were treated more times than others - though review of the data shows this to be limited.

3 Applications were made with agrochemical products containing one or more active ingredients. While data was collected from the farms at product level the results were required at active ingredient level for calculation of chemical load and to facilitate cross-country comparisons.

4 Presentation of the data as kg ai/ha has been used for simplification. This of course hides the great variation in inherent activity of different chemicals. Attempts are made to cover for this in the text.

DEFINITIONS

Regional level:

Base area treated (for a chemical sector)

That part of the crop which receives any treatment at all for the chemical sector in question. This is represented by Crop Area - Untreated Area = Base Area Treated.

Farm level:

Proportion of crop treated

This is defined as "That portion of crop receiving the active ingredient at least once". Where a series of treatments, of differing areas, had been made on a farm then the assumption has been made that the treatments were made sequentially on the largest area receiving that active ingredient. In practice the largest area was nearly always the complete area of crop on that farm so this is usually correct.

Average number of applications

For a given active ingredient this was calculated as the average number of times an active ingredient was applied on a given farm. Where an active ingredient is applied on different areas then the average number of applications/ha is calculated for the whole farm. This can occasionally underestimate the number of applications on a given field.

Cumulative dose

This is the total volume of an active ingredient used on a farm divided by the area of study crop grown on that farm. In situations where a chemical was not always used on the whole farm this has the effect of underestimating the dose - however, as already indicated these situations were limited.

Product applications

Products may be applied alone or in tank mixes. The latter were not catered for in the questionnaire. The term product applications has therefore been introduced meaning products x applications. As a consequence this can exaggerate the number of applications made on a farm where considerable use was made of tank mixes (possibly mixes of two products at low dose).

ALTERNATIVE CROP PROTECTION

Integrated Pest Management (IPM)

The objective here is control of pests (weeds, disease, insects etc) using a mix of the less aggressive chemicals available and the stimulation of the crop or beneficial organisms to control the pest. Such methods may involve choice of resistant varieties, modifying rotations, use of biological pesticides etc.

Integrated Crop Management (ICM)

The objective here is to manage the growing of crops in such a way as to reduce any negative effects on the environment, typically ground water. As such, the same methods may be used as with IPM, but taken further to include fertilisers and any other ‘contaminating’ inputs and cultural methods.

Organic Production (OP)

The objective here is to produce crops in which chemical pest control or fertilisers have played no part.

APPENDIX II

COLLABORATORS AND CONTACTS

HANNOVER

Farm survey:

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EAST ANGLIA

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Mr J MacLeod	National Institute of Agricultural Botany Huntingdon Road Cambridge CB3 0LE Director. Responsible for all comparative testing of varieties in the UK, and prime international centre for variety and seed services.
Mr J North	Department of Land Economy University of Cambridge 16 - 21 Silver Street Cambridge CB3 9EP Ex. Chief Agricultural Officer of Ministry of Agriculture Member of East Anglian farming trust. Farmer.
Mr P Taylor	SAMCO 63 Little Walden Road Saffron Walden Essex CB10 2DL Consultant agronomist; ex. ADAS arable crops advisor. Late President of the Association of Independent Consultants.
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NORTH CENTRAL FRANCE

Farm survey:

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Cooperative Agricole du Dunois (Valbeauce)
Chateaudun
Eure et Loire (28)

M. Jean Paul Bordes
ITCF
Bureau Regional Ile de France
Melun (77)

M. Michel Olive
Developpement et Communication
Cooperative La Brie
Melun

M. Michel Bonnefois
ITCF
Bureau Regional Centre
Blois
Loiret (41)

M. F Limouzin
Chef du Service Agronomie
Cooperative La Franciade
Blois

La Franciade, La Brie and Dunois are leading cooperative groups in the region, with sophisticated supply and technical service operations. (Though La Brie HQ is in Seine et Marne, its coverage is also extensive in the region studied.)

PIEMONTE

Farm survey: Motivaction
Milan

Local specialists:

Prof. Aldo Ferrero
University of Torino

Dr Ivano Scapin & Dr Anna Saglia
Osservatorio per la Malattie della Piante
Torino

Prof Casati & Dr Silvia Giannini
Agricultural Economics Dept
University of Milano

Prof Danilo Borghi
Instituto Sperimentali per la Cerealicoltura

REPORT FOR THE COMMISSION OF EUROPEAN COMMUNITIES
DUTCH MINISTRY FOR THE ENVIRONMENT

REGIONAL ANALYSIS OF USE PATTERNS OF PLANT PROTECTION PRODUCTS IN SIX EU COUNTRIES

PES - A/PHASE 2

A COMPARISON OF AGROCHEMICAL USE ON POTATOES IN FOUR REGIONS IN EUROPE

Lüneburg, Germany
Flevoland, Netherlands
East Anglia, United Kingdom
N E France, France

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POTATOES - CROSS REGIONAL REVIEW

SUMMARY

The study was conducted in mid 1995 on practices employed in 1994. Four regions were reviewed Lüneburg (D), Flevoland (NL), East Anglia (UK) and North East France (Nord, Pas de Calais, Somme). These regions were covered by farmer surveys and discussions with key specialists in the regions.

General

The four regions surveyed were all intensive potato growing regions. The average holding per farm in each region was similar ranging between 10 - 12 hectares. The samples which were designed to review similar farm numbers along the farm holding profile, oversampled the larger holdings resulting in larger average crop holdings ranging from 14 ha in N E France to 34 ha in East Anglia.

Regions varied in their crop type mix. All regions had ware and seed crops while N E France and particularly Lüneburg included starch potatoes. In Lüneburg all three crops were often grown on the same farm. Crop protection requirements differ markedly for the different crop types.

Crop types and crop protection requirements

Crop type	Proportion of all regions %	Comment
Ware	54	Long growing season, blemish-free produce hence high fungicide requirement.
Seed	31	Shorter growing season hence less disease protection but high insecticide requirement to control virus vectors.
Starch	15	Lower priced, lower input crop.

Chemical load

The average volume of active ingredients applied per hectare of crop grown in the samples were:

	Average		(Range)
Lüneburg	9.8	kg ai/ha	(2.7 - 22.3 kg ai/ha)
Flevoland	12.6	kg ai/ha	(1.6 - 34.6 kg ai/ha)
East Anglia	13.1*	kg ai/ha	(2.0 - 26.7 kg ai/ha)
North East France	32.1	kg ai/ha	(9.0 - 73.7 kg ai/ha)

* Excluding sulphuric acid use as a desiccant.

These figures are used for simplicity of comparison but they of course ignore the differences in inherent activity of the various chemicals.

Seed treatment

Seed was treated for in storage and prior to planting. Farmer knowledge in this sector was variable depending on whether they applied the treatments themselves or not. This ranged from Lüneburg where 82% of farmers applied treatments to North East France where only 15% were involved. Generally at least 80% of the seed was treated. In all regions treatments were identified at this level except in N E France where only 53% was identified - a result of farmers reduced involvement with the process. Seed rates varied from 0.5 - 8.0 tonnes/ha across the regions with dose rates per hectare varying accordingly.

Seed treatment prior to planting is an environmentally sound and cost-effective means of protection from pests and no means are suggested for its reduction. Increased use of cold storage techniques could reduce the need for some storage treatments.

Weeds and herbicides

The weed spectra across the regions were not too dissimilar and included weeds that are traditionally difficult to control in the potato crop such as *Galium aparine* and *Solanum nigrum*. Levels of weed control sought by farmers varied considerably with Lüneburg and Flevoland satisfied with lower levels of control than the other two regions.

Weed control was a mixture of herbicides with or without mechanical weed control. Herbicides were used on all the crop in Lüneburg and N E France though only on 78% and 90% respectively in Flevoland and East Anglia. Greatest use of mechanical hoeing was found in East Anglia with least support in Lüneburg and Flevoland.

The mix of active ingredients by region was very different though metribuzin and prosulfocarb were prominent in all regions. Herbicide load per hectare of crop treated varied from 1.5 kg ai/ha in Lüneburg to 2.6 kg ai/ha in N E France. This reflects the lighter soils, higher starch proportion of the crop (lower inputs) in Lüneburg compared with N E France where there was a higher ware proportion, heavier soils and greater use of the higher dose chemicals prosulfocarb and metobromuron. Farmers in Lüneburg, Flevoland and N E France were all said to be experimenting with lower dose mixtures of active ingredients in order to reduce the load and cost.

Mechanical weed control while practised in all regions was encouraged particularly in East Anglia. Results from all regions demonstrate that where this was practised the herbicide load was lower. However, not all soil types are suitable for this process.

Opportunities to reduce herbicide loads are seen as limited. Dose rate cutting is estimated to have gone far enough and mechanical methods are limited by soil type and the risk of damaging the crop.

Diseases and fungicides

All potatoes must be protected against late blight, *Phytophthora infestans*, throughout the season and a high level of control was expected in all regions. A programme of contact protectant fungicides is the basis of the treatments to which may be added systemic partially curative chemicals as the season progresses and ending with a contact protectant towards the end of the season.

The fungicide sector dominates the chemical load in potatoes. Average loads were similar in the three regions of Lüneburg, Flevoland and East Anglia at 6.6, 8.4 and 7.7 kg ai/ha respectively. However, in N E France this was substantially higher at 27.9 kg ai/ha. These average loads were the result of a mix of varying crop type/variety demands, numbers of applications and activity of the chemicals used. Lüneburg and East Anglia averaged around 6 product applications during the season while Flevoland and N E France used 13 - 14. It is not insignificant that the *Phytophthora*-susceptible variety Bintje dominates both Flevoland and N E France with about half the area in the samples. The reason the load in Flevoland was so much lower than France was due to the widespread use of a new more active contact fungicide, fluazinam, compared with N E France where low activity mancozeb was widely used. In both Flevoland and N E France a high proportion of farmers indicated that fungicide use had been greater in the study year 1994 than an average year.

Opportunities to reduce fungicide load are seen as limited under present technological circumstances. Should an alternative to the variety Bintje be found this would evidently help to a certain degree. Farmers at present mainly use a mix of plant stage and weather to determine when to start spraying. Official warning systems exist but were only well used in Lüneburg. Increased use or dissemination of the warnings might help target initial treatments more closely. Better spray decision support systems are being developed in all regions but are some way off practical use as yet.

Insects, nematodes and their control

Aphids, *Myzus persicae* were regarded as important in all areas. Nematodes, *Globodera* spp were a problem in East Anglia and, to a lesser degree, in Lüneburg. Colorado beetle, *Leptinotarsa* spp was regarded as a pest by just over half the farmers in Lüneburg though local specialists felt this was overrated. Elsewhere it was of little consequence.

The need to control aphids is the main determinant of insecticide load. Here the seed crop requires greater protection than ware or starch. Lowest rates were applied in N E France where seed crops were least represented and highest rates in E Anglia where seed crops were most represented as well as there being use of the high dose soil nematicides. The use of high or low activity chemicals also played its part in modifying chemical loads.

Most farmers determined the need to spray aphids on grounds of pest pressure (aphid count). The official warning system was also used particularly in Lüneburg.

Opportunities to reduce use of aphid treatments were regarded as very limited though increased use of the warning system might help. Nematicide use had declined dramatically in Lüneburg and Flevoland but there was concern there that an increase in use might be required in the medium term.

Miscellaneous pests and pesticides

Slugs in E Anglia were the only pest treated in this sector where about a quarter of the crop was treated. In N E France a localised problem had recently arisen. Treatments are targeted as required and no opportunity is seen for reduction.

Other agrochemicals

This was largely confined to desiccants for haulm destruction to facilitate harvesting and prevent disease penetrating down to the tuber. Use ranged from 59% of the crop in Lüneburg to 98% of the crop in Flevoland. Limited chemical loads were applied in all regions except E Anglia where 47% of the crop was treated with large volumes of sulphuric acid.

Little opportunity is seen for reduction in use in this sector.

Trends in pesticide use and agrochemical generalities

The majority of growers tended to feel that their use of pesticides had remained the same as the previous five years. However, there were widespread variations around this point between regions and between pesticide sectors.

Most farmers had no plans to change their product use except in Flevoland where a small majority indicated they might change. Main changes indicated in this region were in fungicides for better control and herbicides on grounds of economics. However, most farmers in all regions expressed a very high degree of satisfaction with the choice of products available to them and the developments in the pesticide market.

Concerning handling and environmental restrictions on the label, the great majority of farmers felt these were very important or important in determining their choice and use of products.

Information sources

Sources of pesticide information relied on by the farmers were wide and varied in importance by region. The cooperative rep ranked highest in N E France while the merchant was most relied on in Flevoland and E Anglia. In Lüneburg the plant protection adviser was most used. In Lüneburg and Flevoland the farming press was also widely used.

Profitability

The profitability of the crop was regarded by over 85% to be between satisfactory - very good in all regions. In all regions this had increased from the position five years before.

Models of costs and returns were obtained, however, they are not strictly comparable. Agrochemicals as a percentage of gross income was the best parameter for comparison. In Lüneburg, Flevoland and E Anglia these showed agrochemical costs as 8 - 11% of gross income while in N E France this was 19%.

The effect that anticipated profit would have on the choice and use of pesticides was indicated by the majority in all regions as having no influence.

Concerning the chemical sectors that had greatest effect on profitability there was universal agreement across all regions that this was fungicides. The sector that had the least effect on profitability received less homogeneous responses.

The great majority of farmers felt that it was not possible to reduce the use of pesticides without reducing profitability. Farmers were least adamant on this in Flevoland and Lüneburg.

Alternative crop protection systems

Farmers were questioned as to their awareness and interest in Integrated Crop Management (ICM), Integrated Pest Management (IPM) and Organic Production (OP). A relatively high awareness was demonstrated in all regions to all systems though IPM awareness was very low in Flevoland. The greatest awareness across all regions was demonstrated for ICM in Flevoland and N E France. There was some concern that the interpretation of these alternative techniques was different in each region. Most interest in developing these techniques on their farm was given to ICM in N E France.

Environmental issues

The Lüneburg region contained the highest proportion of farmers in environmentally restricted areas. There 27% of farms claimed to be in restricted water catchment areas and 2% (one farm) in an environmentally sensitive area. About half of this sub-sample in the Lüneburg region indicated that this posed difficulties in selecting pesticides.

The highest proportion of farmers who considered environmental factors when choosing their pesticides was found in Lüneburg followed at some distance by E Anglia. Few farmers in N E France and Flevoland apparently considered environmental factors in this context.

Conclusion

The potato crop was profitable in 1994 and one in which farmers are not prepared to take a risk with crop protection.

Little opportunity is seen for reduction in pesticide use in the immediate future. Wide development of warning systems and their use for disease and insect/nematode control would be advantageous.

Reduction of varieties sensitive to late blight (*Phytophthora infestans*) would make an impact on fungicide use but any replacement would obviously first have to meet market demands.

1.0 THE REGIONS, METHODOLOGY AND SAMPLES

1.1 The regions

Four regions that were intensive producers of potatoes were selected. Those chosen were:

Germany - Lüneburg
Netherlands - Flevoland
United Kingdom - East Anglia
France - North East (Nord, Pas de Calais, Somme)

1.2 Methodology

The format used consisted of a farmer group discussion held in East Anglia to determine broad parameters followed by farmer surveys in the four regions using a questionnaire of approximately one hour in length. Fieldwork was conducted in mid 1995 and the questions related to use of agrochemicals in the previous season (1994). Results having been obtained and partially analysed were used as a basis for interviews with local specialists in the regions to discuss findings and broaden the view.

1.3 The survey samples

The objective of the farmer survey was not only to ascertain current agrochemical practices in the region but also to identify differences in agronomic practice between farms.

Patterns of crop distribution in all regions showed the typical pattern of the largest area of crop grown by relatively few larger units.

When designing the sample prior to commencement of research, the causal factors of any variation are not fully known. It is often the case however that one of the more common bases for variation in practice is that of enterprise size.

Budgetary restraint limited the sample size to around 60 in each region. It was decided that in order to expose variation, a sample with as far as practically possible adequate numbers of farms across the crop size distribution profile should be represented.

The background statistics for the regions are presented in the individual regional reviews but they are different in make up and are not easily compared. The samples resulting were as follows:

Table 1.3 The sample

Region	Lüneburg (D)		Flevoland (NL)		E Anglia (UK)		N E France (F)	
Potato area per farm - ha	Farms %	Area %	Farms %	Area %	Farms %	Area %	Farms %	Area %
2 < 10	32	8	33	16	30	4	47	19
10 < 20	27	18	43	40	23	10	32	31
20 +	42	74	23	45	47	86	21	50
Total No, ha	60	1,076	60	897	60	2,060	62	862
Average - ha	-	18	-	15	-	34	-	14
Regional average - ha	-	11	-	12	-	12	-	10

It will be noted that the average potato holding in the sample was larger than the average for each region. This is a consequence of spreading the sample relatively evenly down the crop size profile based on farm numbers. In E Anglia the difference is substantial and largely resulted from sampling six farms of 100+ hecares. These accounted for 45% of the area. They were, however, retained in the sample being professionally managed advanced enterprises.

2.0 GENERAL RESEARCH FINDINGS

2.1 Farming demographics

2.1.1 Land tenure

Region	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Number of farms	60	60	60	62
Crop area - ha	1,076	897	2,060	862
Tenure category	Farms %			
> 60% owned	55	5	48	2
40 - 60% owned	28	2	18	3
< 40% owned	17	93	32	95

The tenure pattern shows two distinct situations with the majority of farmers in Lüneburg and E Anglia owning > 60% of their land and those in Flevoland and N E France owning < 40%.

2.1.2 Occupational status

Full-time farmers predominated in all regions.

Lüneburg	95%
Flevoland	88%
E Anglia	100%
N E France	98%

2.1.3 Farm enterprises

Table 2.1.3 Farm enterprises

Region	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Number of farms	60	60	60	62
Enterprises	Farms %			
Crops				
Cereals	93	87	95	100
Maize	66	8	5	32
Sorghum	-	-	-	2
Sugar Beet	48	98	87	84
Oilseed rape	24	2	21	13
Sunflowers	-	-	5	-
Peas	-	13	40	58
Field vegetables	5	-	46	29
Top fruit	3	-	3	2
Soft fruit	-	-	2	3
Temp grass	26	2	10	24
Perm grass	55	7	30	69
Animals				
Dairy	50	3	3	23
Beef	45	3	10	35
Veal	2	-	-	3
Pigs	64	-	6	16
Poultry	19	3	-	5
Other				
Tourism	2	2	-	2

The regions showed a wide variety of enterprises on the farms. Livestock featured high in Lüneburg and, to a lesser extent, in N E France.

2.2 Crop agronomy

2.2.1 Crop types and varieties

Table 2.2.1i Crop types by farm

Region	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Number of farms	60	60	60	62
Crop type	Farms %			
Ware only	30	75	52	61
Starch only	15	-	-	23
Seed only	7	13	45	3
Ware + starch	25	-	-	2
Ware + seed	7	12	3	10
Ware + seed + starch	15	-	-	2
Starch + seed	2	-	-	-

The crop types grown in the regions are presented by farm and by area in the the tables below together with the main varieties.

A wide variation in crop types per farm is evident in Lüneburg and N E France.

Table 2.2.1ii Crop types by area

Region	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Crop area - ha	1,076	897	2,060	862
Crop type	Area %			
Ware	34	78	60	71
Starch	45	-	-	16
Seed	17	22	40	12

Table 2.2.1iii Main varieties (>5% + of area)

Region	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Number of farms	60	60	60	62
Variety	Farms %			
Agria		15		
Bintje		50		45
Cilena	7			
Estima			5	
Hansa	6			
Maris Piper			41	
Ponto	11			
Producent	11			
Russet				5
Sante		4	8	
Saturna	10			
Wilja			5	

Crop types and varieties influence agrochemical demand. The following points emerged during specialist interviews.

Crop types

Increased need for agrochemicals

			Sector affected
Ware	-	Lack of skin blemishes	+ F
	-	Longer growing season for main crop	+ F, I
Seed	-	Essential to control aphid vectors of virus disease	+ I

Decreased need for agrochemicals

Ware	-	Higher tolerance of insect levels	- I
Starch	-	More tolerant of disease	- F
	-	Less spent on the crop	- All
Seed	-	Shorter growing season	- F
	-	Less nitrogen use reducing potential increase in *Phytophthora*	- F

Varieties

	Sector affected
Increased need for agrochemicals	
- Most popular varieties particularly Bintje and, to a lesser extent, Maris Piper are susceptible to *Phytophthora*	+ F
- The most susceptible variety on a farm can often determine the spray regime for all varieties	+ F
- Foliage varies modifying desiccant needs	± D
Decreasing need for agrochemicals	
- Some varieties have in-bred resistance to nematodes and partial resistance to *Phytophthora*	- I, F

2.2.2 Soil types

Table 2.2.2 Soil types

Region	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Crop area - ha	1,076	897	2,060	862
Soil type	Farms %			
Sand	81	-	18	4
Silt	5	22	27	71
Clay	<1	78	11	17
Organic	1	-	29	1
Other	16	-	15	7

Farmers were asked to classify their soils very simply by the main textural category.

Soil types have implications on pesticide usage.

Sandy soils, widespread in Lüneburg and otherwise present mainly in E Anglia, require more irrigation. In the Lüneburg region it was claimed this reduces the incidence of disease (*Phytophthora* - blight) while in the other regions it was regarded as increasing the incidence of *Phytophthora* particularly in association with additional nitrogen which may be required. Seed crops (and starch) are often associated with sandy soils, these have a shorter growing season and therefore require less disease protection though insecticide requirements are higher.

In E Anglia, potatoes have been grown on silt and organic soils for a long time which has lead to the build up of nematode populations. In N E France silt soils were regarded as having the least requirement for pesticides.

Organic soils, featured only in E Anglia among these regions, also make greater demands on herbicides.

2.2.3 Rotations

Table 2.2.3 Rotations

Region	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Number of farms	60	60	60	62
Potatoes per year of rotation	Farms %			
1 : 2	2	-	-	3
2 : 4	-	-	-	2
1 : 3	22	38	2	25
5 : 15	2	-	-	-
2 : 6	-	2	2	-
2 : 7	-	2	-	-
1 : 4	58	52	50	53
1 : 5	15	5	23	23
1 : 6	2	-	18	2
1 : 7	-	2	7	2
1 : 8	-	-	5	-
1 : 10	-	-	3	-
No set rotation	2	-	-	-

Some farms practice more than one rotation hence totals may be >100%. The predominant rotation length was 1 : 4 though a substantial proportion in all regions (other than E Anglia) practised 1 : 3.

In Lüneburg it was claimed that there was economic pressure to return to 1 : 3. In Flevoland, with 38% of farms practising 1 : 3 rotation, it was claimed that rotations had shortened over the last ten years but the pattern had stabilised. Potatoes are not permitted in a rotation of less than 1 : 3. In the N E France region, the average length of rotation was said to be concentrating around 1 : 4 as indicated by the sample.

2.2.4 Fertiliser use

Table 2.2.4 Fertiliser use

Region		Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Crop area		1,076 ha	897 ha	2,060 ha	862 ha
Fertiliser classification	Specification kg/ha	Area %			
Nitrogen					
High	> 250	3	21	13	13
Medium	150 - 250	35	39	26	63
Low	1 - 150	61	27	46	23
Nil	0	1	-	12	1
No answer	-	-	13	3	-
Phosphorus					
High	> 120	9	38	51	37
Medium	70 - 120	55	38	28	59
Low	1 - 70	14	4	5	1
Nil	0	22	5	16	1
No answer	-	-	15	-	-
Potassium					
High	> 300	15	32	45	75
Medium	150 - 300	54	27	38	23
Low	1 - 150	16	7	2	2
Nil	0	15	24	15	-
No answer	-	-	11	-	-

Fertiliser use follows soil type but is tempered by the crop type and its destination. Excess nitrogen can increase incidence of *Phytophthora*. In the Lüneburg region local experts indicated that if > 250 kg/ha of nitrogen was used this increased the incidence of *Phytophthora* markedly. All regions were conscious of this and had refined their use of nitrogen accordingly.

2.3 Commercial issues

2.3.1 Destination of produce

Table 2.3.1 Destination of produce

Region	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Number of farms	60	60	60	62
Destination	Farms %			
Wholesaler/retailer	57	65	57	32
Direct to consumer	47	8	11	32
Prepacker	23	2	44	31
Processor - chips	12	25	30	27
- crisps	-	12	21	8
Seed - own use	20	15	6	5
- for sale	12	3	3	8
Caterers	2	-	-	2
Others	27	5	8	21

2.3.2 Advance contracts and pesticide restrictions

Advance contractual arrangements were undertaken by between 55 - 65% of farmers except in E Anglia where only 13% (8 farmers) undertook them. However, these latter accounted for 45% of the area.

Restrictions on pesticides within these advance contracts were claimed by a few farmers in each region. In summary these were:

Table 2.3.2 Pesticide restrictions in contracts

Region	Number of farms	Comments
Lüneburg	6	Farmers nominated all chemical sectors. Local specialists suggested that contractual requirements were limited to the non use of desiccants for premium ware potatoes, certain requirements by processors, and the contractual obligation to treat seed crops for aphids.
Flevoland	17	Farmers nominated all sectors with fungicides predominating. Restrictions were imposed by supermarkets, coops, wholesalers and processors.
East Anglia	6	Farmers mentioned storage treatments and growth suppressants mostly imposed by major retail buyers and supermarket chains.
N E France	11	All sectors were nominated though growth suppressants and desiccants featured most prominently.

3.0 PESTICIDE USE

3.1 Summary of chemical use

3.1.1 General

In broad terms of active ingredient load there were only limited differences between the regions except for N E France where the fungicide load was particularly high. This, however, is largely explainable by the chemical mix employed.

3.1.2 Seed treatment

Seed was treated both for storage and prior to planting. Knowledge of seed treatments used was variable depending on whether farmers applied the treatments themselves or not. This varied from Lüneburg where 82% of farmers applied treatments to N E France where only 15% were involved. Dose rates per hectare varied as a factor of the seed rates which varied from 0.5 - 8 tonnes/ha across the regions surveyed.

3.1.3 Herbicides

All regions had widespread infestations of weeds that were difficult to control in the potato crop. Farmers, however, varied considerably in the levels of weed control that they expected with Lüneburg and Flevoland seeking lower levels than the other two regions. This is reflected in the herbicide loads though the chemical mix in each region was different with low dose chemicals particularly evident in Lüneburg.

3.1.4 Fungicides

Fungicide load dominates the potato pesticide load. Potatoes require season long protection from late blight (*Phytophthora*) necessitating an intensive programme of chemicals. A high level of control was expected across all regions though Lüneburg appeared the least exigeant.

The ware crop is the most demanding of the potato crops. Flevoland and N E France had the highest proportion of ware varieties amongst the regions surveyed. Both applied a similar number of applications but of different chemicals. N E France, with the heaviest fungicide load, depended on traditional contact protectant fungicides whilst Flevoland had moved to a newer lower dose active ingredient.

3.1.5 Insecticides

Aphid control was the major determinant in insecticide use across the regions. These have to be completely controlled in the seed crops whilst the ware and starch crops can tolerate modest levels of infestation. E Anglia had the highest seed crop share in the region and shows the highest insecticide load. Nematodes were also highest in E Anglia requiring high dose soil insecticides.

3.1.6 Miscellaneous pesticides

Slugs were the only pests mentioned in this sector and only treated for in E Anglia.

3.1.7 Other agrochemicals

This section was largely restricted to desiccants necessary for haulm destruction to facilitate harvesting and to prevent late blight (*Phytophthora*) infection of the tubers. Limited chemical loads were applied in all regions except E Anglia where large quantities of sulphuric acid were applied to about half the crop.

Table 3.1 Summary of chemical use

Region	Lüneburg (D)			Flevoland (NL)			East Anglia (UK)			N E France (F)		
Crop area grown - ha	1,076			897			2,060			862		
Chemical sector	% crop treated	Average volume of active ingredient kg/ha		% crop treated	Average volume of active ingredient kg/ha		% crop treated	Average volume of active ingredient kg/ha		% crop treated	Average volume of active ingredient kg/ha	
		Crop treated	Crop grown		Crop treated	Crop grown		Crop treated	Crop grown		Crop treated	Crop grown
Seed treatment	78①	0.634	0.492	81②	0.332	0.268	80②	0.933	0.746	53②	0.981	0.520
Fungicides	100	6.590	6.590	100	8.437	8.437	100	7.775	7.775	100	27.863	27.863
Herbicides	100	1.471	1.471	78	1.939	1.507	90	1.826	1.643	99.5	2.643	2.625
Insecticides	93	1.009	0.938	98	1.094	1.072	93	2.652	2.466	95.6	0.395	0.378
Other pesticides	-	-	-	-	-	-	23	0.723	0.166	-	-	-
Other agrochemicals (desiccants)	59	0.568	0.335	98	1.319	1.293	78	0.346③	0.269③	68	1.113	0.757
Total	100	*	9.826	100	*	12.577	100	*	13.065	100	*	32.097

* Treatments are not necessarily applied to the same area of crop in each chemical sector so no total is provided for this column.

Seed treatment data was poor and under estimates actual use:

① Restricted to treatments prior to planting.
② Includes some storage treatments as well as those prior to planting.
③ Excluding sulphuric acid used on 47% of the crop estimated at 115 kg ai/ha.

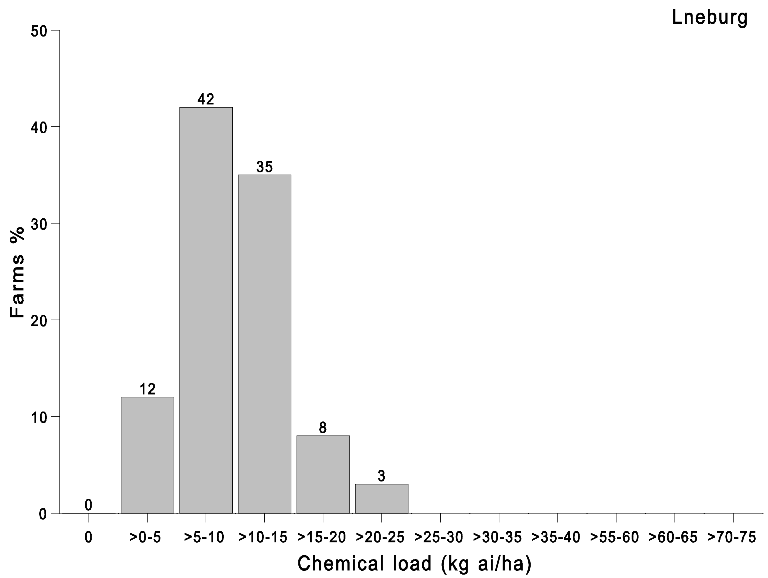
3.2 Variation in chemical load between farms and regions

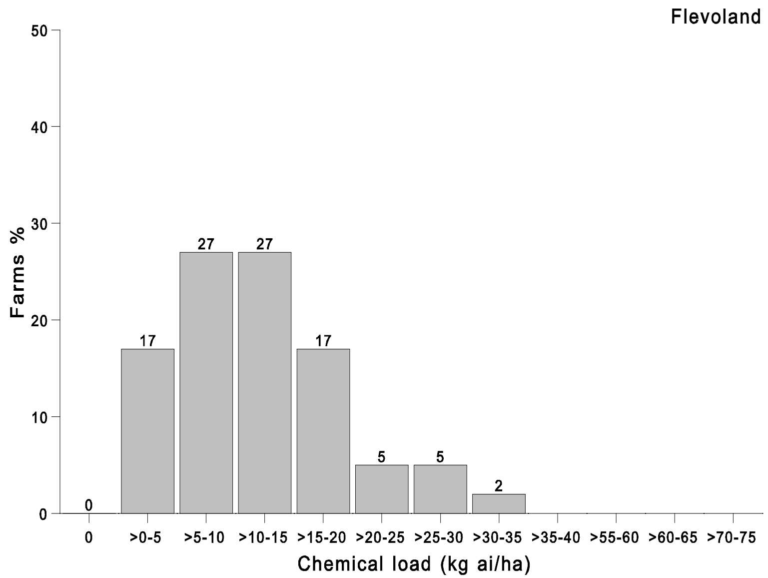
Table 3.2 Variation in chemical load between farms and regions

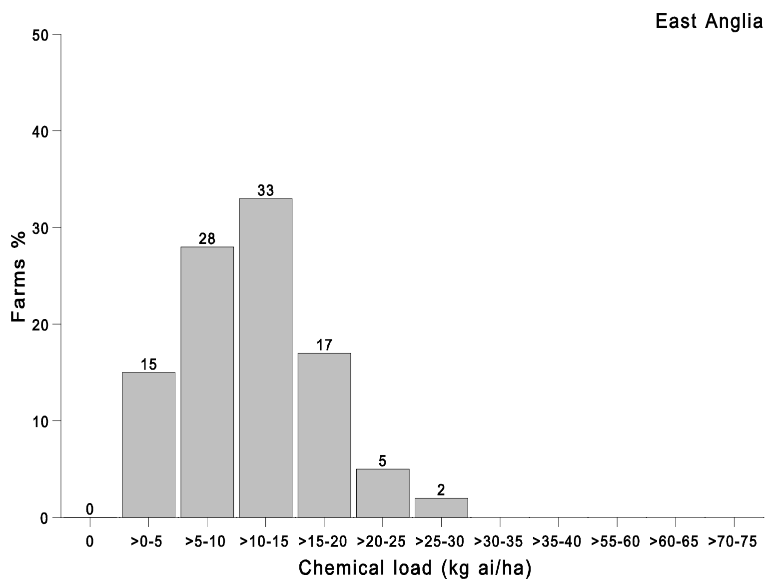
Region	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Number of farms	60	60	60	62
Chemical load kg ai/ha	Farms %			
0	0	0	0	0
>0 - 5	12	17	15	0
>5 - 10	42	27	28	2
>10 - 15	35	27	33	2
>15 - 20	8	17	17	19
>20 - 25	3	5	5	19
>25 - 30		5	2	23
>30 - 35		2		10
>35 - 40				19
>55 - 60				2
>60 - 65				3
>70 - 75			+	2
Range kg ai/ha	2.7 - 22.3	1.6 - 34.6	2.0 - 26.7	9.0 - 73.7

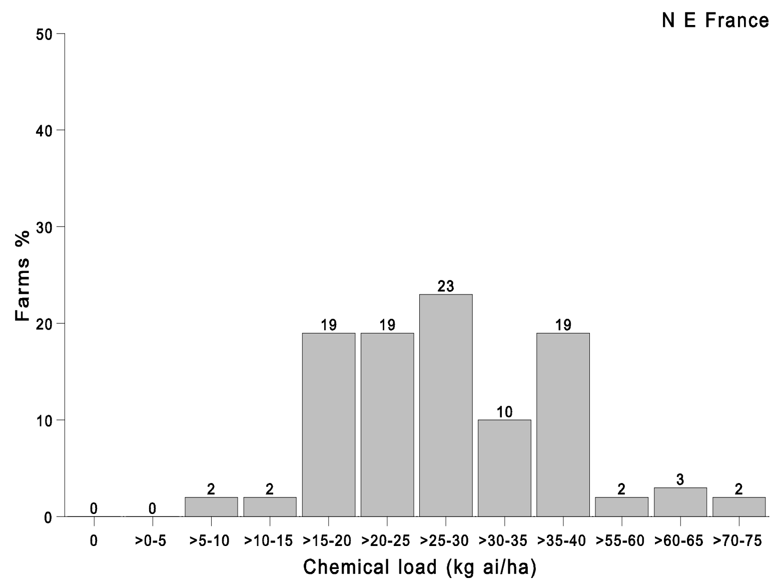
\+ Sulphuric acid was used on 33% of farms at c. 115 kg ai/ha.

Chart 3.2 Variation in chemical load between farms and regions






East Anglia
Farms %
50
40
30
20
10
0
15
28
33
17
5
2
0
>0-5
>5-10
>10-15
>15-20
>20-25
>25-30
>30-35
>35-40
>55-60
>60-65
>70-75
Chemical load (kg ai/ha)


N E France
Farms %
50
40
30
20
10
0
2
2
19
19
23
10
19
2
3
2
0
>0-5
>5-10
>10-15
>15-20
>20-25
>25-30
>30-35
>35-40
>55-60
>60-65
>70-75
Chemical load (kg ai/ha)

4.0 SEED AND SEED TREATMENT

4.1 Seed sources

Table 4.1 Seed sources

Region	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Crop area - ha	1,076	897	2,060	862
Sources	Area %			
Purchased only	32	63	75	79
Farm-saved only	12	12	11	-
Farm-saved/purchased	56	25	13	20
Total farm-saved	40	30	17	10

These figures, which do not tie in satisfactorily with answers given in Section 2.3.1, were broadly supported by local specialists.

4.2 Background to seed treatment

As may be seen from Section 4.2.2, seed treatments were often not applied by the farmers. Farmers were not necessarily totally informed in this sector and their responses as a consequence varied in accuracy.

4.2.1 Target diseases

Table 4.2.1 Target diseases

Region	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Number of farms	60	60	60	62
Diseases	Farms %			
Storage				
Fusarium	17	15	32	32
Phoma	40	3	45	
Storage/soil				
Helminthosporium	5	17	43	44
Soil				
Rhizoctonia	25	72	42	2
Synchytrium endobioticum			2	
Polyscytalum pustulans			3	
Erwinia carotovora	8		5	
Streptomyces			2	
Spongospora subterranea			2	
Arctium lappa	2			
Damage to crop when emerging				
Phytophthora	5			
No answer/don't know	23	1	15	52

Local specialists did not necessarily agree with these views. Comments received were:

Lüneburg - *Rhizoctonia* 50%
Fusarium 30%
Phoma 10 - 20%

E Anglia - *Helminthosporium* can be picked up in the field or in store and may be more important than farmers felt.

N E France - Specialists added *Phoma* and *Pythium* in store.

Those views do not always correlate with the treatments made (Section 4.3).

4.2.2 Seed treatment application

Farmers' views on proportion of seed treated were as shown.

Table 4.2.2i Proportion of seed treated

Region	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Area - ha	1,076	897	2,060	862
Amount of seed treated	Area %			
All	66	72	77	79
Some	21	9	17	15
None	13	-	3	4
Don't know	-	19	4	-

Farmers claimed the the majority of seed received a treatment.

Table 4.2.2ii Who treated the seed

Region	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Number of farms	60	60	60	62
	Farms %			
Original grower	2	8	56	32
Farmer	82	40	24	15
Merchant	-	28	14	44
Mobile operator	-	-	7	-
Others	2	-	-	-
Don't know/ no answer	14	22	-	3

Farmers involvement in seed treatment varied widely from 82% in Lüneburg to 15% in N E France.

Specialists views obtained were:

Lüneburg - 80% of seed pre-treated into store, of which 20% applied by seed merchants and 60% by the farmers under the merchants direction. Subsequent preplanting treatments undertaken by the farmers.

Flevoland - Storage treatments usually carried out by the seed merchants and could be up to 100% of crop. Preplanting treatments undertaken by the farmers.

N E France - Virtually all seed pre-treated into store by the merchant followed by preplanting treatment either by the merchant or the farmer.

4.3 Seed treatment by active ingredient

The seed treatments identified by the farmers are presented in Tables 4.3.1 - 4.3.4. While the preplanting treatments may be viewed with some confidence, the storage treatment responses are evidently only those identified by the farmers. These are nevertheless included for information.

4.3.1 Lüneburg

Table 4.3.1 Seed treatment by active ingredient - Lüneburg

Active ingredients	% crop treated (Base: 1,076 ha)	Average dose g ai/ha treated with that ai
Preplanting		
pencycuron	51	497
tolclofos-methyl	20	402
maneb	4	3,600
mancozeb	1	3,840
dimethoate	1	160
Others - unidentified	3	400*

* Dose attributed.

4.3.2 Flevoland

Table 4.3.2 Seed treatment by active ingredient - Flevoland

Active ingredients	% of crop treated (Base: 897ha)	Average dose g ai/ha treated with that ai
Storage		
thiabendazole (TBZ)	11	93
imazalil *	2	45*
Preplanting		
pencycuron	57	402
validamycin	10	129

* in mixture with TBZ

4.3.3 East Anglia

Table 4.3.3 Seed treatment by active ingredient - East Anglia

Active ingredients	% of crop treated (Base: 2,060 ha)	Average dose g ai/ha treated with that ai
Storage		
thiabendazole *	30	190
imazalil	20	22
aminobutane	5	276
tecnazene	1	635
Preplanting		
pencycuron	19	536
tolclofos-m	13	405
iprodione	7	125
General		
maneb	5	4,926
zinc sulphate	5	2,463
unidentified	17	469 †

* May also be used at planting. † Dose attributed.

4.3.4 N E France

Table 4.3.4 Seed treatment by active ingredient - N E France

Active ingredients	% of crop treated (Base: 862 ha)	Average dose g ai/ha treated with that ai
Storage		
thiabendazole	27	84
imazalil	17	35
Preplanting		
pencycuron	34	380
mancozeb	13	2,237
flutolanil	10	280
iprodine	1	50
General		
mepronil	5	133
maneb	2	1,920

4.3.5 Seed rates

Anticipating poor knowledge on seed treatments, farmers were not asked for dose rates. Instead recommended rates were entered. Dose rate per hectare varies therefore as a direct result of seed rates. These are summarised in Table 4.3.5.

Table 4.3.5 Seed rates

Region	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Number of farms	60	60	60	62
Seed rate tonnes/ha	Farms %			
0.5 < 1.0	-	-	5	21
1.0 < 1.5	3	8	2	42
1.5 < 2.0	5	18	12	21
2.0 < 2.5	43	28	33	5
2.5 < 3.0	38	8	28	3
3.0 < 3.5	7	13	7	3
3.5 < 4.0	-	-	3	-
4.0 < 5.0	-	7	-	2
5.0 < 6.0	3	12	-	3
6.0 < 7.0	-	3	-	-
7.0 < 8.0	-	-	-	-
8.0	-	2	-	-
No answer	-	-	10	-
Average t/ha	2.5	3.0	2.4	1.6

Seed rates vary widely and are particularly dependant on the size of tuber used.

4.4 Opportunities to reduce seed treatment load

Seed treatment is recognised as a necessary and efficient low-dose means of disease control. There appears no need to reduce.

5.0 WEEDS AND HERBICIDES

5.1 Target weeds

The following table compares the target weeds mentioned by the farmers in the four regions.

Table 5.1 Target weeds

Region	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Number of farms	60	60	60	62
	Farms %			
Dicotyledons				
Anagallis arvensis	-	-	-	18
Anthemis cotula	14	-	-	-
Atriplex patula	76	33	-	-
Brassica napus	-	8	-	-
Capsella bursa-pastoris	-	3	-	-
Chenopodium album	22	17	65	45
Cirsium spp	12	28	22	26
Convolvulus spp	16	-	27	37
Cruciferae	-	-	-	10
Galeopsis tetrahit	-	-	29	-
Galium aparine	55	63	41	50
Lamium purpureum	-	2	-	-
Matricaria spp	29	-	25	40
Mercurialis spp	-	-	-	23
Polygonum amphibium	-	2	-	-
Polygonum aviculare	16	12	25	-
Polygonum convolvulus	33	23	37	8
Polygonum persicaria	-	37	24	8
Polygonum spp	14	-	-	27
Senecio spp	-	10	-	-
Sinapis arvensis	-	-	16	21
Solanum nigrum	7	57	-	52
Sonchus oleraceus	-	8	-	-
Stellaria media	50	52	33	-
Tussilago farfara	-	12	-	-
Veronica spp	-	5	-	-
Viola arvensis	24	-	-	-
Monocotyledons				
Agropyron repens	74	8	16	15
Alopecurus myosuroides	16	2	16	34
Avena fatua	12	-	24	27
Bromus sterilis	-	-	3	-
Lolium spp	-	5	-	-
Poa annua	14	8	14	16

The widespread penetration of weeds tending to be difficult to control such as *Galium aparine* (cleavers), *Polygonum* spp, *Solanum nigrum* (black nightshade) is apparent together with some grass weeds *Agropyron repens* (couch), *Alopecurus myosuroides* (black grass) and *Avena fatua* (wild oats).

5.2 Resistant species claimed

A few farmers in each region cited cases of what they termed was resistance to certain chemicals. Specialists refuted this suggesting that this was basic selectivity or poor application.

5.3 Levels of weed control sought

Table 5.3 Levels of weed control sought

Region	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Number of farms	60	60	60	62
Control sought	Farms %			
< 70%	-	8	-	2
71 - 80%	5	5	-	2
81 - 90%	40	18	7	5
91 - 100%	53	63	85	84
No answer	2	5	8	5

Farmers generally sought levels of weed control between 91 - 100%, however, those in Lüneburg and Flevoland were clearly prepared to accept lower levels of control.

5.4 Herbicide active ingredients used

5.4.1 Lüneburg

Table 5.4.1 Herbicide use by active ingredient - Lüneburg

Active ingredient	Activity	% of crop treated (Base: 1,076 ha)	No. of applications		Cumulative dose g ai/ha of farm crop receiving that ai		
			Range per farm	Ave per ha treated	min	max	ave
metribuzin	ppoc	69	1 - 2	1.1	21	910	318
rimsulfuron	poc	45	1 - 2	1.2	3	65	14
prosulfocarb	ppoc	30	1 - 3	1.1	1,039	9,600	3,089
fluazifop-p-butyl	pog	10	1 - 2	1.1	200	1,000	448
metobromuron	pc	9	1	1.0	1,000	1,750	1,407
haloxyfop-ethoxyethyl	ppog	8	1	1.0	108	162	136
monolinuron	pc	6	1	1.0	118	1,187	561
glufosinate	poc	6	1	1.0	600	600	600
bentazone	pob	4	2	2.0	1,152	1,919	1,562

Key to abbreviations:

p = pre-emergence
po = post-emergence

b = broad-leaved weeds
g = grasses
c = cross spectrum (b+g)

5.4.2 Flevoland

Table 5.4.2 Herbicide use by active ingredient - Flevoland

Active ingredient	Activity	% crop treated (Base: 897ha)	No. of applications		Cumulative dose g ai/ha of crop receiving that ai		
			Range per farm	Ave per ha treated	min	max	ave
metribuzin	ppoc	55	1 - 2	1.0	105	1,050	471
prosulfocarb	ppoc	35	1	1.0	160	4,000	2,878
metobromuron	pc	10	1	1.0	250	2,000	1,074
glufosinate	poc	6	1	1.0	224	450	405
terbutryne	ppoc	4	1	1.0	250	1,500	851
linuron	ppoc	4	1	1.0	150	676	323
monolinuron	pc	2	1	1.0	150	238	179
aclonifen	pc	2	1	1.0	2,037	2,100	2,079
fluazifop-butyl	pog	2	1	1.0	375	375	375
glyphosate	poc	1	1	1.0	720	720	720
dinoterb	des	<1	1	1.0	1,625	1,625	1,625
oil	adj	<1	1	0.3	6,500	6,500	6,500

Key to abbreviations:

p = pre-emergence
po = post-emergence
des = desiccant
adj = adjuvant
c = cross spectrum (broad leaf weeds + grasses)
g = grasses

5.4.3 East Anglia

Table 5.4.3 Herbicide use by active ingredient - East Anglia

Active ingredient	Activity	% of crop treated (Base: 2,060 ha)	No. of applications		Cumulative dose g ai/ha of crop receiving that ai		
			Range per farm	Ave per ha treated	min	max	ave
paraquat	poc	48	1-2	1.1	139	549	383
metribuzin	ppoc	46	1-3	1.4	525	*2,100	1,066
diquat	poc	25	1	1.0	139	800	356
bentazone	pob	22	1-3	1.1	360	1,512	717
terbutryne	ppoc	19	1	1.0	945	1,190	1,115
glufosinate	poc	19	1-2	1.1	450	900	553
terbuthylazine	pc	15	1	1.0	405	510	491
monolinuron	pc	8	1-2	1.3	769	2,170	1,628
linuron	ppoc	4	1	1.0	1,850	1,850	1,850
trietazine	ppoc	4	1	1.0	1,000	1,000	1,000
pendimethalin	pc	2	1	1.0	1,319	1,979	1,667
prometryn	ppoc	2	1	1.0	850	1,275	1,073
glyphosate	poc	0.3	1	1.0	900	1,199	1,050
metoxuron	poc	0.2	1	1.0	2,000	2,000	2,000
oil	adj	6	1	1.0	1,200	1,200	1,200

Key to abbreviations:

p = pre-emergence c = cross spectrum (broad leaf weeds + grasses)
po = post-emergence b = broad leaf weeds
adj = adjuvant

* The high maximum dose of metribuzin came from one farm which claimed to have applied 2 x 1,050 g metribuzin/ha. This may be possible on highly organic silts.

5.4.4 N E France

Table 5.4.4 Herbicide use by active ingredient - N E France

Active ingredients	Activity	% of crop treated (Base: 862 ha)	No. of applications		Cumulative dose g ai/ha of crop receiving that ai		
			Range per farm	Ave per ha treated	min	max	ave
metribuzin	ppoc	69	1 - 2	1.4	105	1,400	362
prosulfocarb	ppob	52	1	1.0	1,600	4,800	3,292
metobromuron	pc	24	1	1.0	250	2,000	1,081
terbutryne	ppoc	12	1	1.0	250	625	507
linuron	ppoc	11	1	1.0	750	1,980	1,375
aclonifen	pc	9	1	1.0	600	4,200	1,781
paraquat	poc	2	1	1.0	250	1,199	606
diquat	poc/des	1	1	1.0	125	200	153
simazine	pc	1	1	1.0	250	250	250
quizalofop-e	pog	-	1	1.0	83	83	83

Key to abbreviations:

p = pre-emergence
po = post-emergence
des = desiccants

b = broad leaf weeds
g = grasses
c = cross spectrum (b+g)

5.4.5 General commentary

Herbicides were used on the following proportions of crop in the respective regions:

Lüneburg - 100%
Flevoland - 78%
E Anglia - 90%
N E France - 99.5%

Regions used a substantial proportion of post-emergence chemicals though their mix was strikingly different. Metrobuzin and prosulfocarb were prominent in all regions except for the absence of the latter in E Anglia. The low dose rimsulfuron was only present in Lüneburg and paraquat, the most widely used chemical in E Anglia, was only present to a very limited degree in N E France and absent from the other regions. Some of the reasons for absences were no doubt due to registration differences.

5.5 Herbicide use parameters

5.5.1 Herbicide applications

Table 5.5.1 Herbicide applications

On farms using herbicides	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
No. of active ingredients used per farm	2.5	1.8	2.6	2.1
No. of active ingredients used per hectare	1.9	1.2	2.2	1.8
No. of product applications per hectare	2.1	1.5	1.8	1.7
Proportion spraying only part of their farm	40%	10%	28%	19%
Average volume of active ingredient on treated crop kg ai/ha	1.47	1.94	1.83	2.64

Differences between regions are not striking except for the proportion of farmers spraying parts of their crop. Highest in Lüneburg followed by E Anglia, this appears linked in the case of Lüneburg to the high proportion of different crop types on the same farm.

5.5.2 Mechanical weed control

Table 5.5.2i The practice of mechanical weed control

Region	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Number of farms	60	60	60	62
Number of passes	Farms %			
0	70	73	35	66
1	22	17	32	18
2	8	8	17	13
3			3	3
4			8	
5			3	
6			2	
12		2		

Generally speaking it was smaller farmers who used mechanical methods most, with the major exception of a 50 ha farmer in Flevoland who made twelve passes.

Regional comparison shows major differences. In Lüneburg there is a deliberate policy not to encourage mechanical weed control while the reverse is true in E Anglia. It is a practice more suitable on organic soils, if soil moisture is satisfactory. Hilling up was carried out in all regions and specialists believe this may have been included in farmers answers in Lüneburg.

The value of mechanical weed control in reducing herbicide use was not shown conclusively for any region but there was a slight reduction which was consistent across regions.

Table 5.5.2ii Mechanical weed control and herbicide use

Region	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)*	N E France (F)
	Herbicide load kg ai/ha			
No mechanical hoeing	0.832	1.510	1.191	1.681
Mechanical hoeing practised	0.663	0.604	0.876	1.042

* based only on those farms using herbicide

5.6 Herbicide load by farm

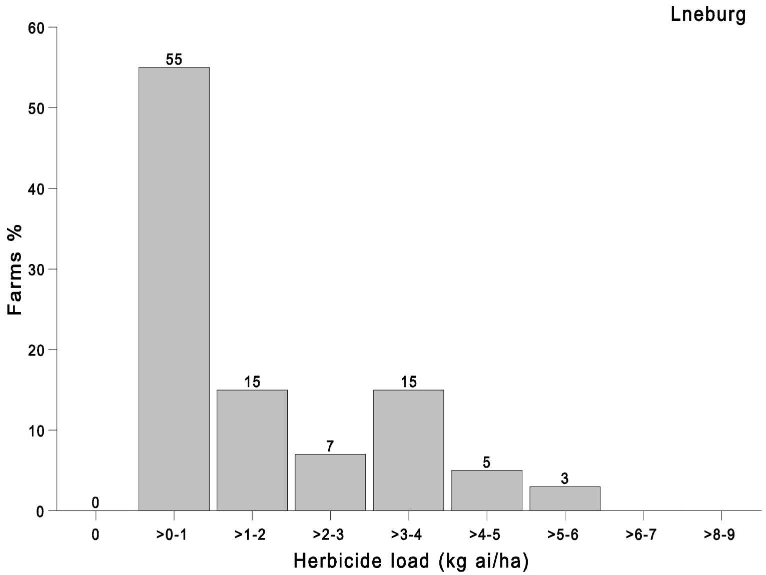
Table 5.6 Herbicide load by farm

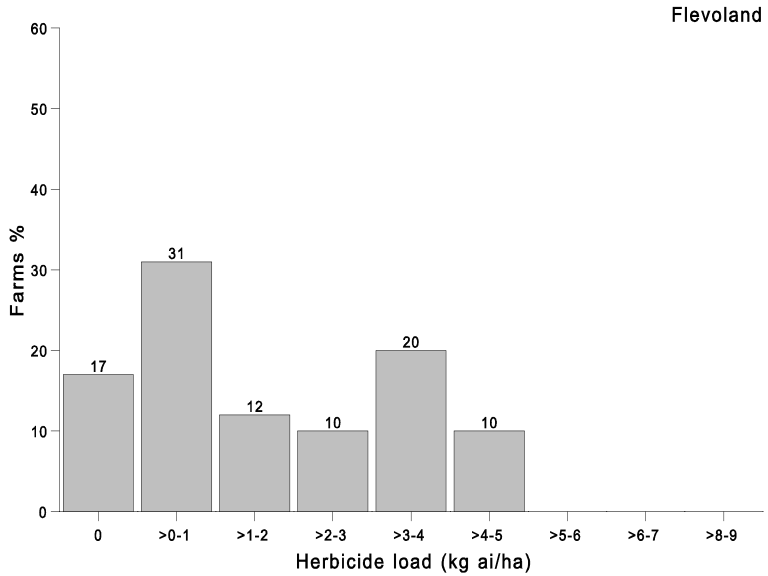
Region		Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Number of farms		60	60	60	62
Herbicide load kg ai/ha		Farms %			
0		0	17	22*	5
>0 - 1		55	31	22	34
>1 - 2		15	12	23	10
>2 - 3		7	10	27	8
>3 - 4		15	20	3	26
>4 - 5		5	10	2	8
>5 - 6		3		0	8
>6 - 7				2	0
>8 - 9					2
Load kg ai/ha grown	Average	1.47	1.51	1.64	2.63
	Range	0.1 - 5.8	0.03 - 4.7	0.1 - 6.7	0.03 - 8.4

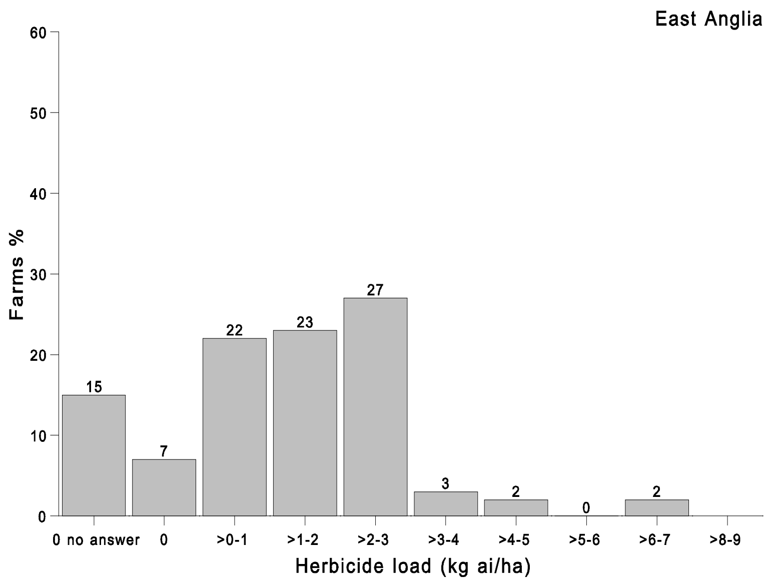
* includes 15% who did not answer

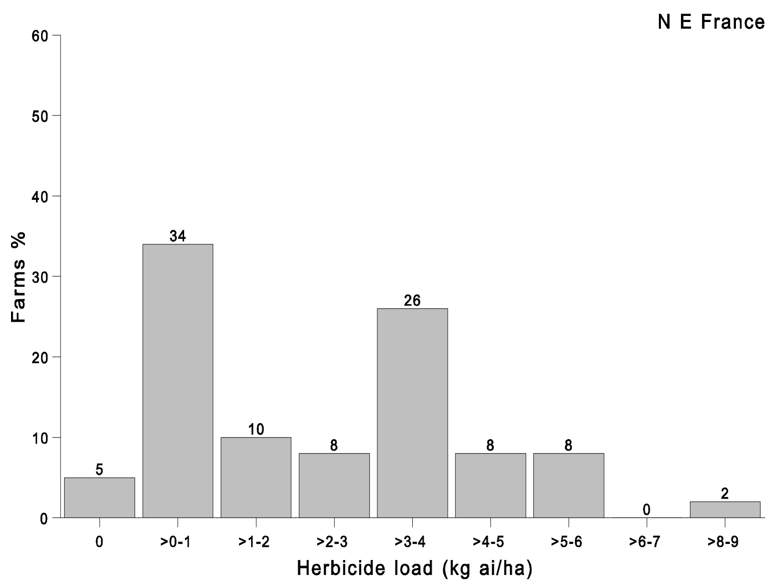
There was no common reason across regions for heavy or lighter use. Heavier users did tend, however, to use higher dose active ingredients and apply more products and make more applications. Lighter users tended to use lower dose active ingredients and to make more targeted or partial applications, and in N E France heavy cutting of dose rates was also involved.

Chart 5.6 Herbicide load by farm






East Anglia
Farms %
60
50
40
30
20
10
0
15
7
22
23
27
3
2
0
2
0 no answer
0
>0-1
>1-2
>2-3
>3-4
>4-5
>5-6
>6-7
>8-9
Herbicide load (kg ai/ha)


N E France
Farms %
60
50
40
30
20
10
0
5
34
10
8
26
8
8
0
2
0
>0-1
>1-2
>2-3
>3-4
>4-5
>5-6
>6-7
>8-9
Herbicide load (kg ai/ha)

5.6.1 Herbicide load relative to yield

Herbicide load was plotted against yield for the different regions (presented in individual country reports). There was the suggestion of a correlation between herbicide load and yield for ware and starch crops in Lüneburg. No relationships were demonstrated in the other regions.

5.7 Herbicide use in the study year (1994) compared with an average year

Table 5.7 Herbicide use in the study year (1994) compared with an average year

Region	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Base area - ha	1,076	897	2,060	862
	Area %			
Greater use	24	27	66	28
The same	0	0	0	0
Lesser use	76	69	32	71
No answer	0	4	3	1

The three regions Lüneburg, Flevoland and N E France clearly showed reduced use which specialists confirmed as within a trend which included dose rate reductions and reduced rate mixtures. E Anglia presented the opposite picture which local specialists confirmed was part of a trend for increased use/dose.

5.8 Opportunities to reduce herbicide load

The strategy of split applications has improved weed control and allowed dose rates to be cut. Specialists believe this trend has gone as far as it can in Lüneburg and N E France - possibly too far because weed control has become poor (a fact perhaps accepted now as 'normal' by farmers in Lüneburg, see Table 5.3).

The lack of availability of sufficient selective post-emergence herbicides was felt by specialists in E Anglia to be an impediment to further spot or targeted spraying.

Mechanical weed control is limited by soil type and the risk of damaging the crop, but purely on the basis of its impact on herbicide usage it appears to have a benefit. Work in E Anglia and Flevoland is in progress to try to optimise this.

6.0 DISEASES AND FUNGICIDES

6.1 Target diseases

Phytophthora infestans, potato late blight, was the only significant disease in all four regions, noted by > 90% of all farms.

Alternaria solani, early blight, was mentioned on less than 10% of farms in Lüneburg. *Sclerotinia* spp was mentioned on 5% of farms in Flevoland.

6.2 Resistance of diseases to fungicides

A number of farmers in each region claimed to have *Phytophthora* resistance to a range of fungicides. Specialists discounted them all except in the case of metalaxyl in all regions, and in Lüneburg and N E France to oxadixyl.

6.3 Levels of disease control sought

Table 6.3 Levels of disease control sought

Region	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Number of farms	60	60	60	62
	Farms %			
< 80%	5	2	0	0
81 - 90%	15	0	0	5
91 - 100%	78	93	85	94
No answer	2	5	15	2

Very high levels of control are necessary for *Phytophthora* treatment and are sought by farmers. In Lüneburg, farmers were least exigeant though specialists felt that a tightening of standards would be necessary to combat an increasingly high incidence of stem *Phytophthora*.

6.4 Fungicide active ingredients used

A season-long programme of protectant, mixed later with curative, fungicides needs to be applied for *Phytophthora* control. All crops were treated in each region.

6.4.1 Lüneburg

Table 6.4.1 Fungicide use by active ingredient - Lüneburg

Active ingredient	Activity	% of crop treated (Base: 1,076 ha)	No. of applications		Cumulative dose g ai/ha of crop receiving that ai		
			Range per farm	Ave per ha treated	min	max	ave
maneb	c/*Phy*	90	1 - 8	5.4	89	13,070	5,207
fentin acetate	c/*Phy*	68	1 - 6	2.1	32	1,943	503
mancozeb	c/*Phy*	43	1 - 4	1.5	839	4,940	1,661
metalaxyl	s/*Phy*	33	1 - 2	1.1	100	2,200	796
cymoxanil	s/*Phy*	29	1 - 4	1.2	89	432	136
fluazinam	c/*Phy*	13	1 - 3	2.3	150	1,500	439
dimethomorph	s/*Phy*	9	1 - 2	1.4	150	300	216
metiram	c/*Phy*	9	2 - 8	3.5	2,879	11,519	5,310
oxadixyl	s/*Phy*	1	1 - 2	1.4	200	400	283

Key to abbreviations:

c = contact *Phy* = *Phytophthora* spp
s = systemic

6.4.2 Flevoland

Table 6.4.2 Fungicide use by active ingredient - Flevoland

Active ingredient	Activity	% of crop treated (Base: 897ha)	No. of applications		Cumulative dose g ai/ha of crop receiving that ai		
			Range per farm	Ave per ha treated	min	max	ave
fluazinam	c/*Phy*	80	2-20	10.8	300	8,000	2,201
mancozeb	c/*Phy*	47	1-9	4.2	1,700	15,416	6,698
cymoxanil	s/*Phy*	47	1-9	4.1	180	1,012	451
maneb	c/*Phy*	42	1-14	3.9	662	32,000	4,609
fentin acetate	c/*Phy*	36	1-14	3.1	219	4,158	862
pencycuron	c/b	14	1-2	1.3*	125	6,500	1,269
metalaxyl	s/*Phy*	13	1-3	1.8	240	1,200	502
thiabendazole	s/b	4	1	1.2*	25	191	91
validamycin	c/b	2	1	1.1*	29	150	125

Key to abbreviations:

c = contact   b = broad spectrum
s = systemic   *Phy* = *Phytophthora*

* Inclusive of seed treatments

6.4.3 East Anglia

Table 6.4.3 Fungicide use by active ingredient - East Anglia

Active ingredient	Activity	% of crop treated (Base: 2,060 ha)	No. of applications		Cumulative dose g ai/ha of crop receiving that ai		
			Range per farm	Ave per ha treated	min	max	ave
mancozeb	c/*Phy*	89	1-12	4.1	679	16,320	5,632
maneb	c/*Phy*	76	1-6	2.5	40	12,277	1,509
fentin acetate	c/*Phy*	58	1-4	1.9	135	1,080	486
cymoxanil	s/*Phy*	39	1-12	4.4	89	1,080	406
fluazinam	c/*Phy*	35	1-5	2.5	150	750	383
metalaxyl	s/*Phy*	27	1-4	2.2	127	600	331
oxadixyl	s/*Phy*	17	2-5	4.1	399	1,000	817
chlorothalonil	s/*Phy*	11	1-6	2.2	750	2,500	1,941
ofurace	s/*Phy*	9	1-5	3.0	57	531	201
zineb	c/*Phy*	9	1-5	3.0	140	837	459
fentin hydroxide	c/*Phy*	5	1-5	1.4	180	2,375	351
benalaxyl	s/*Phy*	4	1-3	2.3	159	480	362
propamocarb	s/*Phy*	4	2-3	3.0	1,983	2,975	2,950

Key to abbreviations:

c = contact   *Phy* = *Phytophthora infestans*
s = systemic

6.4.4 N E France

Table 6.4.4 Fungicide use by active ingredient - N E France

Active ingredient	Activity	% of crop treated	No. of applications		Cumulative dose g ai/ha of crop receiving that ai		
		(Base: 862 ha)	Range per farm	Ave per ha treated	min	max	ave
mancozeb	c/*Phy*	96	1 - 25	12.8	930	51,239	20,325
cymoxanil	s/*Phy*	82	1 - 15	3.0	72	1,440	269
maneb	c/*Phy*	53	1 - 18	8.4	2,000	30,506	15,090
oxadixyl	s/*Phy*	37	1 - 10	2.3	80	2,000	449
propineb	c/*Phy*	10	1 - 2	1.6	870	3,480	1,838
fluazinam	c/*Phy*	7	1 - 3	2.0	300	1,200	591
fentin acetate	c/*Phy*	3	2	2.0	360	360	360
captafol	c/*Phy*	2	2	2.0	480	480	480
folpet	c/*Phy*	2	2	2.0	719	719	719
metiram	c/*Phy*	1.3	2	2.0	3,199	3,199	3,199
chlorothalonil	c/*Phy*	0.3	2	2.0	4,500	4,500	4,500
copper	c/*Phy*	0.2	3	3.0	9,000	9,000	9,000

Key to abbreviations:

c = contact Phy = *Phytophthora*
s = systemic

6.4.5 General commentary

Maneb and mancozeb are the fundamental components of *Phytophthora* control. Added to these as the season progresses are the systemics, metalaxyl, cymoxanil or oxadixyl, and finally towards harvest, fentin acetate. The contact chemicals and some of the systemic mixtures are being replaced by the new highly effective fungicide fluazinam, and in Lüneburg by dimethomorph. This pattern was common to all regions, fuazinam having increased in use in Flevoland dramatically over the last three seasons. A consequence of its use is a major reduction in fungicide volume loading.

6.5 Fungicide use parameters

6.5.1 Fungicide applications

Table 6.5.1i Fungicide applications

On farms using fungicides	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
No. of active ingredients used per farm	4.4	3.5	4.3	4.1
No. of active ingredients used per hectare	3.0	2.9	3.8	2.9
Number of product applications per hectare	5.8	12.8	6.5	14.4
Proportion of farms spraying parts of their crop	22%	27%	17%	6.5%
Average load kg ai/ha crop treated	6.59	8.44	7.78	27.86

The number of sprays varies according to variety and the type of crop - seed, ware or starch. Crops for seed have a shorter season and may require up to seven sprays fewer than a ware crop which may require up to 15 sprays. Potatoes for starch production have a long season but inputs tend to be low.

Table 6.5.1ii presents the average number of sprays per farm and crop type mix.

Table 6.5.1ii Average number of fungicide product applications per farm and crop type mixes

Crop type	Ware only	Starch only	Seed only	Ware + starch	Ware + seed	Ware + seed + starch	Starch + seed
Region	Average no. product applications/farm						
Lüneburg	6.0	8.9	(7.6)	5.1	8.0	4.5	10.9
Flevoland	13.8	-	9.7	-	10.6	-	-
E Anglia	8.9	-	4.8	-	(3.2)	-	-
N E France	16.4	11.8	(13.0)	(27.7)	21.8	(16.1)	-

(   ) = < 10% of farms

The difference in number of applications for ware and seed crops is apparent in most regions. In Lüneburg, however, the difference between the crops is not clear and indeed ware crops seem to have received fewer treatments than starch potatoes.

6.6 Fungicide load by farm

Table 6.6 Fungicide load by farm

Region		Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Number of farms		60	60	60	62
Fungicide load kg ai/ha		Farms %			
0		0	0	0	0
>0 - 5		31	36	35	0
>5 - 10		58	31	32	2
>10 - 15		10	18	28	6
>15 - 20		2	7	2	29
>20 - 25			5		23
>25 - 30			0		18
>30 - 35			2		15
>35 - 40					2
>50 - 55					5
>60 - 65					2
"Average use"*				3*	
Load kg ai/ha grown	Average	6.59	3.44	7.78	27.86
	Range	1.4 - 16.7	0.3 - 32.0	0.7 - 17.3	9.0 - 66.2

* Products not identified.

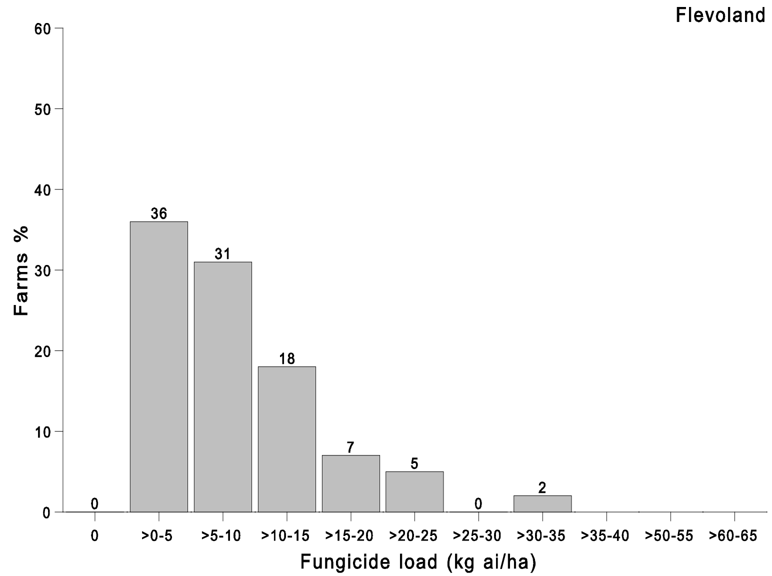
N E France stands out for its much heavier load of fungicides. This region and Flevoland had the highest proportion of ware potato production area in the sample, 71% and 78% respectively.

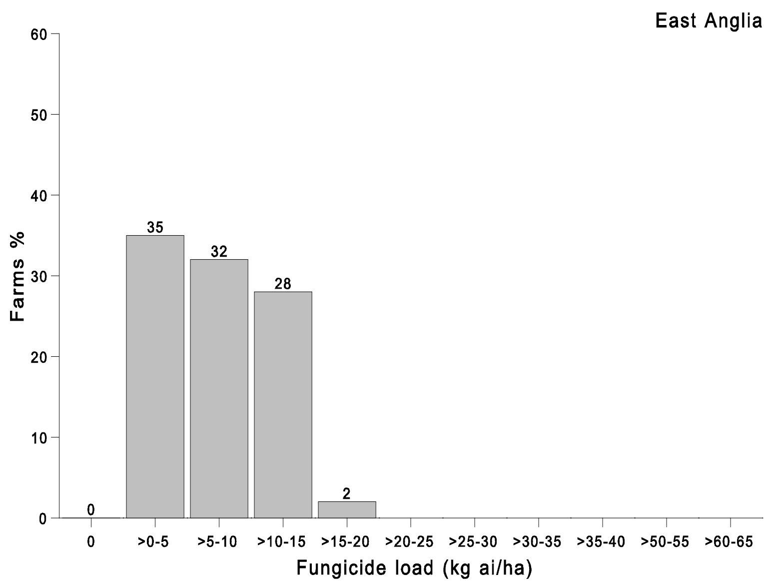
Both Flevoland and N E France made a very high number of product applications per hectare. In the former case at least this was due to the exceptionally long season. However, the load in N E France was three times as high.

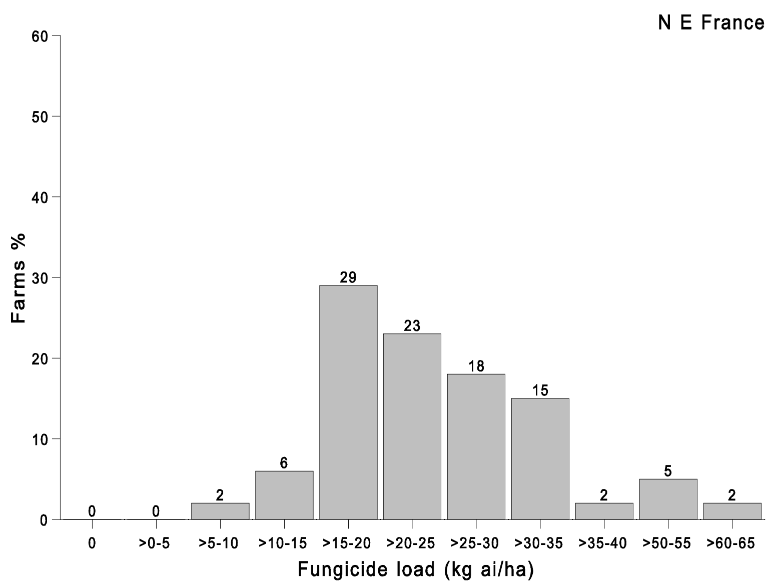
The average number of spray applications of the most used protectant fungicide, mancozeb was 12.8 in N E France, whilst in Flevoland it was only 4.2 on half the area. However, in Flevoland the difference had been taken up by the use of fluazinam which had an average of 10.2 applications/ha treated.

The reason for the high fungicide load in N E France relative to Flevoland was thus due almost entirely to the use of the high dose rate active ingredient mancozeb compared with the low dose fluazinam.

Chart 6.6 Fungicide load by farm




East Anglia
Farms %
60
50
40
30
20
10
0
35
32
28
2
0
>0-5
>5-10
>10-15
>15-20
>20-25
>25-30
>30-35
>35-40
>50-55
>60-65
Fungicide load (kg ai/ha)


N E France
Farms %
60
50
40
30
20
10
0
0
2
6
29
23
18
15
2
5
2
0
>0-5
>5-10
>10-15
>15-20
>20-25
>25-30
>30-35
>35-40
>50-55
>60-65
Fungicide load (kg ai/ha)

6.6.1 Fungicide load relative to yield

Fungicide load was plotted against yield for the different regions (presented in the individual country reports).

In a crop protection programme which is extremely sensitive to the day-to-day incidence of disease attack and where yield is optimised through other aspects, there should be no relationship between agrochemical load and yield.

In potatoes, the main disease control programme is a protectant one and similarly, if yield is optimised via other aspects there should be no relationship between agrochemical load and yield.

In both cases it would be expected to find, statistically, a clumping of yield data around the crop's potential yield.

In Lüneburg, Flevoland, E Anglia and in seed and starch crops in N E France there was no relationship demonstrated between yield and fungicide load. For ware potatoes in N E France, however, there was an increase in yield between 10 and 35 kg fungicide ai/ha. This suggests that disease control was, firstly, important in preserving yields and, secondly, that control was technically sub-optimal at the lower fungicide loads used. Two aspects present themselves. Either that the chemicals used (or the way they were used) was not optimal, or that the lower loads/lower yields were not necessarily less cost-effective.

6.7 Fungicide use in the study year (1994) compared with an average year

Table 6.7 Fungicide use in the study year (1994) compared with an average year

Region	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Crop area - ha	1,076	897	2,060	862
	Area %			
Greater use	16	45	3	34
The same	61	30	84	56
Lesser use	17	19	7	10
No answer	6	6	6	0

In Lüneburg it tended to be larger farmers who believed they used less or more than average. Again in Flevoland it was larger farmers who thought they had used more than average in 1994. In the continental European regions there was greater variability within each region than in E Anglia where the great majority used the same quantity.

6.8 Factors determining the start of fungicide application

Table 6.8 Factors determining the start of fungicide application

Region	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Number of farms	60	60	60	62
	Farms %			
Calendar date	38	3	27	23
Disease stage	25	10	21	16
Plant stage	60	83	48	34
Warning system	55	27	22	27
Weather	77	70	34	71

In all regions ‘plant stage’ along with ‘weather’ were the most important factors in determining the start of spraying. Warning systems operate in all regions but farmers will only use these if the warning occurs before ‘plant stage’ or ‘weather’. The systems were not relied upon as a means of delaying application, such is the level of risk aversion among potato growers.

6.9 Opportunities to reduce fungicide load

Spray decision support systems are being developed in all regions, utilising computer technology to harness the huge variability inherent in ‘weather’. Farmers naturally use ‘weather’ and if these warning systems can build on this and combine it with other factors, there is a chance of delaying the start and perhaps stretching the interval between sprays.

All specialists believed that prophylactic strategies were fundamental with present chemicals. Systemic, partially curative, active ingredients used alone are likely to result in resistance.

In Flevoland, specialists pointed out the crucial importance of farmer attitude in introducing change, and that variability in attitudes was a real consideration which would need to be addressed.

Varietal resistance or reduced susceptibility may increase in the longer term. However, the top priority for breeding is determined by market demand. Future technologies may be able to link these two attributes more closely.

7.0 INSECTS AND INSECTICIDES

7.1 Target insects and nematodes

Farmers responses indicated the following:

Table 7.1 Target insects and nematodes

Region	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Crop area - ha	1,076	897	2,060	862
Pest	Area %			
Insects				
Agrotis spp (cutworm)	0	0	40	0
Leptinotarsa spp (Colorado potato beetle)	58	4	0	12
Myzus persicae (peach/potato aphid)	77	94	92	99
Nematodes				
Globodera spp (potato cyst nematode)	25	15	68	2

Specialists felt *Leptinotarsa* was overstated in Lüneburg. They indicated that aphids were the most important pest. *Globodera* only required significant control measures in E Anglia but there was a fear by specialists that the nematode problem in Lüneburg and Flevoland was not adequately recognised by the farmers.

7.2 Insects exhibiting resistance

Some farmers in each region claimed to have cases of aphids resistant to several insecticides. Only in E Anglia did specialists accept these cases as genuine. These involved three common organophosphates, demeton-s-methyl, dimethoate and oxydemeton-methyl, and the carbamate pirimicarb.

7.3 Levels of insect control sought

Table 7.3 Levels of insect control sought

Region	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Number of farms	60	60	60	62
	Farms %			
< 70%	3	2	0	0
71 - 80%	7	12	2	0
81 - 90%	28	23	2	3
91 - 100%	52	53	92	95
Don't know	10	10	5	2

The preparedness in Lüneburg to accept lower levels of pest control was considered to be due to the high proportion of starch potato growers. In Flevoland, farmers accept populations up to 50 aphids/leaf before spraying ware crops (78% of the area of the study). Such a system is recommended for ware crops in E Anglia.

7.4 Insecticide active ingredient use

Insecticides were used on 87 - 98% of farms several times throughout the season mainly to control aphids.

7.4.1 Lüneburg

Table 7.4.1 Insecticide use by active ingredient - Lüneburg

Active ingredient	Activity	% of crop treated (Base: 1,076 ha)	No. of applications		Cumulative dose g ai/ha of crop receiving that ai		
			Range per farm	Ave per ha treated	min	max	ave
methamidophos	s/b	38	1 - 9	3.5	479	4,800	1,843
pirimicarb	s/aph	28	1 - 4	1.6	149	800	307
deltamethrin	c/b	25	1 - 3	1.7	3	30	9
cypermethrin	c/b	9	1 - 3	2.2	59	180	110
oxydemeton-m	s/b	7	1 - 2	1.5	120	386	224
alphacypermethrin	c/b	3	1 - 4	1.2	4	10	9
parathion-e	c/b	2	2	2.0	104	209	129
ethoprophos	c/nem	1	1	1.0	7,000	7,000	7,000
lambda-cyhalothrin	c/b	<1	2	2.0	9	9	9
fenvalerate	c/b	<1	1	1.0	30	30	30

Key to abbreviations:

c = contact
s = systemic
aph = aphicide
b = broad spectrum
nem = nematicide

7.4.2 Flevoland

Table 7.4.2 Insecticide use by active ingredient - Flevoland

Active ingredient	Activity	% of crop treated (Base: 897ha)	No. of applications		Cumulative dose g ai/ha of crop receiving that ai		
			Range per farm	Ave per ha treated	min	max	ave
pirimicarb	s/aph	44	1-7	2.3	125	2,000	490
deltamethrin	c/b	36	1-10	4.1	4	100	32
esfenvalerate	c/b	35	1-10	3.1	4	100	16
dimethoate	s/b	33	1-5	1.6	200	2,000	539
parathion-e	c/b	10	1-2	1.3	250	1,250	420
oxydemeton-m	s/b	8	1-3	1.7	187	750	459
aldicarb	c/nem	8	1	1.0	200	1,500	751
phosphamidon	s/b	3.3	1-2	1.3	375	500	412
thiometon	s/b	2.6	1	1.0	250	250	250
propoxur	c/b	2.2	1	1.0	100	100	100
chlorpyrifos	cf/b	0.8	1	1.0	1,919	1,919	1,919
demeton-s-	c/b	0.7	2	2.0	1,000	1,000	1,000
methyl	c/nem	0.4	1	1.0	3,000	4,000	3,750
ethoprofos	adj	1.4	5-8	5.9	19,759	55,327	30,703
petroleum oil							

Key to abbreviations:

c = contact
f = fumigant
s = systemic
adj = adjuvant

aph = aphids
b = broad spectrum
nem = nematodes

7.4.3 East Anglia

Table 7.4.3 Insecticide use by active ingredient - East Anglia

Active ingredient	Activity	% of crop treated (Base: 2,060 ha)	No. of applications		Cumulative dose g ai/ha of crop receiving that ai		
			Range per farm	Ave per ha treated	min	max	ave
pirimicarb	s/aph	72	1-7	2.3	127	980	364
aldicarb	cs/nem	26	1	1.0	700	6,719	3,057
oxamyl	cs/b	25	1	1.0	2,500	5,500	5,189
deltamethrin	c/b	13	1-3	1.8	7	22	13
dimethoate	s/b	13	1-2	1.2	339	680	410
heptenophos	s/aph	12	1-3	1.9	119	360	223
cypermethrin	c/b	9	1-3	1.5	24	75	39
chlorpyrifos-e	cf/b	6	1	1.0	219	219	219
demeton-s-methyl	c/b	3	1-8	1.5	170	1,949	328
alphacypermethrin	c/b	2	2	2.0	20	20	20
lambda-cyhalothrin	c/b	1	7	7.0	26	26	26
esfenvalerate	c/b	0.7	4	4.0	20	20	20

Key to abbreviations:

s = systemic   aph = aphids
c = contact   b = broad spectrum
f = fumigant   nem = nematodes
adj = adjuvant

7.4.4 N E France

Table 7.4.4 Insecticide use by active ingredient - N E France

Active ingredient	Activity	% of crop treated	No. of applications		Cumulative dose g ai/ha of crop receiving that ai		
		(Base: 862 ha)	Range per farm	Ave per ha treated	min	max	ave
pirimicarb	s/aph	52	1 - 3	1.4	100	750	199
deltamethrin	c/b	37	1 - 3	1.3	5	25	11
tau-fluvalinate	c/b	38	1 - 3	1.5	21	288	72
thiometon	s/b	35	1 - 2	1.5	60	240	170
lambda-cyhalothrin	c/b	34	1 - 3	1.3	2	19	8
fenvalerate	c/b	9	1 - 2	1.5	10	100	44
heptenophos	s/aph	9	1 - 2	1.8	200	400	368
dimethoate	s/b	6	1 - 4	2.4	600	3,200	2,289
lindane	c/b	4	1	1.0	750	1,350	907
esfenvalerate	c/b	2	2	2.0	25	25	25
chlorpyrifos-m	cf/b	1	2	2.0	499	499	499
cyfluthrin	c/b	1	1 - 2	1.5	150	250	200
oxydemeton-m	s/b	1	1	1.0	200	200	200
fenitrothion	c/b	0.2	2	2.0	50	50	50

Key to abbreviations:

s = systemic aph = aphids
c = contact b = broad spectrum
f = fumigant

7.4.5 General commentary

The lists of active ingredients all typify use where the overwhelmingly important pests are aphids. The specific aphicide, pirimicarb, was very widely used particularly in E Anglia and N E France, followed by the synthetic pyrethroid deltamethrin, other synthetic pyrethroids and one or two organophosphates. In E Anglia, the nematicides aldicarb and oxamyl were important, both of which in addition control early season aphids. These add substantially to the chemcial load.

7.5 Insecticide use parameters

7.5.1 Insecticide applications

Table 7.5.1 Insecticide applications

On farms using insecticides	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
No. of active ingredients used per farm	1.9	2.1	2.4	2.5
No. of active ingredients used per hectare	1.1	1.9	1.8	2.3
Number of product applications per hectare	2.4	4.5	3.0	2.0
Proportion of farms spraying parts of their crop	46%	23%	20%	10.5%
Average load kg ai/ha crop treated	1.01	1.09	2.65	0.40

There was a wide range in the number of product applications per ha in all regions up to 1 - 14 spread in Flevoland and E Anglia. The range is partly due to type of crop (seed, ware or starch), but also partly due to natural variation in pest attack between farms.

7.6 Insecticide load by farm

Table 7.6 Insecticide load by farm

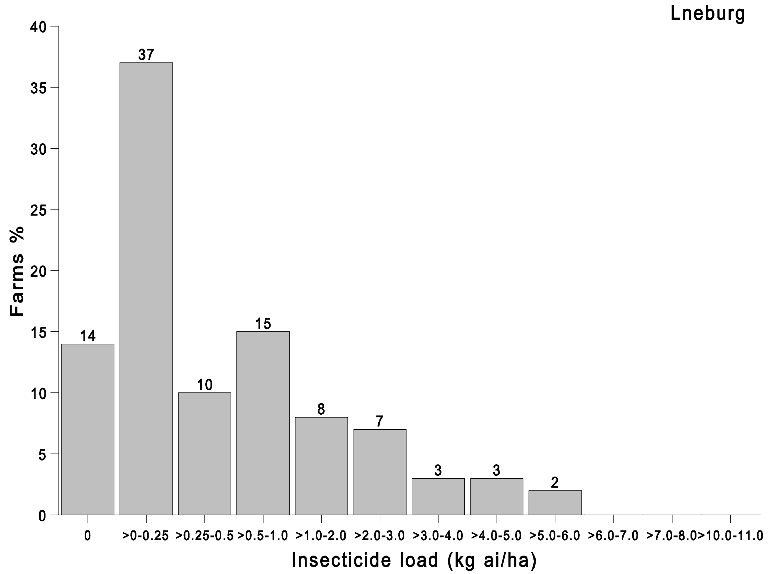
Region	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Number of farms	60	60	60	62
Insecticide load kg ai/ha	Farms %			
0	14	4	7	8
>0 - 0.25	37	30	10	39
>0.25 - 0.5	10	13	20	37
>0.5 - 1.0	15	28	17	10
>1.0 - 2.0	8	17	12	5
>2.0 - 3.0	7	2	5	2
>3.0 - 4.0	3		18	
>4.0 - 5.0	3		2	
>5.0 - 6.0	2		10	
>7.0 - 8.0		2*		
>10.0 - 11.0		2*		
Insecticide load kg ai/ha grown — Average	0.94	1.07	2.47	0.38
Insecticide load kg ai/ha grown — Range	0.001-5.6	(0)0.004-10.5	(0)0.05-5.8	(0)0.006-2.6

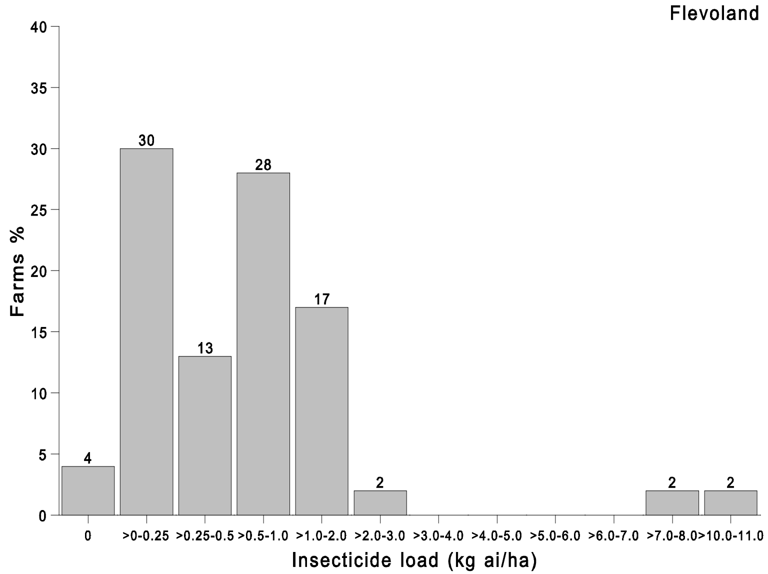
* includes the use of petroleum oil

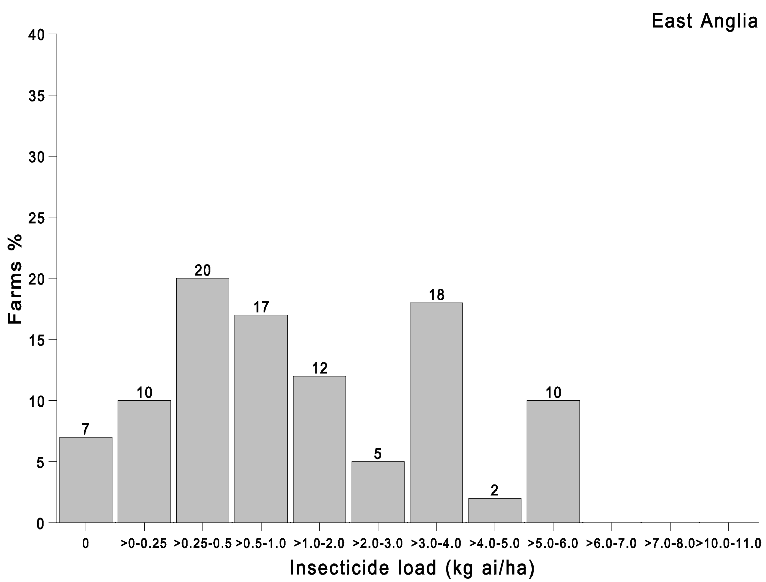
The higher loads in E Anglia were entirely due to the use of the nematicides, aldicarb and oxamyl, both of which were applied at several kilogrammes per hectare. The two high loads in Flevoland were the result of petroleum oil being used on two farms.

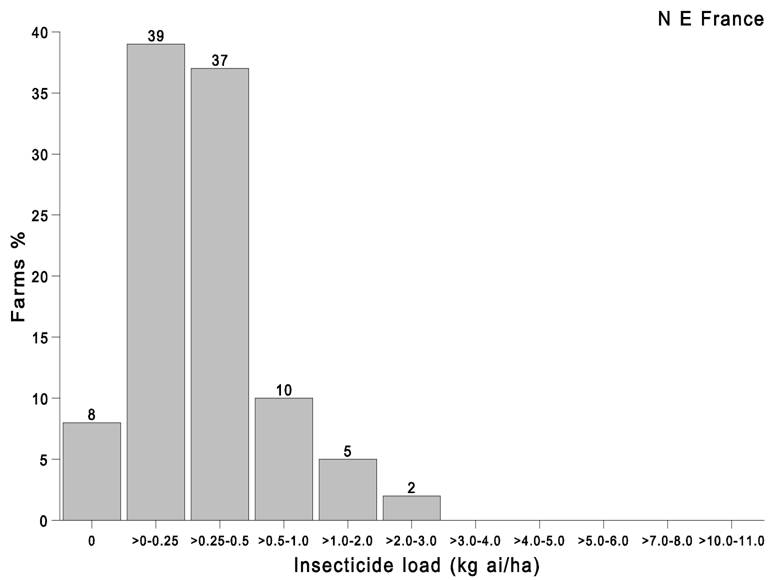
Generally speaking high loads were the result of using organophosphates or pirimicarb, compared with light loads where synthetic pyrethroids were used. Lighter loads were also a consequence of fewer applications used on ware and starch crops.

Chart 7.6 Insecticide load by farm






East Anglia
Farms %
40
35
30
25
20
15
10
5
0
7
10
20
17
12
5
18
2
10
0
>0-0.25
>0.25-0.5
>0.5-1.0
>1.0-2.0
>2.0-3.0
>3.0-4.0
>4.0-5.0
>5.0-6.0
>6.0-7.0
>7.0-8.0
>10.0-11.0
Insecticide load (kg ai/ha)


N E France
Farms %
40
35
30
25
20
15
10
5
0
8
39
37
10
5
2
0
>0-0.25
>0.25-0.5
>0.5-1.0
>1.0-2.0
>2.0-3.0
>3.0-4.0
>4.0-5.0
>5.0-6.0
>7.0-8.0
>10.0-11.0
Insecticide load (kg ai/ha)

7.7 Insecticide use in the study year (1994) compared with an average year

Table 7.7 Insecticide use in the study year (1994) compared with an average year

Region	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Crop area - ha	1,076	897	2,060	862
	Area %			
Greater use	18	20	8	13
The same	72	40	81	81
Less use	4	34	0	0
No answer	6	4	10	3

Usage across all regions in 1994 was the same as usual.

7.8 Factors determining the start of insecticide application

Table 7.8 Factors determining the start of insecticide application

Region	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Number of farms	60	60	60	62
	Farms %			
Date	15	27	5	8
Plant stage	23	35	14	9
Pest stage	18	15	33	4
Pest pressure	43	62	52	56
Warning system	42	28	13	18
Don’t know	0	0	0	5

Aphid pressure was the main factor determining when to start to spray for *Myzus* control. In addition in Lüneburg a warning system was used to a greater extent than elsewhere.

7.9 Opportunities to reduce insecticide/nematicide load

Specialists felt there was little opportunity to reduce insecticide use for aphid control. However, better use of the warning systems might lead to improved timing and reduced use.

Nematicide use has declined dramatically in Lüneburg and Flevoland over the past few years according to specialists but there was concern that there might be an increase required in the medium-term.

8.0 MISCELLANEOUS PESTS AND PESICIDES

8.1 Target pests

The only pests mentioned were slugs which were only reported to be a significant problem by farmers in E Anglia. In the area of the study in Lüneburg, the soils are too sandy although on the more organic soils slugs do occur. There was only one farmer in each of Flevoland and N E France who mentioned slugs though no molluscicides were applied. Specialists in N E France said there had been an increase in the slug *Limax horticae* but it was localised. In E Anglia the situation was as follows:

Table 8.1 Miscellaneous pests in East Anglia (UK)

Pest	Farms (Base: 60)	
	No.	%
Slugs (*Limax budapestensis*)	24	40
Snails (*Helix* spp)	3	5

8.2 Molluscicide use by active ingredient in East Anglia (UK)

20 farmers applied molluscicides to 469 ha (23%). Table 8.2 summarises use by active ingredient.

Table 8.2 Molluscicide use by active ingredient in East Anglia (UK)

Active ingredient	% of crop treated (Base: 2,060 ha)	No. of applications		Cumulative dose g ai/ha of crop receiving that ai		
		Range per farm	Ave per ha treated	min	max	ave
methiocarb	14	1-6	2.9	219	879	389
metaldehyde	8	1-7	3.5	300	2,625	1,317
thiodicarb	0.5	1	1.0	*	*	*

* One respondent - no dose given.

Slugs are a serious problem on certain soils and fields. Certain varieties, including the most widely grown variety in East Anglia, Maris Piper, are prone to damage. Treatments were well targeted and little opportunity is seen for reduction.

9.0 OTHER AGROCHEMICALS

9.1 Background

Chemicals were applied to desiccate potato haulms and suppress regrowth. In 1994 this was practiced on over three quarters of the farms.

9.2 Other agrochemicals active ingredients used

9.2.1 Lüneburg

Table 9.2.1 Other agrochemicals active ingredients used - Lüneburg

	% of crop treated (Base: 1,076 ha)	No. of applications		Cumulative dose g ai/ha of crop receiving that ai		
		Range per farm	Ave per ha treated	min	max	ave
Desiccants:						
diquat	59	1 - 4	1.3	200	2,000	568
Others:						
thiabendazole	<1	4	4.0	4,012	4,012	4,012
bitter salts	<1	1	1.0	-	-	-

9.2.2 Flevoland

Table 9.2.2 Other agrochemicals active ingredients used - Flevoland

Active ingredients	% of crop treated (Base: 897 ha)	No. of applications		Cumulative dose g ai/ha of crop receiving that ai		
		Range per farm	Ave per ha treated	min	max	ave
Desiccants:						
diquat	76	1-3	1.1	300	1,800	643
metoxuron	23	1	1.0	400	1,600	1,078
DNOC	9	1-3	1.2	2,000	6,000	5,193
glufosinate	6	1	1.0	225	450	405
Growth regulator:						
MCPA	0.9	1	1.0	75	75	75

9.2.3 East Anglia

Table 9.2.3 Other agrochemicals active ingredients used - East Anglia

Chemical	% of crop treated (Base: 2,060 ha)	No. of applications		Cumulative dose g ai/ha per ha of farm crop receiving that ai		
		Range per farm	Ave per ha treated	min	max	ave
Sprout suppression:						
maleic hydrazide	1.4	1	1.0	4,000	4,000	4,000
Haulm destruction:						
sulphuric acid	47	1	1.0	*	*	*
glufosinate	16	1-2	1.2	450	900	642
diquat	11	1	1.0	100	3,000	858
paraquat	1	1	1.0	400	400	400
others unidentified	2			-	-	-

* Applied by contractors at an average of 150 l/ha (770g/l) = 115.5 kg ai/ha

9.2.4 N E France

Table 9.2.4 Other agrochemicals active ingredients used - N E France

Active ingredients	% of crop treated (Base: 862 ha)	No. of applications		Cumulative dose g ai/ha of crop receiving that ai		
		Range per farm	Ave per ha treated	min	max	ave
diquat	68	1 - 5	1.8	200	3,000	999
glufosinate	18	1 - 2	1.4	74	750	455

9.2.5 General commentary

Desiccants for haulm destruction were applied to facilitate harvesting and also to minimise the spread of *Phytophthora* from the foliage to the tubers.

Growth regulators were applied in Flevoland and E Anglia to prevent secondary growth and berry formation occurring in what was a very long season.

9.3 Other agrochemical use parameters

9.3.1 Other agrochemical applications

Table 9.3.1 Other agrochemical applications

On farms using other agrochemicals	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
No. of active ingredients used per farm	1	1.4	1.1	1.1
No. of active ingredients used per hectare	1	1.2	1.0	1.4
Number of product applications per hectare	1.2	1.3	1.1	1.3
Proportion of farms spraying parts of their crop	54%	27%	23%	22%
Average load kg ai/ha crop treated	0.57	1.32	0.35*	1.11

* excludes sulphuric acid treatments (Table 9.2.3) made at an average of 150l/ha, 115.5kg ai/ha.

9.4 Other agrochemicals load per farm

Table 9.4 Other agrochemicals load per farm

Region	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Number of farms	60	60	60	62
Load kg ai/ha	Farms %			
0	22	5	20	27
>0 - 0.5	63	22	23	19
>0.5 - 1.0	13	38	25	34
>1.0 - 2.0	2	24	0	18
>2.0 - 3.0		3	0	2
>3.0 - 4.0		5	2	
>4.0 - 5.0		2	2	
Sulphuric acid @ 115 kg ai/ha			33	
Load kg ai/ha grown Average	0.34	1.29	0.27*	0.76
Range	0.05 - 2.0	(0)0.1 - 4.0	(0)0.1 - 4.4	(0)0.07 - 3.0

* excludes sulphuric acid

Variations in dose rate were wide, due to the different requirements of particular farms, fields and varieties as a consequence of varying soil moisture and amounts of vegetation.

The unique use of sulphuric acid, mainly applied by contractors in E Anglia, is of interest. It provides the most rapid destruction of haulms and poses no risk of translocation to tubers.

9.5 Opportunities to reduce 'other agrochemicals' loads

Desiccation is important and specialists say that there is generally little room for reduction in chemical use. Other non-chemical techniques have been tried but result either in damage to the crop (tubers) or too severe an environmental impact (burning).

Cultural techniques, including varietal choice, can minimise the amount of foliage present in late summer but as a priority the avoidance of desiccant use is not high.

10.0 TRENDS IN PESTICIDE USE

10.1 Variation in pesticide use in potatoes over the last five years

Table 10.1 Variation in pesticide use over the last five years

Region	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Crop area - ha	1,076	897	2,060	862
	Area %			
Seed treatment	↓	↓	↑	↑
Increased use	8	11	32	20
The same	70	49	51	54
Less use	17	31	10	0
Don’t know/no answer	5	9	7	23
Herbicides	↓	↓	↑	↑
Increased use	12	5	26	23
The same	70	38	57	74
Less use	18	56	8	2
Don’t know/no answer	0	1	8	0
Fungicides	↑	↑	↑	↑
Increased use	23	54	33	37
The same	72	22	53	60
Less use	5	21	8	0
Don’t know/no answer	0	3	6	3
Soil insecticides	↓	↓	↑	↑
Increased use	7	1	15	19
The same	35	11	70	38
Less use	15	52	8	0
Don’t know/no answer	43	36	6	41
Foliar insecticides	↑	↓	↑	↑
Increased use	25	16	21	20
The same	53	54	65	74
Less use	3	23	8	0
Don’t know/no answer	18	7	6	4
Desiccants	↓	↑	↓	↑
Increased use	5	12	0	15
The same	52	20	77	74
Less use	28	5	10	2
Don’t know/no answer	15	63	13	9

↑↓ arrows show graphically main direction of trend.

In Lüneburg, pesticide use had largely remained the same except for a significant minority of farmers who believed fungicide and foliar insecticide use had increased and desiccants decreased.

Flevoland farmers felt there had been an increase in fungicide use (agreed by specialists) and a reduction in herbicide and soil insecticides and for a minority also in seed treatment use.

The majority of farms in E Anglia felt usage had remained the same but a significant minority felt fungicides, seed treatment, herbicides and foliar insecticides had increased.

N E France farmers held similar views to those in E Anglia, ‘the same’, but some had experienced an increase in fungicides, seed treatment, herbicides and foliar insecticides.

The conclusion across all regions is therefore that a significant minority of farmers (the majority in Flevoland) had experienced an increase in fungicide use. Greatest unanimity within a region concerning changes occurred in Flevoland.

10.2 Plans to maintain or change pesticide use in potatoes

Table 10.2i Plans to maintain or change pesticide use in potatoes

Region	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Number of farms	60	60	60	62
	Farms %			
Will change	7	3	5	18
Possibly change	25	52	23	6
Will not change	62	42	67	76
Don’t know	7	3	8	0

Except in Flevoland the majority would maintain their previous use. Farmers who said they will or may change were then asked in which agrochemical sector and for what reason change would be made.

Table 10.2ii Agrochemical sector and reason identified for change

Reasons	Better control				Availability				Economics				Environment			
	% of farmers who will or may change. Base: L 19, F 33, E 17, N 15															
Region	L	F	E	N	L	F	E	N	L	F	E	N	L	F	E	N
Seed treatment	11	18	53	7	-	6	47	-	21	24	35	-	5	3	29	-
Herbicides	32	33	59	33	5	12	35	-	26	51	29	7	21	27	35	-
Fungicides	37	64	76	20	11	9	35	-	26	27	29	7	5	27	41	-
Soil insecticides	5	3	41	-	5	0	41	-	21	3	29	-	11	0	41	-
Foliar insecticides	26	33	35	-	11	6	41	-	26	33	29	-	5	15	41	-
Growth suppressants	5	6	29	-	-	3	29	-	11	6	24	-	-	3	29	7
Desiccants	5	18	29	-	-	9	35	-	11	27	24	-	-	12	35	-
Molluscicides	-	-	24	-	-	-	29	-	-	-	24	-	-	-	29	-

L = Lüneburg, F = Flevoland, E = E Anglia, N = N E France

Fungicides was the predominant sector for change for reasons of better control. The herbicides sector was the second most important sector for change for reasons of 'better control' in E Anglia and 'economics' in Flevoland. The cost-efficacy of seed treatment ranked highly for the farmers in E Anglia.

Growers in E Anglia also expressed a high level of concern for all sectors regarding 'environment' and availability (distribution).

10.3 Change across all crops in the last five years

Table 10.3 Change across all crops in the last five years

Region	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Number of farms	60	60	60	62
	Farms %			
Increased use	28	28	35	23
The same	33	23	43	37
Less use	38	43	12	6
Don't know/no answer	0	5	10	34

This question reflected usage across all crops on the farm.

Lüneburg and Flevoland demonstrated similar results with most farms having changed in use one way or the other. E Anglia and the N E France showed a greater proportion remaining the same but those that had changed tended to have increased.

In Lüneburg, reduced use in cereals outweighed the increase in potatoes. The majority in Flevoland felt there had been a decrease - a view particularly strongly held by those who applied the lowest loads (less than 5 kg ai/ha). This related to both soil nematicides in potatoes and general usage in sugar beet.

11.0 PESTICIDE/AGROCHEMICAL GENERALITIES

11.1 Sufficiency of product choice

Table 11.1 Farmers indicating satisfaction in the choice of products

Region	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Number of farms	60	60	60	62
	Farms %			
Herbicides	80	87	70	71
Fungicides	85	75	88	92
Insecticides	85	87	87	98
Nematicides	43	35	72	32

Interestingly there was significant dissatisfaction regarding herbicide choice particularly in E Anglia and N E France. Low responses for nematicides were because many farmers were not involved in this sector.

11.2 Attitudes to developments in the pesticide market

Farmers were asked to comment on development in the agrochemicals market with respect to availability of new products, improved efficacy, ease of application and lowered residue levels. They responded good, satisfactory or poor. Table 11.2 shows the results for 'good' and 'satisfactory' combined.

Table 11.2 Farmers expressing satisfaction with agrochemicals developments

Region	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Number of farms	60	60	60	62
	Farms %			
Availability of new products	95	81*	80*	67*
Increasing efficacy	96	90	90	70*
East of application	100	90	88*	63*
Lower residues	73	83	81	53*

In all regions the figures for 'lower residues' were affected by many farmers who 'did not know'. However, those figures asterisked are where the remainder, who did not express satisfaction, actually expressed dissatisfaction.
There appears to be some dissatisfaction with herbicides in terms of avilability of new

product.

Potato growers in N E France appear to show least satisfaction with developments in the market.

11.3 Attitudes to handling restrictions on the label

Table 11.3 Attitudes to handling restrictions on the label

Region	Lüneburg (D)		Flevoland (NL)		E Anglia (UK)		N E France (F)	
Number of farms	60		60		60		62	
	Farms %							
Importance	v imp	imp	v imp	imp	v imp	imp	v imp	imp
On **choice** of products	58	37	37	52	65	28	40	32
On **use** of products	63	33	28	57	65	28	47	37

The least importance accorded to handling restrictions occurred in N E France, followed by farmers in Flevoland.

11.4 Attitudes to environmental restrictions on the label

Table 11.4 Attitudes to environmental restrictions on the label

Region	Lüneburg (D)		Flevoland (NL)		E Anglia (UK)		N E France (F)	
Number of farms	60		60		60		62	
	Farms %							
Importance	v imp	imp	v imp	imp	v imp	imp	v imp	imp
On **choice** of products	60	35	20	50	57	37	40	35
On **use** of products	62	37	12	60	57	37	43	39

Farmers with least interest in environmental restrictions were found in Flevoland. About a quarter said such restrictions were not important in influencing their choice of products. Farmers in N E France were close behind with about a fifth expressing that view. Less than 5% shared these views in Lüneburg and E Anglia. These figures demonstrate a considerable difference in attitude between the regions.

11.5 Sources of information

Farmers were asked to indicate their source of information/advice on agrochemicals, and to attribute a score on a scale 1 - 5, where 5 was most important.

Table 11.5 Information sources

Region	Lüneburg (D)		Flevoland (NL)		E Anglia (UK)		N E France (F)	
Number of farms	60		60		60		62	
	Farms %							
Information source	% farms	score	% farms	score	% farms	score	% farms	score
Cooperative rep	48	3.6	27	4.4	5	4.5	58	3.7
Farming press	73	3.2	62	3.0	20	2.9	44	3.2
Manufacturers rep	12	2.6	3	3.5	12	3.8	15	3.3
Merchant	47	3.2	82	4.2	60	4.5	37	4.0
Neighbour	40	3.1	33	3.1	8	2.3	15	3.7
Plant protect.	61	3.6	37	3.2	30	3.9	39	3.8
advisor	18	3.2	15	4.7	18	4.2	6	2.8
Private consultant	-	-	17	2.2	-	-	52	2.4
Other								

The data are interesting and show large regional differences. While all farmers used several sources, those in E Anglia appear to have used fewest, although scores for quality/reliability were generally high. In Lüneburg, most sources were used but the average scores were generally low.

12.0 PROFITABILITY AND PESTICIDES

12.1 Profitability of potatoes

Table 12.1 Profitability of potatoes

Region	Lüneburg (D)		Flevoland (NL)		E Anglia (UK)		N E France (F)	
Number of farms	60		60		60		62	
	Farms %							
	Study year 1994	5 years ago	Study year 1994	5 years ago	Study year 1994	5 year s ago	Study year 1994	5 years ago
Very good	30	5	47	-	60	2	13	5
Good	28	32	40	25	27	25	32	19
Satisfactory	33	42	7	35	7	38	21	39
Poor	8	13	3	23	-	23	31	13
Very poor	0	-	2	15	-	5	3	-
Don't know/no answer	-	8	2	2	7	7	-	24

In all regions profitability over the five years prior to the study year had improved markedly.

The same question was asked with regard to the farm as a whole and for all regions except N E France a similar although less marked trend was apparent. In N E France 1994 had slighly more farmers expressing a positive view for the farm as a whole than for potatoes, although it was still a better year than five years before.

12.2 Returns and costs of production

Models of returns and costs of production are presented in the individual region reports. The details and terms used vary considerably and are not directly comparable.

Table 12.2 Comparison of agrochemical costs - ware

Region	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Agrochemical costs - as % of variable costs	18 9.4	34* 11	24 8.4	33* 19

- as % of gross income				

* includes some fixed costs.

The figures as a proportion of variable costs can not really be compared as regions differed so markedly in the costs build up. The best comparison is agrochemical costs as a proportion of gross income where most regions were similar except in N E France where their proportion was about twice the other regions.

12.3 Influence of profitability on pesticide usage

Farmers were asked to predict their reaction in terms of three aspects of pesticide usage where good or poor potato profitability was anticipated.

Table 12.3 Influence of profitability on pesticide usage

Region	Lüneburg (D)		Flevoland (NL)		E Anglia (UK)		N E France (F)	
Number of farms	60		60		60		62	
	Farms %							
Anticipated profit	good	poor	good	poor	good	poor	good	poor
Price of product								
Use more expensive product	12	2	13	2	5	5	10	5
Use less expensive product	7	15	5	12	3	15	3	11
No influence	78	75	78	82	80	68	84	79
Don’t know/no answer	3	8	3	3	12	12	3	5
Dose rate								
Reduce dose	12	13	5	10	3	5	2	2
Increase dose	3	2	3	0	2	7	0	6
No influence	83	77	88	87	85	77	94	87
Don’t know/no answer	2	8	3	3	10	13	5	5
Age of product								
Use older product	3	7	0	3	2	5	5	10
Use newer product	28	12	10	3	17	12	13	10
No influence	65	70	87	92	72	70	79	76
Don’t know/no answer	3	12	3	3	10	13	3	5

The great majority of farmers would not be influenced by anticipated profit.

12.4 Effect of pesticides on profitability

Farmers were asked to identify the agrochemical sectors which they thought had the greatest and least effect on the profitability of the crop.

Table 12.4 Effect of pesticides on profitability

Region	Lüneburg (D)		Flevoland (NL)		E Anglia (UK)		N E France (F)	
Number of farms	60		60		60		62	
	Farms %							
Effect on profit	great	least	great	least	great	least	great	least
Sector								
Nematicides	2	35	2	5	18	5	-	16
Herbicides	5	2	2	45	2	14	13	10
Fungicides	65	-	72	3	42	-	84	-
Insecticides	18	7	8	22	13	5	2	18
PGRs	2	20	2	-	5	23	-	5
Desiccants	3	3	-	3	2	17	-	29
Seed treatment	5	30	-	5	5	14	-	8
Don't know	-	3	-	8	13	22	2	11

Fungicides were felt by a majority of farmers to have the greatest effect on profit in all regions. A minority of farmers in each region separately felt that one or other of the sectors had least or most effect. In Flevoland a substantial proportion of farmers identified herbicides as providing the least effect on profit.

12.5 Possibility to reduce pesticide use without reducing profitability

Table 12.5 Possibility to reduce pesticide use without reducing profitability

Region	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Number of farms	60	60	60	62
	Farms %			
Yes	13	18	2	5
Perhaps	12	17	7	8
No	72	62	85	87
Don't know	3	3	7	-

Farmers were asked if they felt it was possible to reduce pesticide use without reducing profitability. The great majority (particularly of those answering) felt that this was not possible. However, there were small numbers in Lüneburg and Flevoland who felt it was or perhaps was possible.

Those answering 'yes' or 'perhaps' were asked in which sector this reduction might be possible.

In Flevoland, the sectors fungicides and herbicides were most commonly put forward. In Lüneburg, farmers suggested herbicides and seed treatments.

Specialists generally were unsure whether farmers would in practice risk reducing pesticide inputs.

13.0 ALTERNATIVE CROP PROTECTION SYSTEMS

13.1 Awareness of alternative systems

Farmers were asked if they were aware of any alternative system of crop protection in potatoes that might be equally profitable to conventional systems. No prompts were given to them. Those not mentioning a system were then asked specifically if they were aware of Integrated Crop Management (ICM), Integrated Pest Management (IPM) or Organic Production (OP).

Definitions were given to farmers for the different regimes (Appendix I). However, local terms and understandings played a role in these answers and the results need to be viewed with care.

Table 13.1 Awareness of alternative systems that might be equally profitable

Region	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Number of farms	60	60	60	62
Unprompted	Farms %			
ICM	32	27	47	66
IPM	27	2	47	10
OP	20	22	52	2
None	57	53	25	15
Don't know/no answer	2	0	10	0
Prompted	Awareness amongst farmers who had not mentioned the system - % of total sample			
ICM	30	67	17	15
IPM	24	5	12	33
OP	26	71	30	65

Unprompted awareness was generally highest for ICM although OP was well recognised in E Anglia. (It was questionable whether farmers were thinking in profitability terms here.)

The highest unprompted responses came from N E France for ICM. The term used was 'agriculture raisonée' which has a very broad interpretation in France.

Following prompting, Flevoland farmers appeared to have the best awareness but specifically of ICM and OP, and many in E Anglia and N E France mentioned OP.

IPM was the least supported of the alternative systems.

13.2 Interest in developing alternative systems

Farmers were asked for their level of interest in developing the various alternative systems mentioned:

Table 13.2 Interest in developing alternative systems

Region	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Number of farms	60	60	60	62
	Farms %			
IPM	43	15	22	23
ICM	40	55	25	76
OP	20	13	13	8

Considerable interest was shown in developing ICM in all regions except E Anglia. The support ICM received in N E France should be set against the remark made in Section 13.1 concerning definition.

Specialists in all regions stressed that potato production was a high risk enterprise and farmers were very risk-averse.

14.0 ENVIRONMENTAL ISSUES

14.1 Farms in restricted areas

The Lüneburg region had the most farms in restricted areas. Nineteen farms (27%) claimed to be in restricted water catchment areas and one (2%) in an environmentally sensitive area. Ten farmers (17%) indicated their restriction posed difficulties in selecting pesticides.

Among the other regions only one farmer each in Flevoland and N E France were in restricted areas but neither indicated difficulty with choice of pesticides.

14.2 Considerations influencing choice of pesticides

Farmers were asked to choose from a list of suggested environmental considerations, those they took into account when choosing pesticides.

Table 14.2 Environmental considerations influencing choice of pesticides

Region	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Number of farms	60	60	60	62
	Farms %			
Ground water	73	13	28	8
Surface water	63	17	28	8
Soil protection	70	13	37	8
Flora	58	15	37	18
Fauna	70	27	40	29
Produce quality	70	12	80	11
None of these	10	67	17	60
Don’t know	8	0	2	5

Farmers in Lüneburg appeared to have the strongest environmental concerns when choosing pesticides, particularly about ground water. The other three regions had far lower levels of interest, E Anglia being the highest of the three. Specialists in these three regions were not surprised by the responses. They felt that the farmers’ main priority was to produce a top quality product free of residues and that governmental departments would vet the products that came on the market and make suitable environmental judgements.

APPENDIX I

DEFINITIONS AND CAVEAT

BACKGROUND

1 Ideally this study should have been conducted on an individual field basis. Economics and practical considerations however, precluded this. Farmers were therefore asked abou their treatments for the entire crop over their whole farm.

2 Typically fields were treated several times for any one pesticide sector (fungicides, insecticides, particularly). Occasionally on certain farms some fields were treated more times than others - though review of the data shows this to be limited.

3 Applications were made with agrochemical products containing one or more active ingredients. While data was collected from the farms at product level the results were required at active ingredient level for calculation of chemical load and to facilitate cross-country comparisons.

4 Presentation of the data simply as kg ai/ha has been used for simplification. This of course hides the great variation in inherent activity of different chemicals. Attempts are made to cover for this in the text.

DEFINITIONS

Regional level:

Base area treated (for a chemical sector)

That part of the crop which receives any treatment at all for the chemical sector in question. This is represented by Crop Area - Untreated Area = Base Area Treated.

Farm level:

Proportion of crop treated

This is defined as “That portion of crop receiving the active ingredient at least once”. Where a series of treatments, of differing areas, had been made on a farm then the assumption has been made that the treatments were made sequentially on the largest area receiving that active ingredient. In practice the largest area was nearly always the complete area of crop on that farm so this is usually correct.

Average number of applications

For a given active ingredient this was calculated as the average number of times an active ingredient was applied on a given farm. Where an active ingredient is applied on different areas then the average number of applications/ha is calculated for the whole farm. This can occasionally underestimate the number of applications on a given field.

Cumulative dose

This is the total volume of an active ingredient used on a farm divided by the area of study crop grown on that farm. In situations where a chemical was not always used on the whole farm this has the effect of underestimating the dose - however as already indicated these situations were limited.

Product applications

Products may be applied alone or in tank mixes. The latter were not catered for in the questionnaire. The term product applications has therefore been introduced meaning products x applications. As a consequence this can exaggerate the number of applications made on a farm where considerable use was made of tank mixes (possibly mixes of two products at low dose).

ALTERNATIVE CROP PROTECTION

Integrated Pest Management (IPM)

The objective here is control of pests (weeds, disease, insects etc) using a mix of the less aggressive chemicals available and the stimulation of the crop or beneficial organisms to control the pest. Such methods may involve choice of resistant varieties, modifying rotations, use of biological pesticides etc.

Integrated Crop Management (ICM)

The objective here is to manage the growing of crops in such a way as to reduce any negative effects on the environment, typically ground water. As such the same methods may be used as with IPM, but taken further to include fertilisers and any other ‘contaminating’ inputs and cultural methods.

Organic Production (OP)

The objective here is to produce crops in which chemical pest control or fertilisers have played no part.

APPENDIX II

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NETHERLANDS

The group discussions and field survey were carried out by Landell Mills.

CONTACTS

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Mr H Campmans	IKC AGV (Information and Knowledge Centre for Arable Farming and Field Production of Vegetables) Edelhertweg 1, P O Box 369 8200 Lelystad Officer responsible for advising on technical implementation of government policy with regard to Integrated Crop Management and MJPG (policy for reduction of fertiliser and crop protection inputs)
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REPORT FOR THE COMMISSION OF EUROPEAN COMMUNITIES
DUTCH MINISTRY FOR THE ENVIRONMENT
DUTCH MINISTRY OF AGRICULTURE

REGIONAL ANALYSIS OF USE PATTERNS OF PLANT PROTECTION PRODUCTS IN SIX EU COUNTRIES

PES - A/PHASE 2

A COMPARISON OF AGROCHEMICAL USE ON APPLES IN THREE REGIONS IN EUROPE

Provence/Languedoc/Rhône-Alps, France
Trentino, Italy
Lerida, Spain

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APPLES - CROSS REGIONAL REVIEW

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APPLES - CROSS REGIONAL REVIEW

SUMMARY

General

This study was conducted in mid-1995 on practices employed in 1994. Three regions were reviewed: Provence/Languedoc/Rhône-Alps (France), Trentino (Italy) and Lerida (Spain).

All regions were dominated by varieties of the 'Golden' group.

Trentino followed a well developed ICM/IPM system.

Chemical loads

The average volume of active ingredients applied per hectare of crop grown ranged between:

		Average	(Range)
- Provence/Languedoc/Rhône-Alps	:	41.4 kg ai/ha	(0 - 9.6 kg ai/ha)
- Trentino	:	33.7 kg ai/ha	(0 - 2.5 kg ai/ha)
- Lerida	:	27.4 ka ai/ha	(0.1 - 7.2 kg ai/ha)

Though fungicides dominated, these were made up of many varying chemicals of differing intrinsic activity.

Weed control and herbicides

Weed species varied in degree by region but among the target species mentioned by farmers there were always a number of the more difficult to control perennial species.

Weed control was generally practised along the tree rows leaving the portion between the rows to grass or vegetation that was mowed.

Herbicide loads were modest in all regions with contact acting chemicals being used to the greatest degree. The heaviest loads were found in Provence/Languedoc/Rhône-Alps due to greater use of soil-acting residual herbicides. Targeted spraying, where farmers treated parts of their orchards with a given product, was most used in Lerida (22%) followed by Provence/Languedoc/Rhône-Alps (14%). Trentino practised this least (4%).

Diseases and fungicides

Venturia inaequalis (apple scab) was a major disease in all regions and seen as most important in Trentino. *Podosphaera leucotricha* (powdery mildew) was also present throughout but more prevalent in Lerida.

Fungicide loads dominated the overall chemical load and were highest in Provence/Languedoc/Rhône-Alps followed by Trentino and lowest in Lerida. These loads tended to be related to the high dose rate contact fungicides for *Venturia* control and sulphur for *Podosphaera* treatments. In Lerida where the latter disease is of greatest importance there was also widespread use of lower dose systemic broad spectrum products which include *Podosphaera* in their spectra. Resistance management limits the number of applications that can be made with these chemicals.

Fungicide label dose rates are given in concentration of spray liquid (grams per 100 litres etc), hence variation in volumes applied per hectare lead to variation in chemical load per hectare. Average volumes of spray liquid used varied by a factor of 10 between highest and lowest users within each region with consequential effect on dose rate per hectare. Most applications were at 1,000 l/ha in the French region and Lerida, and at 1,500 l/ha in Trentino.

Farmers used a number of parameters to determine when to start their spray programmes. An official warning system is available in all regions, particularly for *Venturia* treatments. This was most used by the farmers in Trentino.

Targeted spraying of parts of the orchards was most practised in Provence/Languedoc/Rhône-Alps (16%) and Lerida (14%). In Trentino this was only used on 3% of the farms.

Insects and insecticides

A wide range of target pests was mentioned by farmers. *Carpocapsa pomonella* (codling moth) and various aphid species were widely mentioned in all regions. *Quadraspidiotus perniciosus* (San Jose scale) was mentioned in all regions but was of major significance in Lerida. Mites were seen as important, particularly in Provence/Languedoc/Rhône-Alps and Lerida. They were of lesser consequence in Trentino where ICM/IPM techniques have reduced their prevalence.

A number of other insect pests including *Ceratitis capitata* (Mediterranean fruit fly) were more prevalent in Lerida.

Insecticide loads were lowest in Trentino and highest in Lerida, reflecting the ICM/IPM technique in Trentino but also the broader pest pressure in Lerida and the widespread use of petroleum oils.

Application volumes ranged in a similar manner to fungicides.

Among the factors used for determining the start of spraying, the official warning systems were followed by a majority in Lerida and Trentino. They had less of a following in Provence/Languedoc/Rhône-Alps where a substantial proportion of farmers, particularly for *Carpocapsa*, preferred to start spraying by a particular date regardless of whether the pest had been registered or not.

Targeted spraying of portions of the crop was practised most in Lerida (14%) followed by Trentino (9%) and Provence/Languedoc/Rhône-Alps (7%).

Miscellaneous pests and pesticides

Only a few farmers mentioned the use of rodenticides though this was felt to be understated in Trentino.

Other agrochemicals - plant growth regulators (PGRs)

PGRs were mostly used for fruit thinning and reduction of russetting of Golden Delicious and related varieties. Chemical loads were very low but growers in Lerida and Trentino made greatest use of them.

Trends in pesticide use

Trends in pesticide use over the five years prior to the study year (1994) showed use having largely remained the same in Provence/Languedoc/Rhône-Alps with a reduction in Trentino and Lerida.

General satisfaction was indicated by farmers on the choice of products available to them and their developments. However, farmers anticipating no change in their immediate future use of chemicals were in the majority in all countries. In Lerida this was less marked.

Farmers in all regions indicated that label restrictions on handling and environmental aspects were important, both in choice and in use of products. On balance, environmental aspects rated slightly lower than handling restrictions.

Profitability and pesticides

In Provence/Languedoc/Rhône-Alps and Lerida, substantially fewer farmers felt that their apple crops were profitable in 1994 compared with five years before. The reverse situation was experienced in Lerida.

The majority of farmers felt that anticipated profitability of the crop would not affect their choice of pesticides.

The agrochemical sector providing the greatest effect on profitability was seen as fungicides,

followed by insecticides in the French region and Trentino, while this was insecticides in Lerida. Herbicides were identified as providing the least effect in all regions.

Alternative crop protection systems

Farmers appeared generally well aware of the alternative crop protection systems though it is suggested that there may have been confusion in understanding the difference between integrated crop management and integrated pest management. A high level of interest was indicated in the responses to developing the techniques on their own farms which, in the case of Lerida in particular, conflicted with specialist experience.

Environmental considerations

Environmental considerations affected the choice of agrochemicals most in Trentino, reflecting the local protocol. These aspects were also considered in the other regions but less than a quarter of the respondents mentioned any one particular factor that they took into consideration.

Conclusion

The regions varied widely in their use of agrochemicals, from the ICM/IPM Trentino protocol to the heavier users of chemicals in Provence/Languedoc/Rhône-Alps.

Apples require considerable protection against diseases, insects and mites but opportunities are seen for some reduction in agrochemical use.

In all chemical sectors some farmers are taking a targeted approach to applying some of their treatments (part-crop spraying) and it is suggested that this might be extended.

Herbicide use has moved away from soil-acting chemicals to a large extent but this could probably be increased.

In disease and insect control wider use of the ICM/IPM systems as practised in Trentino could have beneficial effects elsewhere. In this context the increased use of warning systems would be of benefit. Optimisation of application volumes would also seem to be an area where unnecessary use might be reduced.

1.0 THE REGIONS, METHODOLOGY AND SAMPLES

1.1 The regions

Three regions were selected as being intensive producers of apples. Those chosen were:

France - Provence/Languedoc/Rhône-Alps
Italy - Trentino
Spain - Lerida

The Trentino region has practised widespread use of an integrated crop/pest management system for a number of years - the so-called Trentino protocol.

1.2 Methodology

The format followed consisted of two farmer group discussions held in Trentino and Lerida. These were used to determine broad parameters followed by farmer surveys in the three regions using a questionnaire of approximately one hour in length. Fieldwork was conducted in mid-1995 and the questions related to the use of agrochemicals in the previous season (1994). Results, having been obtained and partially analysed, were used as a basis for interviews with local specialists in the regions to discuss the findings and broaden the view.

1.3 The survey samples

The objective of the farmer survey was not only to ascertain current agrochemical practices in the region but also to identify differences in agronomic practice between farms.

Patterns of crop distribution by farm in all regions showed the typical pattern of the largest area of crops concentrated in the hands of relatively few larger units.

When designing the sample prior to commencement of research, the causal factors of any variation are not fully known. It is often found, however, that one of the more common bases for variation in practice is that of enterprise size.

Budgetary restraint limited the sample size to around 60 in each region. It was decided that in order to expose variation, a sample with as far as practically possible adequate numbers of farms across the crop size distribution profile should be represented.

The statistics for the regions are presented in the individual regional reviews but are different in make-up and are not easily compared. The samples resulting were the following:

Table 1.3 Farm survey samples

Apple area per farm - ha	Provence/ Languedoc/ Rhône-Alps (France)		Trentino (Italy)		Lerida (Spain)	
	Farms %	Area %	Farms %	Area %	Farms %	Area %
0.3 < 1	-	-	10	1	-	-
1 < 2	-	-	27	9	-	-
1 < 5	-	-	-	-	38	9
2 < 5	27	6	42	32	-	-
5 < 10	32	15	12	20	23	15
10+	-	-	10	38	-	-
10 < 20	21	22	-	-	27	33
20+	19	57	-	-	12	44
Total No. ha	62	862	60	213	60	676
Average - ha	-	13.9	-	3.6	-	11.3
Regional average - ha	-	4.3	-	1.7	-	2.1

It will be noted that the average apple holding in the samples was larger than for the regions. This is a consequence of spreading the sample relatively evenly across the farm holding profile based on farm numbers.

2.0 GENERAL RESEARCH FINDINGS

2.1 Farming demographics

2.1.1 Land tenure

Table 2.1.1 Land tenure

Region	Provence/ Languedoc/ Rhône-Alps (F)	Trentino (I)	Lerida (E)
Number of farms Total apple area - ha	62 862	60 213	60 676
Tenure category			
>60% owned 40-60% owned <40% owned	73 11 16	83 8 9	73 13 13

The large majority of farmers in all three regions owned most of their land.

2.1.2 Occupational status

Table 2.1.2 Occupational status

Region	Provence/ Languedoc/ Rhône-Alps (F)	Trentino (I)	Lerida (E)
Number of farms	62	60	60
Occupational status	Farms %		
Full-time Part-time No reply	95 3 2	73 22 5	90 8 2

Most farmers were employed full-time on their farms. Local specialists indicated that in the Lerida region as a whole there was a larger proportion of part-time apple growers than in the sample - approximately 30%.

2.1.3 Farm enterprises

Table 2.1.3 Farm enterprises

Region	Provence/ Languedoc/ Rhône-Alps (F)	Trentino (I)	Lerida (E)
Number of farms	62	60	60
	Farms %		
Crops			
Cereals	27	-	58
Maize	6	2	33
Sorghum	8	-	-
Sugar Beet	-	-	-
Oilseed Rape	8	-	-
Sunflowers	13	-	5
Peas	-	-	-
Field Vegetables	18	2	7
Other Top Fruit	94	57	98
Soft Fruit	6	2	-
Temporary Grass	-	-	8
Permanent Grass	-	5	13
Animals			
Dairy	-	-	-
Beef	-	2	-
Veal	-	2	2
Pigs	-	-	7
Poultry	-	2	3
Other			
Tourism	2	-	-

For most of the farms, crops in the 'Other Top Fruit' category were the most widely grown. Arable crops such as cereals and maize were grown by many farmers in the French and Spanish region, but were unimportant in Trentino, Italy. Livestock were of little importance in all three regions.

2.2 Crop agronomy

2.2.1 Varieties

Table 2.2.1 Main varieties

Region	Provence/ Languedoc/ Rhône-Alps (F)		Trentino (I)		Lerida (E)	
	Farms 62	Area 862 ha	Farms 60	Area 213 ha	Farms 60	Area 676 ha
Variety	%					
Golden group						
Golden Delicious	92	57	98	77	59	6
Golden Supreme	-	-	-	-	24	47
Golden Smoothee	-	-	-	-	24	2
Golden	-	-	-	-	14	3
Gala group						
Gala	29	7	13	2	-	-
Royal Gala	15	1	-	-	19	2
Mundial Gala	-	-	-	-	10	1
Red group						
Top Red	-	-	-	-	41	8
Early Red One	-	-	-	-	24	3
Red Chief	-	-	-	-	20	3
Granny Smith	60	17	30	3	25	3
Starking group	19	1	69	7	19	1
Ozargold	13	1	-	-	-	-
Elstar	8	1	-	-	-	-
Fuji	6	1	-	-	-	-
Jonagold	6	1	-	-	-	-
Morgenduff	-	-	25	4	-	-

Golden Delicious and related varieties were by far the most widely grown apples in all three regions. They have become dominant due to handling, storage and disease resistance properties, although this latter property has been less strong in recent years. Several other varieties such as Granny Smith, Gala group and Starking group were grown on many farms, but do not represent a very large proportion of the crop. Gala types have the benefit of early maturation which enables farmers to commence picking sooner. This may also mean fewer pesticide sprays per season as less protection time is needed.

2.2.2 Soil types

Table 2.2.2 Soil types - main constituents

Region	Provence/ Languedoc/ Rhône-Alps (F)	Trentino (I)	Lerida (E)
Crop areas (ha)	862	213	676
	Area %		
Sand	31	53	3
Silt	51	7	8
Clay	27	19	9
Organic	7	10	10
Other	1	11	42
No Reply	-	-	30

Farmers had some difficulty in classifying their soils into such very broad categories. There was believed to be little direct influence of soil type on pesticide use for this perennial crop.

2.2.3 Irrigation

In Provence/Languedoc/Rhône-Alps most farms are irrigated to achieve good cropping, and where this water is applied overhead, it can increase the likelihood of some diseases occurring, particularly *Venturia inaequalis* (apple scab). In the other two regions most apples are grown under irrigated conditions. No observations were made as to the increased likelihood of disease as a consequence.

2.2.4 Fertiliser use

Table 2.2.4 Fertiliser use by region

Region			Provence/ Languedoc/ Rhône-Alps (F)	Trentino (I)	Lerida (E)
Crop area (ha)			862	213	676
Constituent		Specification kg/ka	Area %		
Nitrogen	High	>101	21	0	65
	Medium	51-100	57	13	19
	Low	1-50	15	28	6
	Nil	0	0	59	0
	No reply		6	0	9
Phosphorus	High	>51	32	0	58
	Medium	26-50	47	11	15
	Low	1-25	8	35	13
	Nil	0	5	55	3
	No reply		8	0	12
Potassium	High	>61	48	11	62
	Medium	31-60	30	25	16
	Low	1-30	9	14	11
	Nil	0	2	50	1
	No reply		11	0	12

Clearly Lerida (E) was the highest user of fertilisers and Trentino (I) the lowest. In recent years quantities have been reduced as apple growers have become more aware of the need to achieve the correct balance of nutrients in the crop in order to maximise yield, fruit quality and storage characteristics. In addition to N P K some farmers applied magnesium and calcium if these elements were insufficiently available from the soil.

Excess nitrogen and insufficient calcium can lead to the physiological disorder ‘bitter pit’, whereas insufficient nitrogen can lead to poor leaf development.

2.2.5 Yields

Apple yields are not reported on as they are so variable dependant on variety, training methods, age of orchard etc.

2.3 Commercial issues

2.3.1 Destination of produce by region

Region	Provence/ Languedoc/ Rhône-Alps (F)	Trentino (I)	Lerida (E)
Number of farms	62	60	60
Destination	Farms %		
Wholesaler/coop	76	93	93
Direct to consumer	11	7	12
Others undefined	13	0	2

Distribution of produce was similar for all three regions.

2.3.2 Contracts agreed in advance

There was some confusion among farmers in answering this question, particularly in Lerida where 96% of famers said they did or sometimes did agree contracts in advance. In Trentino and Provence/Languedoc/Rhône-Alps the corresponding figures were 10% and 8%. In discussion with local experts, it seems formal supply contracts were rarely set ahead of harvest in any of the regions, but there was often an understanding with local cooperatives or wholesalers that produce would be accepted from the farm at harvest.

2.3.2.1 Contracts restricting pesticides

Only three farmers in each region indicated that there were pesticide restrictions associated with supply contracts. Some of these contracts were thought by specialists to be for supply of apples for baby foods. Here specific residue tolerances were believed to apply.

2.3.2.2 Pesticides affected by restrictions

No specific pesticides were mentioned by farmers, but restrictions included all product sectors.

3.0 PESTICIDE USE

3.1 Summary of pesticide use

Regional totals and percentages by product type are shown in Table 3.1. In all regions the fungicides contributed the largest use, with insecticides/acaricides second largest. Nearly all of the crop area was treated with these product types in all three regions.

3.1.1 Herbicides

The pattern of use of these products was similar in all three regions. Treatment was predominantly along the row of the trees with the inter-row areas normally being untreated and maintained by regular mowing.

A slightly lower proportion of the orchards was treated with herbicides than with insecticides or fungicides, particularly in Trentino. Herbicide loading per hectare was substantially less than for fungicides and insecticides.

3.1.2 Fungicides

These products represented the largest volume of pesticides for all three regions. Disease control normally requires a season-long programme of sprays predominantly with protectant fungicides which have high recommended rates. The two most important diseases were *Venturia inaequalis* (scab) and *Podosphaera leucotricha* (mildew). The former was less important in Lerida than the other two regions as the climate was drier, hence the reduced fungicide load in Lerida. Conversely, *Podosphaera* was deemed to be more important in Lerida.

3.1.3 Insecticides

This category also included specific acaricides. This group of products contributed the second highest weight of pesticides per hectare for Provence Languedoc/Rhône-Alps. If spray oils are included with insecticides/acaricides then the ranking position for Lerida and Trentino would also be second. The key target pests were *Carpocapsa pomonella* (codling moth) and aphids. In Lerida, San Jose Scale was also very important. Good insect control is essential if fruit quality is to be achieved. Thus sprays are timed to coincide with pest atttacks. There were sustantial differences beween regions in the main types of product used. This will be discussed more fully in Section 3.5.

3.1.4 Spray oils

Although the main use for spray oils is for their insecticide/acaricide activity, they can also reduce some fungal attacks. Some oils are also used as adjuvants to enhance herbicide activity.

Lerida was the largest user of petroleum oil sprays, usually in combination with parathion or DNOC insecticides. These sprays were usually applied in the dormant season as they reduce the level of overwintering pests. They are predominantly used for insect/mite control, but there is some fungal activity as well. Volumes of oil are necessarily high to achieve the required effects. However, many farmers no longer use petroleum oil based products in their programmes.

3.1.5 Plant growth regulants (PGRs)

PGRs are used mainly to improve fruit skin finish, and to optimise fruit size. A higher proportion of farms used PGRs in Lerida and Trentino than in Provence/Languedoc/Rhône-Alps. Two main types of products were used, plant hormones and fruit finish products which contain sulphur. There was no clear pattern of use, although use of products to promote good skin finish is particularly important in Golden Delicious and related varieties.

3.1.6 Other pesticides

Minor use of rodenticides use was recorded on three farms in two regions. Provence/Languedoc/Rhône-Alps and Trentino.

Table 3.1 Summary of chemical use by region

Region	Provence/Languedoc/ Rhône-Alps (F)			Trentino (I)			Lerida (E)		
Area grown (ha)	862			213			676		
Chemical sector	Proportion of crop treated %	Average volume of active ingredient kg/ha		Proportion of crop treated %	Average volume of active ingredient kg/ha		Proportion of crop treated %	Average volume of active ingredient kg/ha	
		Crop treated	Crop grown		Crop treated	Crop grown		Crop treated	Crop grown
Fungicides	98	33.20	32.57	99	27.70	27.56	96①	11.53	11.07
Herbicides	90	2.30	2.06	82	0.99	0.81	98	1.46	1.43
Insecticides/Acaricides	98	4.46	4.37	98	1.86	1.83	99	6.36	6.28
Plant growth regulators	18	8.10	1.49	64	0.31	0.20	75	0.52	0.39
Other pesticides	5	1.92	0.10	0.5	4.00	0.02	0	0	0
Spray oils	14	6.07	0.85	15	22.07	3.31	36	22.56	8.10
Total	99	*	41.44	100	*	33.73	100		27.35

* Treatments were not necessary applied to the same area of crop in each chemical sector so no total is provided in this column.

① Identified use, actual use believed close to 100%.

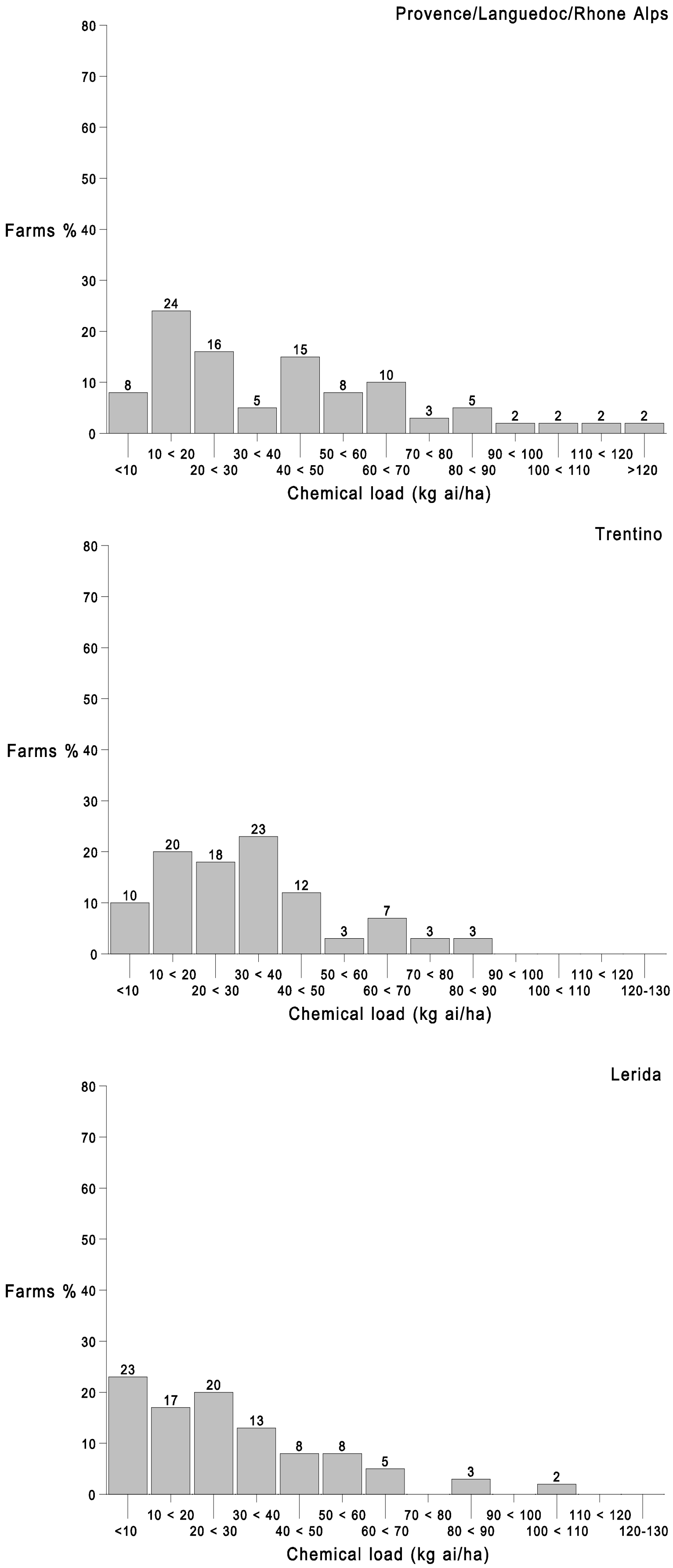
3.2 Variations in chemical load between farms and regions

Table 3.2 Variations in chemical load between farms and regions

Region	Provence/ Languedoc/ Rhône-Alps (F)	Trentino (I)	Lerida (E)
Number of farms	62	60	60
Chemical load kg ai/ha	Farms %		
<10	8	10	23
10<20	24	20	17
20<30	16	18	20
30<40	5	23	13
40<50	15	12	8
50<60	8	3	8
60<70	10	7	5
70<80	3	3	-
80<90	5	3	3
90<100	2	-	-
100<110	2	-	2
110<120	2	-	-
>120	2	-	-
Range kg ai/ha of crop grown	1.7 - 146.7	0.6 - 83.4	1.4 - 109.6

A large majority of farms in each region were using less than 50 kg ai/ha. The few farms in the higher categories correspond to the greater use of spray oils and/or contact fungicides.

Figure 3.2 Variations in chemical load between farms and regions



4.0 WEEDS AND WEED CONTROL

4.1 Target weeds

Table 4.1 Main target weeds by region

Region	Provence/ Languedoc/ Rhône-Alps (F)	Trentino (I)	Lerida (E)
Number of farms	62	60	60
Target weeds	Farms %		
Dicotyledons			
Amaranthus spp	19	28	45
Artemisia spp	-	34	-
Cardaria draba	-	-	5
Chenopodium spp	13	21	5
*Cirsium arvensis**	55	62	-
Convolvulus spp*	76	-	7
Equisetum spp*	16	13	-
Malva spp	24	20	33
Polygonum aviculare	-	-	52
Portulaca oleracea	-	-	7
Rubia spp*	10	-	-
Rubus spp*	18	-	-
Rumex spp*	-	25	40
*Urtica dioica**	-	23	-
Monocotyledons			
*Agropyron repens**	68	-	-
*Cynodon dactylon**	5	67	73
Digitaria spp	10	-	5
Echinochloa crus-galli	19	-	-
Lolium spp*	44	-	-
Poa annua	-	11	-
*Sorghum halepense**	32	10	90

* = perennial

Most of these weeds are difficult to control and many are perennials. There were some similarities between the regions, but in general the dominant species varied.

Only *Amaranthus, Chenopodium, Malva* spp and *Sorghum halepense* had significant presence across all three regions.

4.2 Weeds claimed to be resistant to herbicides

Although some farmers cited a number of species which they believed were resistant to certain herbicides, this was refuted by the local specialists in this crop. The likely reasons for instances of poor weed control were incorrect timing, insufficient frequency of treatment, or use of reduced dose rates. Many of the weeds mentioned are known to be difficult to control. Some are perennials with underground roots or rhizomes.

4.3 Levels of weed control sought

Table 4.3 Levels of weed control sought

Region	Provence/ Languedoc/ Rhône-Alps (F)	Trentino (I)	Lerida (E)
Number of farms	62	60	60
Control sought	Farms %		
<70%	6	3	12
71-80%	16	17	12
81-90%	15	33	8
91-100%	52	43	63
Don't know	11	3	5

Responses were similar across regions, with more farmers seeking the highest level of control than any other category. Most farmers would expect broad-leaved weed control to be better than grasses.

4.4 Herbicide use by active ingredient

4.4.1 Provence/Languedoc/Rhône-Alps

Table 4.4.1 Herbicide active ingredients used in Provence/Languedoc/Rhône-Alps

Active ingredient	Activity	% of crop treated (Base: 862 ha)	No. of applications		Cumulative dose g ai/ha of crop receiving that ai		
			Range per farm	Ave per ha treated	min	max	ave
glyphosate	c	56	1 - 2	1.4	95	4,095	558
2.4-D	c	55	1 - 3	1.7	48	2,016	541
glufosinate	c	51	1 - 2	1.3	60	600	273
amitrole	sc	40	1 - 3	1.2	311	2,879	692
diuron	s	40	1 - 3	1.2	142	1,710	623
simazine	s	31	1 - 2	1.5	103	685	492
isoxaben	s	18	1 - 2	1.3	125	303	291
paraquat	c	16	1 - 3	1.7	51	679	249
ammonium thiocyanate	c	15	1 - 3	1.2	279	2,579	921
terbuthylazine	s	13	1 - 2	1.1	92	1,710	433
diquat	c	10	1 - 3	1.9	40	225	110
norflurazon	s	10	1	1.0	479	1,120	805
oryzalin	s	5	1	1.0	959	960	959
glyphosate-trimesium	c	5	1 - 2	1.7	384	1,200	866
atrazine	s	1	1 - 2	1.7	800	1,600	945
oil adjuvant	adj	15	1 - 2	1.1	234	1,511	745

Key to abbreviations:

c = contact post-emergence s = soil acting residual adj = adjuvant

4.4.2 Trentino

Table 4.4.2 Herbicide active ingredients used in Trentino

Active ingredient	Activity	% of crop treated (Base: 213 ha)	No. of applications		Cumulative dose g ai/ha of crop receiving that ai		
			Range per farm	Ave per ha treated	min	max	ave
glyphosate	c	63	1 - 3	1.9	30	2,001	775
MCPA	c	24	1 - 3	2.1	25	1,125	499
glufosinate	c	22	1 - 3	1.3	35	855	244
paraquat	c	9	1	1.0	35	240	158
dicamba	c	6	2	2.0	78	78	78
diquat	c	6	1	1.0	17	64	61
propyzamide	s	6	1 - 2	1.9	150	1,000	886
simazine	s	6	1	1.0	570	570	570
glyphosate-trimesium	c	4	2	2.0	736	736	736

Key to abbreviations:

c = contact post-emergence s = soil acting residual

4.4.3 Lerida

Table 4.4.3 Herbicide active ingredients used in Lerida

Active ingredient	Activity	% of crop treated (Base: 676 ha)	No. of applications		Cumulative dose g ai/ha of crop receiving that ai		
			Range per farm	Ave per ha treated	min	max	ave
glyphosate	c	72	1 - 5	2.4	126	5,039	696
MCPA	c	50	1 - 5	2.7	90	2,160	565
glufosinate	c	39	1 - 6	2.7	59	1,274	421
diquat	c	30	1 - 7	2.6	80	1,440	461
fluazifop-b	c	20	2	2.0	75	250	239
pendimethalin	s	17	1 - 2	1.4	164	1,517	412
simazine	s	16	1 - 3	1.5	400	3,000	760
paraquat	c	15	1 - 5	3.1	159	2,700	474
quinclorac	sc	3	1 - 2	1.1	335	2,592	855
fluroxypyr	c	2	3	3.0	180	180	180
cycloxydim	c	1	1	1.0	170	170	170
sethoxydim	c	1	2	2.0	279	279	279

Key to abbreviations:

c = contact post-emergence   s = soil acting residual

Comparisons between regions

Glyphosate, a non-selective, non-residual, contact/post-emergence translocated herbicide was the most important product for weed control in apple orchards in all three areas. It is particularly effective against perennial weeds due to downwards translocation towards the root system.

There has been a move away from residual soil-acting products, such as simazine and diuron, in recent years. This change was most apparent in Trentino. However, several farmers in Lerida and Provence/Languedoc/Rhône-Alps still used substantial quantities of residual herbicides.

4.5 Herbicide use parameters

The following tables provide certain comparative summarised parameters.

Table 4.5.1 Herbicide applications

On farms using herbicides	Provence/ Languedoc/ Rhône-Alps (F)	Trentino (I)	Lerida (E)
Number of active ingredients used per farm	4.0	1.7	3.3
Number of active ingredients used per hectare	3.8	1.5	2.7
Number of product applications per hectare	1.3	2.1	6.0
Proportion of farmers spraying parts of their crop	13%	4%	22%
Average volume of active ingredients per hectare of crop treated (kg ai/ha)	2.30	0.99	1.46

Table 4.5.2 Herbicide placement

Region	Provence/ Languedoc/ Rhône-Alps (F)	Trentino (I)	Lerida (E)
Number of farms	62	60	60
Form of placement	Farms %		
Along the rows	73	80	97
Overall	5	-	3
Between rows	5	10	-
Spot treatment	2	3	-
None	16	10	-

Review of the parameters presented in Tables 4.5.1 and 4.5.2 broadly shows the following.

The number of active ingredients used per farm was greater in the French region due to their habit of using more soil-acting herbicides as well as the contact chemicals.

Product applications were highest in Lerida, however, the practice of only spraying parts of the orchards was also most developed there.

Herbicide placement shows that the habit of treating along the rows rather than spraying overall was widely practised and most used in Lerida. Herbicide placement was taken into account when determining herbicide doses.

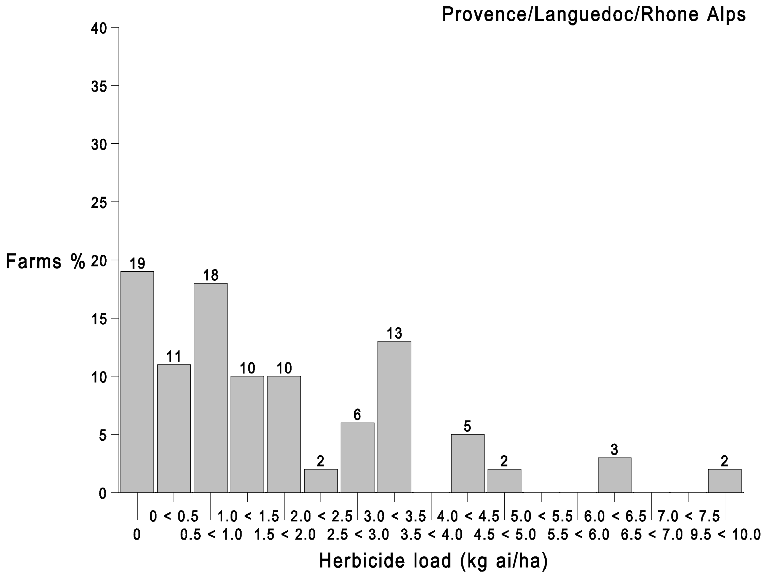
4.6 Herbicide load per farm

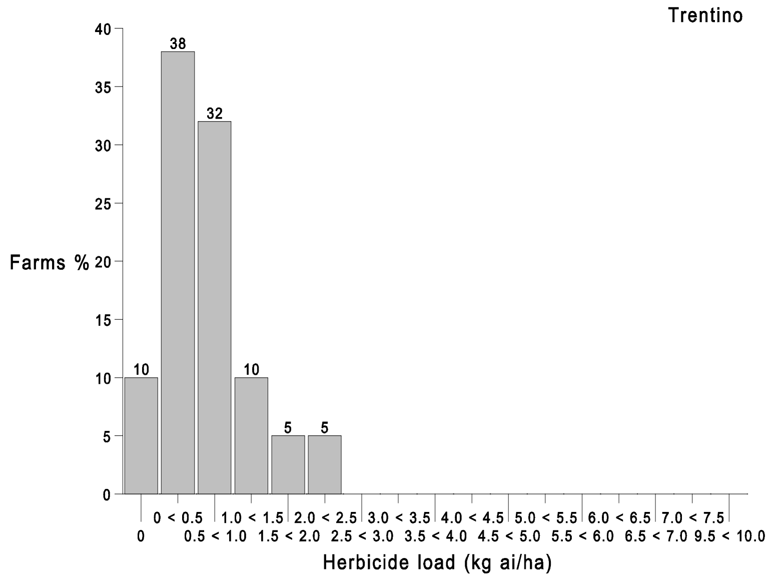
Table 4.6 Herbicide load by farm

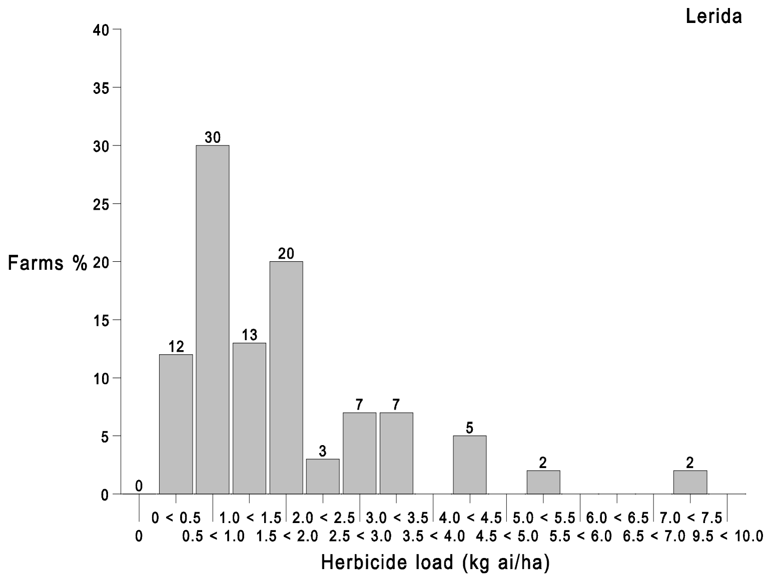
On farms using herbicides	Provence/ Languedoc/ Rhône-Alps (F)	Trentino (I)	Lerida (E)
Number of farms	62	60	60
Herbicide load kg ai /ha	Farms %		
0	19	10	0
0<0.5	11	38	12
0.5<1.0	18	32	30
1.0<1.5	10	10	13
1.5<2.0	10	5	20
2.0<2.5	2	5	3
2.5<3.0	6	-	7
3.0<3.5	13	-	7
3.5<4.0	-	-	-
4.0<4.5	5	-	5
4.5<5.0	2	-	-
5.0<5.5	-	-	2
5.5<6.0	-	-	-
6.0<6.5	3	-	-
6.5<7.0	-	-	-
7.0<7.5	-	-	2
9.5<10.0	2		
Range kg ai/ha crop grown	(0) 0.04 - 9.6	(0) 0.05 - 2.5	0.1 - 7.2

The slightly higher loading in some Provence/Languedoc/Rhône-Alps crops was due to the wider use of higher dose residual herbicides. Spray oils were also used on some farms in this region to enhance the performance of certain foliar applied graminicides. These quantities were also included in the spray oils total for that region in Table 3.1.

Chart 4.6 Variation in herbicide load by farm across regions







4.7 Mechanical weed control

Mechanical weed control was rarely practised in any region. The only type of mechanical activity was the mowing of the grass between tree rows, normally three to four times per year in most cases.

4.8 Herbicide use in the study year (1994) compared with an average year

Table 4.8 Herbicide use in the study year (1994) compared with an average year

Region	Provence/ Languedoc/ Rhône-Alps (F)	Trentino (I)	Lerida (E)
Number of farms	62	60	60
	Farms %		
Greater quantity	23	45	57
Lesser quantity	76	42	42
No reply	1	13	1

In Trentino and Lerida, farmers'opinions were almost evenly divided on use of herbicides compared with an average year. In Provence/Languedoc/Rhône-Alps most farmers believed they had used less in 1994 than in an average year.

4.9 Opportunities to reduce herbicide load

4.9.1 Comments from the regions

Most farmers in all regions only treated with herbicides within the tree row, so that about 25-30% of the surface area received chemicals. The rest was mown to keep vegetation down. Some spot application of difficult weeds was also carried out occasionally.

In recent years there has been a clear move away from higher dose residual herbicides, such as simazine, to post-emergence products such as glyphosate and glufosinate. This trend is likely to continue.

4.9.2 Further suggestions

A few farmers still carry out overall herbicide treatment, so have the opportunity for some reduction. Levels of control achieved within the tree row may be greater than is necessary to reduce crop competition, and may be somewhat ‘cosmetic’. Selective treatment of orchard areas, maximised in Lerida at 22%, could probably be extended through judicious targeting.

The use of adjuvants and oils to enhance the performance of some post-emergence products is practised by some farmers, but could be extended in order to reduce chemical pesticide load.

5.0 DISEASES AND FUNGICIDES

5.1 Target diseases

Table 5.1 Target diseases

Region	Provence/ Languedoc/ Rhône-Alps (F)	Trentino (I)	Lerida (E)
Number of farms	62	60	60
Target diseases	Farms %		
Venturia inaequalis (scab, tavelure)	61	85	68
Podosphaera leucotricha (powdery mildew, oidium)	23	53	82
Fruit diseases	2	12	15
Don’t know/no reply	14	2	5

Clearly *Venturia* was seen to be more important in Trentino. Specialists there indicated that this disease had increased in recent years, and indeed this region may be wetter than the others. It was also the most important disease in Provence/Languedoc/Rhône-Alps. Although *Venturia* was ranked high in Lerida, farmers believed *Podosphaera* to be more important. This is a drier region.

Specialists in Provence/Languedoc/Rhône-Alps said that *Podosphaera* infection was lower than normal in 1994. Specialists in Trentino felt that farmers over-estimated the importance of *Podosphaera.*

5.2 Diseases claimed to be resistant to fungicides

Some farmers in all three regions claimed experience with disease resistance to fungicides, mostly with *Venturia,* but farmers in Lerida also cited *Podosphaera*. Products mentioned included the ergosterol biosynthesis fungicides such as triazoles. Resistance to these types of fungicides is well documented by scientists, particularly for *Venturia*, but also for powdery mildew diseases such as *Podosphaera*.

Some farmers claimed resistance in *Venturia* to some broad-spectrum protectant fungicides such as the dithiocarbamates. There is no scientific evidence for this, and any poor control of disease is more likely to be due to non-optimum application methods or timing.

5.3 Levels of disease control sought

Table 5.3 Levels of disease control sought by farmers

Region	Provence/ Languedoc/ Rhône-Alps (F)	Trentino (I)	Lerida (E)
Number of farms	62	60	60
Control sought	Farms %		
<70%	-	-	2
71-80%	-	7	-
81-90%	3	30	8
91-100%	92	60	85
Don’t know	5	3	5

Farmers in all regions hoped to achieve very high levels of disease control. The slightly lower figures for Trentino were refuted by local experts who considered farmers sought higher levels, but might be persuaded to accept less if fruit quality and finish were not directly threatened. Specialists indicated that high levels of control are necessary at the beginning of the season against primary infections so that the diseases, particularly *Venturia*, do not get a strong hold on the orchard.

5.4 Fungicide use by active ingredient

5.4.1 Provence/Languedoc/Rhône-Alps

Table 5.4.1 Fungicide active ingredients used in Provence/Languedoc /Rhône-Alps

Active ingredient	Activity	% of crop treated	No. of applications		Cumulative dose g ai/ha of crop receiving that ai		
		(Base: 862 ha)	Range per farm	Ave per ha treated	min	max	ave
mancozeb	c/*Ven*	71	1 - 12	6.5	560	90,960	11,401
captan	c/*Ven*	52	1 - 10	4.4	474	44,820	6,914
sulphur	c/*Pod*	46	1 - 12	7.7	3,000	90,239	41,825
thiram	c/*Ven*	32	1 - 7	2.1	2,000	44,631	5,187
triadimefon	s/b	25	2 - 10	7.4	150	850	536
dithianon	c/*Ven*	20	1 - 5	2.4	187	6,750	1,788
copper products	c/b	17	1 - 7	1.6	120	35,000	3,814
cyproconazole	s/b	12	1 - 3	1.5	12	35	18
tolyfluanid	s/b	11	1 - 5	1.2	750	3,000	1,059
dichlofluanid	c/b	10	1 - 4	1.1	750	3,000	945
flusilazole	s/b	9	2 - 6	4.5	60	261	102
difenoconazole	s/b	8	1 - 5	2.1	37	250	137
pyrifenox	s/b	7	1 - 3	2.0	4	500	132
hexaconazole	s/b	7	2 - 6	2.6	25	90	52
nuarimol	s/b	5	1 - 5	1.2	6	18	17
penconazole	s/b	4	1 - 6	3.6	25	150	57
fenarimol	s/b	3	2 - 3	2.3	79	119	89
carbendazim	s/b	1.0	2 - 3	2.4	899	1,000	955
DNOC	c/b	1.4	1 - 2	1.5	50	644	248
myclobutanil	s/*Pod+Ven*	0.8	1	1.0	44	44	44
bupirimate	s/*Pod*	0.6	1	1.0	30	375	167
iprodione	c/b	0.5	2	2.0	1,500	1,500	1,500
thiophanate-m	s/b	0.5	2	2.0	1,350	1,350	1,350
triforine	s/*Pod+Ven*	0.5	2	2.0	665	665	665
ziram	c/b	0.5	1	1.0	2,160	2,160	2,160
dinocap	c/*Pod*	0.2	3	3.0	2,519	2,519	2,519
fosetyl-al	s/b	0.2	2	2.0	5,280	5,280	5,280
petroleum oil	c/b	5	1	1.0	720	23,750	7,150

Key to abbreviations: c = contact; s = systemic; b = broad spectrum; *Pod* = *Podosphaera*; *Ven* = *Venturia* (primary target)

5.4.2 Trentino

Table 5.4.2 Fungicide active ingredients used in Trentino

Active ingredient	Activity	% of crop treated (Base: 213 ha)	No. of applications		Cumulative dose g ai/ha of crop receiving that ai		
			Range per farm	Ave per ha treated	min	max	ave
metiram	c/*Ven*	70	1 - 15	5.1	1,281	38,448	10,756
dithianon	c/*Ven*	59	1 - 10	4.6	691	10,368	3,741
captan	c/*Ven*	55	2 - 8	3.3	375	9,172	3,292
dodine	c/*Ven*	48	1 - 4	2.7	389	5,250	2,661
mancozeb	c/*Ven*	47	1 - 12	5.4	575	34,560	10,162
ziram	c/*Ven*	38	1 - 10	3.9	774	23,219	8,998
penconazole	s/b	38	1 - 10	4.2	54	1,175	458
hexaconazole	s/b	37	1 - 6	3.1	7	261	88
sulphur	c/*Pod*	35	1 - 15	7.4	1,200	31,199	13,631
myclobutanil	s/b	35	1 - 8	4.7	15	714	359
copper oxychloride	c/b	22	1 - 7	1.3	299	35,000	4,132
bitertanol	s/b	19	1 - 7	4.1	209	2,100	1,217
benomyl	s/b	10	1 - 3	1.4	240	899	479
flusilazole	s/b	6	4	4.0	432	432	432
carbendazim	s/b	5	1 - 2	1.5	479	599	545
zineb	c/*Ven*	3	2	2.0	2,099	2,099	2,099
vinclozolin	s/b	2	3	3.0	1,500	1,500	1,500
fenarimol	s/b	1	2 - 13	5.7	83	467	211
nuarimol	s/b	1	2	2.0	115	143	129
thiram	c/*Ven*	1	3	3.0	7,500	7,500	7,500

Key to abbreviations:

c = contact
s = systemic

b = broad spectrum
Pod = *Podosphaera*
Ven = *Venturia* (primary target)

5.4.3 Lerida

Table 5.4.3 Fungicide active ingredients used in Lerida

Active ingredient	Activity	% of crop treated (Base: 676 ha)	No. of applications		Cumulative dose g ai/ha of crop receiving that ai		
			Range per farm	Ave per ha treated	min	max	ave
captan	c/*Ven*	65	1 - 8	4.0	750	12,600	5,734
triadimenol	s/b	61	1 - 4	1.6	49	800	346
pyrifenox	s/b	50	1 - 6	2.2	19	475	160
ziram	c/*Ven*	39	1 - 8	1.7	899	16,200	6,773
thiram	c/*Ven*	29	1 - 8	2.9	800	18,000	4,483
cyproconazole	s/b	26	1 - 4	1.2	4	70	27
sulphur	c/*Pod*	17	2 - 7	3.8	4,000	42,000	14,325
carbendazim	s/b	15	1 - 5	2.4	115	1,562	638
flusilazole	s/b	15	1 - 4	2.2	12	1,200	130
myclobutanil	s/b	14	1 - 6	1.7	43	234	124
bitertanol	s/*Ven*	9	1 - 2	1.4	125	700	333
hexaconazole	s/b	8	1 - 3	1.9	14	59	46
fenarimol	s/b	7	1 - 4	2.4	29	120	75
chlorothalonil	c/b	6	1 - 3	1.1	1,125	1,312	1,138
diniconazole	s/b	6	1 - 3	1.8	35	187	72
thiophanate-m	s/b	5	2 - 3	2.5	1,620	3,037	2,260
mancozeb	c/*Ven*	3	2 - 3	2.3	2,799	6,000	3,773
copper	c/b	3	3	3.0	6,750	6,750	6,750
difenconazole	s/b	3	1 - 3	2.3	59	299	200
triadimefon	s/b	3	1	1.0	337	337	337
nuarimol	s/*Pod*	2.4	1	1.0	5	5	5
benomyl	s/b	2.1	1 - 5	3.1	375	2,343	1,352
bupirimate	s/*Pod*	1.8	1 - 3	2.3	125	300	241
maneb	s/*Ven*	1.3	2	2.0	921	4,000	3,657
penconazole	s/b	0.7	1 - 4	2.2	75	219	137

Key to abbreviations:

c = contact   b = broad spectrum
s = systemic   *Pod* = *Podosphaera*
Ven = *Venturia* (primary target)

5.4.4 Fungicide active ingredients used - general commentary

The most commonly used contact/protectant fungicides for *Venturia* control were the dithiocarbamates and captan. There were regional differences as to which specific dithiocarbamate dominated. Mancozeb was important in Provence/Languedoc/Rhône-Alps but metiram was used most in Trentino. Captan was the most widely used active ingredient in Lerida. Dithianon and dodine, which are relatively low dose contact fungicides, were very widely used against *Venturia* in Trentino.

The main contact/protectant fungicide for *Podosphaera* was sulphur. It was used in all regions but to a greater extent in Provence/Languedoc/Rhône-Alps. Dose rates for this active ingredient are higher than for most other fungicides.

Use of systemic fungicides varied between farms within regions. Although these are lower dose products than the protectants, for resistance management reasons, growers should not rely on them alone for disease control. Lerida was a large user of this type of product, because their activity includes good control of *Podosphaera*, the most highly cited disease.

5.5 Fungicide use parameters

The following tables contain comparative summarised parameters.

Table 5.5.1 Fungicide applications

On farms using fungicides	Provence/ Languedoc/ Rhône-Alps (F)	Trentino (I)	Lerida (E)
Number of active ingredients used per farm	4.2	5.3	4.5
Number of active ingredients used per hectare	3.5	5.5	3.9
Number of product applications per hectare	13	21	11
Proportion of farmers spraying parts of their crop	16%	3.4%	14%
Average volume of active ingredients per hectare of crop treated (kg ai/ha)	33.20	27.70	11.53

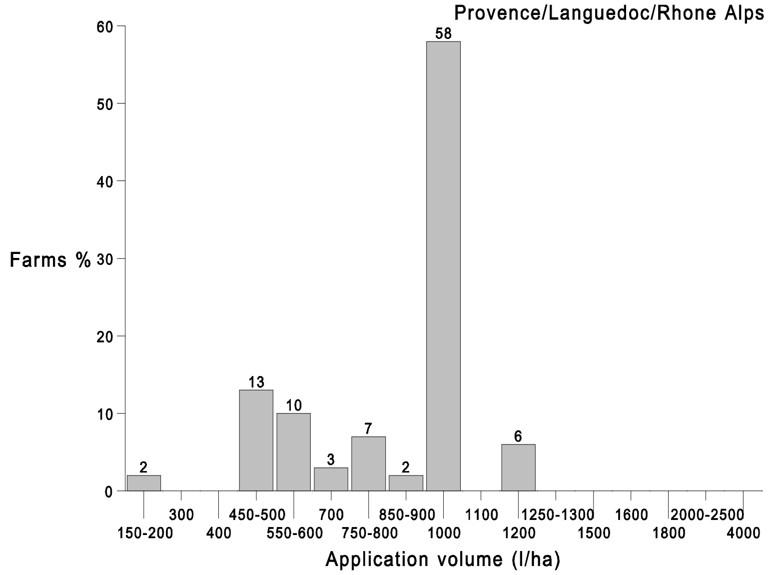
The number of active ingredients used may be seen relative to the chemical load in Table 5.5.1. The French region is the heaviest due to substantial use of the high dose contact fungicides such as mancozeb, captan and sulphur. Against this, however, they appeared to target their crops more than in Trentino and similarly to Lerida. This latter aspect is no doubt linked to crop size per farm.

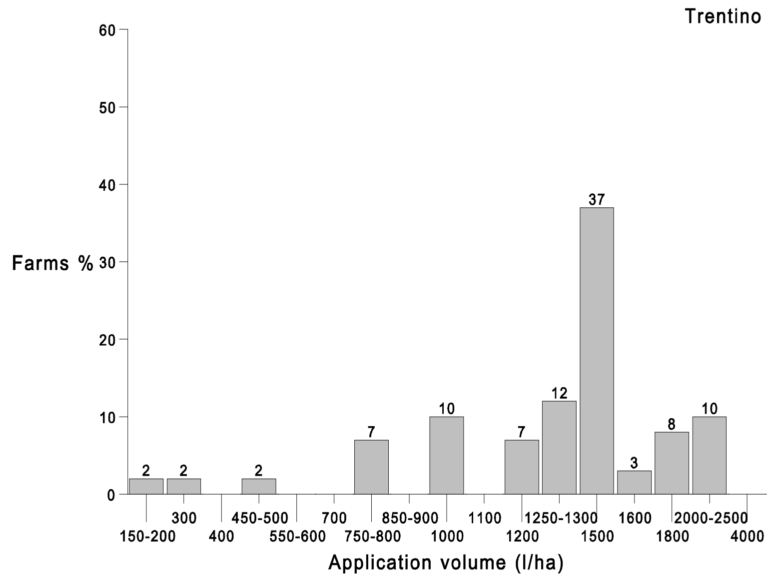
Table 5.5.2 Application volumes

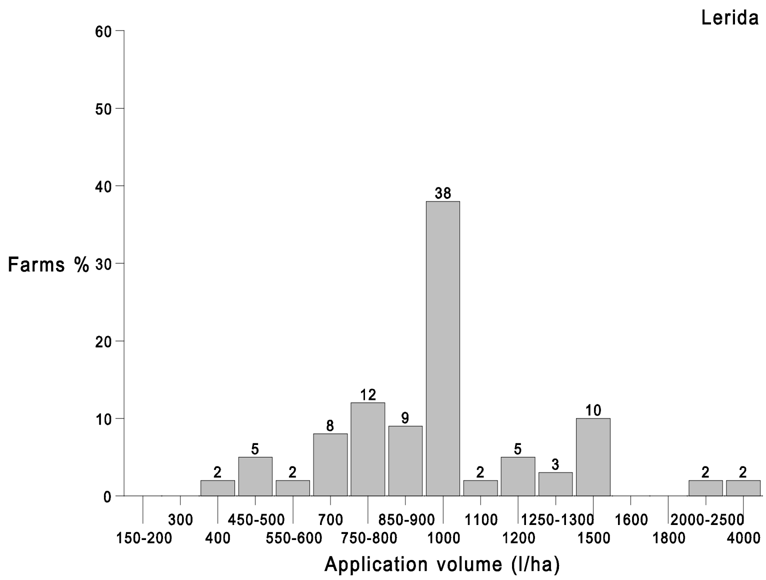
Region	Provence/ Languedoc/ Rhône-Alps (F)	Trentino (I)	Lerida (F)
Number of farms	62	60	60
Average application volume l/ha	Farms %		
150 - 200	2	2	-
300	-	2	-
400	-	-	2
450 - 500	13	2	5
550 - 600	10	-	2
700	3	-	8
750 - 800	7	7	12
850 - 900	2	-	9
1,000	58	10	38
1,100	-	-	2
1,200	6	7	5
1,250 - 1,300	-	12	3
1,500	-	37	10
1,600	-	3	-
1,800	-	8	-
2,000 - 2,500	-	10	2
4,000	-	-	2

Application volumes increase through the season as leaf canopy develops. However these figures represent the average used for fungicides during the season. Variation between farms is substantial and will relate in some cases to the form of tree planting (size, number etc). However, given that dose rates are given in concentrations per volume of spray, eventual dose rates per hectare will vary as a consequence of spray volume. It is suspected also that spray run off will occur at some of the heavier volumes applied (Trentino) hence unnecessary use of chemical.

Chart 5.5.2 Application volumes





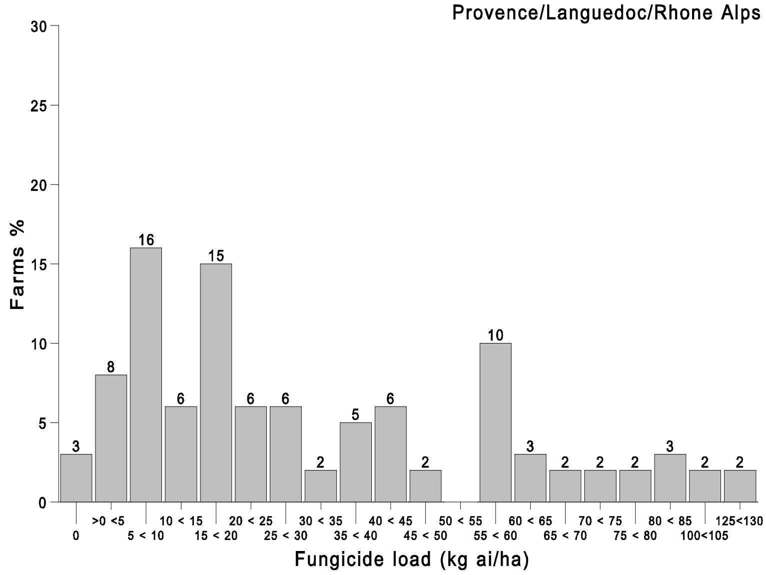


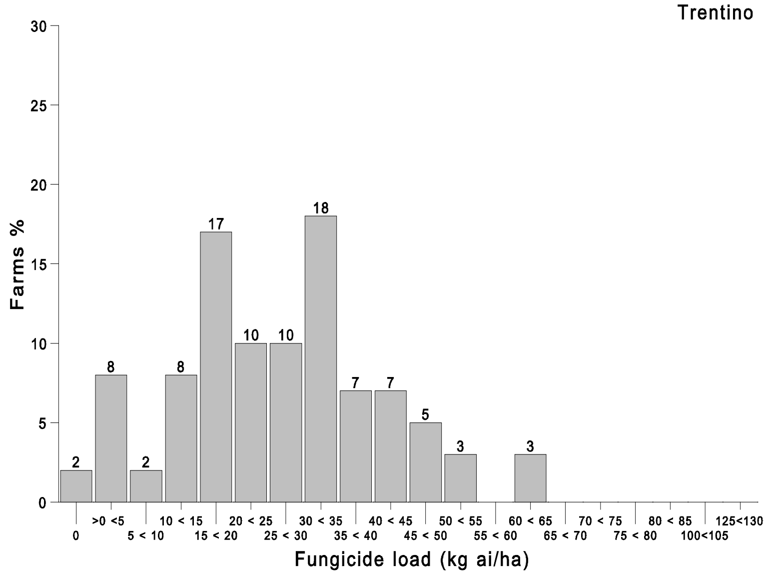
5.6 Fungicide load per farm

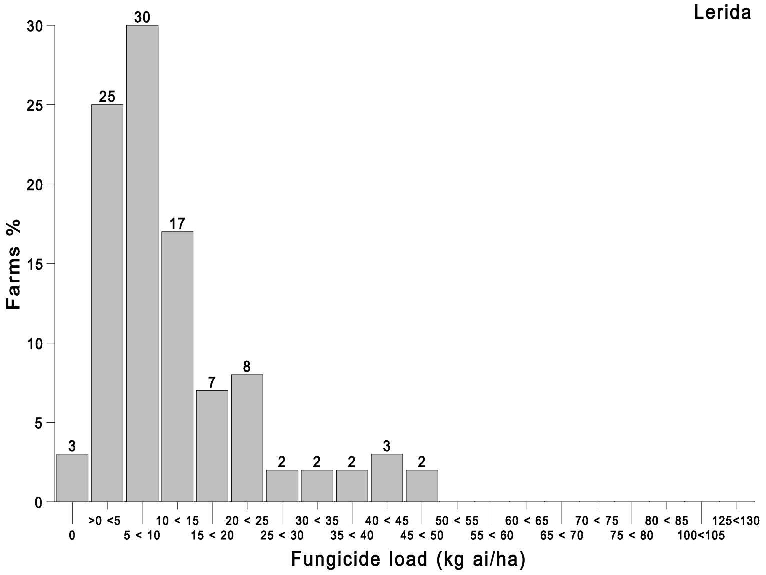
Table 5.6 Fungicide load by farm

Region	Provence/ Languedoc/ Rhône-Alps (F)	Trentino (I)	Lerida (E)
Number of farms	62	60	60
Fungicide load kg ai /ha	Farms %		
0	3	2	3
>0<5	8	8	25
5<10	16	2	30
10<15	6	8	17
15<20	15	17	7
20<25	6	10	8
25<30	6	10	2
30<35	2	18	2
35<40	5	7	2
40<45	6	7	3
45<50	2	5	2
50<55	-	3	-
55<60	10	-	-
60<65	3	3	-
65<70	2	-	-
70<75	2	-	-
75<80	2	-	-
80<85	3	-	-
100<105	2	-	-
125<130	2	-	-
Range kg ai/ha of crop grown	(0) 1.3 - 125.2	(0) 0.1 - 62.0	(0) 0.3 - 42.9

Chart 5.6 Variation in fungicide load by farm across regions







Many farmers in Provence/Languedoc/Rhône-Alps used high quantities of sulphur for control of *Podosphaera* and also to improve fruit finish. Sulphur was used in the other regions, but to a lesser degree.

As noted earlier, the French region also used the high dose contact fungicides widely as did Trentino.

The Lerida region, however, showed less frequent use of the contact products used primarily for *Venturia* because of lower pressure from this disease compared with the other two regions. Where *Podosphaera* was the more important disease, farmers in the Lerida region resorted more to systemic chemicals for its control.

5.7 Fungicide use in the study year (1994) compared with an average year

Table 5.7 Fungicide use in the study year (1994) compared with an average year

Region	Provence/ Languedoc/ Rhône-Alps (F)	Trentino (I)	Lerida (E)
Number of farms	62	60	60
Fungicide use	Farms %		
Greater quantity	24	17	12
Lesser quantity	6	22	13
Same quantity	65	60	70
No reply	5	2	5

Most farmers used the same quantity of fungicides in 1994 compared with an average year.

5.8 Factors determining the start of fungicide application

The factors that farmers claimed to use to determine fungicide application are presented in Table 5.8.

Many farmers in all regions were not really clear on which factors were considered before starting spraying for diseases.

Warning systems for determining spray timing for *Venturia inaequalis* are well established as part of IPM or ICM programmes. These systems are based on a

combination of plant stage, weather conditions and leaf surface moisture. Specialists advised that there were no warning systems *per se* for *Podosphaera leucotricha,* but the farmers may be advised when to spray by advisors.
Many farmers who do not use the full warning system for *Venturia* appear to make the decision to commence spraying based on a combination of the other factors. This seemed particularly the case in the Provence/Languedoc/Rhône-Alps region.

It is noted that calendar date spraying is not a major feature in spray timing in Trentino, which is the most IPM/ICM conscious region of the three. Here much greater use of the warning system was made.

Greater use of warning systems does seem possible for some farmers, particularly those in the Provence/Languedoc/Rhône-Alps region.

Table 5.8 Factors determining the start of fungicide application (Farms %)

Factor	Calendar dates			Plant stage			Disease stage			Weather conditions			Warning system			Don’t know			Don’t have disease		
Region Factor	Pro	Tre	Ler	Pro	Tre	Ler	Pro	Tre	Ler	Pro	Tre	Ler	Pro	Tre	Ler	Pro	Tre	Ler	Pro	Tre	Ler
Podosphaera Powdery mildew	55	3	43	26	12	28	10	12	23	40	33	40	21	43	53	-	2	-	-	35	2
Venturia Scab	45	3	35	26	25	15	13	27	17	48	60	45	27	65	55	-	2	-	-	8	15
Fruit diseases	34	2	17	13	-	12	8	2	8	18	3	10	29	8	15	5	-	5	13	83	65
Other	10	-		3	-		2	-		3	-		11	-	15	13	-	-	24	-	-

Regions: Pro = Provence/Languedoc/Rhône-Alps (F)
Tre = Trentino (I)
Ler = Lerida (E)

5.9 Opportunities to reduce fungicide load

5.9.1 Comments by region

With present products, specialists from all three regions felt there was little scope for substantial further reductions in the use of fungicides in apple growing. Most of the protectant non-systemic fungicides are high dose rate products and require frequent applications to protect the foliage and fruit during the growing season.

5.9.2 Further suggestions

Despite the specialists comments there may be opportunity to reduce the number of protectant *Venturia* sprays applied on some farms if warning systems were more fully utilised. This probably applies more to Provence/Languedoc/Rhône-Alps than the other regions.

There was more use of the contact fungicide dithianon for *Venturia* control in Trentino than in Provence/Languedoc/Rhône-Alps and no use recorded in Lerida. Similarly another *Venturia* product dodine, was only recorded in Trentino. Both products have lower recommend rates than dithiocarbamates and captan. Dithianon tends to be used in the early part of the season, but is more expensive. Similarly captan has slightly lower dose rates than the dithiocarbamates.

Sulphur is a high dose product but there is no real protectant fungicide alternative for *Podosphaera* control. Many lower dose systemic products such as the ergosterol biosynthesis inhibitors (EBI's), which include triazoles, do control *Podosphaera* and *Venturia* well, but their sole use for these diseases is not good resistance management strategy.

Many newer EBI's, such as later triazoles, have even lower dose rates than earlier ones and as they become further established slight reduction of fungicide load will be possible.

Attention to optimising application volumes could also be of benefit in reducing any unnecessary use of fungicides that might occur.

6.0 INSECTS, MITES, INSECTICIDES AND ACARICIDES

6.1 Target pests

Table 6.1 Main target pests by region

Region	Provence/Languedoc /Rhône-Alps (F)			Trentino (I)			Lerida (E)		
Pests	Farms %	No. of generations		Farms %	No. of generations		Farms %	No. of generations	
	(Base 62)	Range	Av	(Base 60)	Range	Av	(Base 60)	Range	Av
Aphids									
Dysaphis plantaginea	79	1 - 3	1.63	90	1 - 3	1.61	82	1 - 6	2.67
Aphis pomi	53	1 - 5	1.97	67	1 - 5	2.16	88	1 - 12	3.06
Eriosoma lanigerum	35	1 - 2	1.24	48	1 - 4	1.39	57	1 - 4	1.80
San Jose scale									
Quadraspidiotus perniciosus	10	1 - 3	2.00	2	2	2.00	82	1 - 5	2.59
Mites	73	1 - 3	2.07	52	1 - 7	3.30	75	1 - 7	3.21
Panonychus ulmi etc									
Codling moth	100	1 - 10	3.33	80	1 - 4	2.02	77	1 - 9	2.54
Carpocapsa pomonella									
Leaf blister moth	-	-	-	13	1 - 4	1.63	55	1 - 3	1.87
Leucoptera scitella									
Apple clearwing moth	10	1 - 6	2.67	25	1 - 2	1.20	57	1 - 6	2.10
Synathedon myopiformis	13	1 - 6	3.25	67	1 - 4	1.89	45	1 - 4	2.56
Tortrix moths various									
Apple weevil	2	1	1	2	1	1.00	-	-	-
Anthonomous pomorum									
Med fruit fly	2	1	1	-	-	-	43	1 - 3	1.73
Ceratitis capitata									
Ermine moth	-	-	-	-	-	-	-	-	-
Hyponomeuta padellus									
Lepoard moth	37	1 - 6	2.00	-	-	-	3	1 - 3	1.50
Zeuzera pyrina									
Psylla	8	2	2.00	2	4	4.00	3	3	3.00
Psylla spp	6	1 - 6	3.00	-	-	-	-	-	-
Leaf miners various									
Green leaf hopper	-	-	-	2	n/a	n/a	-	-	-
Empoasca decipiens									
Goat moth	-	-	-	-	-	-	2	6	6.00
Cossus cossus									

The above table shows the relative importance of the pests in the eyes of the farmers. Specialists generally agreed on the importance of *Carpocapsa* and *Dysaphis*. *Aphis pomi* was believed to be less important in Trentino than some farmers thought. A number of insects were more prevalent in Lerida than in the other two regions.

6.2 Insects exhibiting resistance

About half of the farmers in each region believed there was pest resistance to some products, and most species were cited. Specialists in each region agreed that there were some resistance problems, but the phenomenon may not be as widespread as farmers indicated.

Mite resistance to several products such as clofentezine, hexathiazox and organophosphates were recognised particularly in the French region, and the official recommendation is to alternate the use of acaricides to avoid build up of resistance to the different acaricide groups.

Cases of resistance in *Carpocapsa* to insect growth regulators are also well documented in the French region and Trentino. There are also reports of resistance to pyrethroids and organophosphates with this pest.

Aphid resistance was seen to be a problem in Lerida, dimethoate being cited. There was also a decline in efficacy in controlling *Dysaphis* in Trentino with some of the older insecticides, but local specialists could not confirm whether this was true resistance.

6.3 Levels of pest control sought

Table 6.3 Levels of pest control sought

Region	Provence/ Languedoc/ Rhône-Alps (F)	Trentino (I)	Lerida (E)
Number of farms	62	60	60
Control sought	Farms %		
71-80%	2	7	4
81-90%	12	35	10
91-100%	84	50	85
Don't know	2	8	1

This demonstrates that farmers expected a high degree of pest control in apples. The slightly lower figures for Trentino may take into account the importance of IPM in that region. However, although they may accept lower control for mites and *Aphis*, local specialists believed farmers in Trentino would expect full control of the most damaging pests such as *Dysaphis* and *Carpocapsa.*

6.4 Insecticide and acaricide use

6.4.1 Provence/Languedoc/Rhône-Alps

Table 6.4.1 Insecticide and acaricide use by active ingredient in Provence/ Languedoc/Rhône-Alps

Active ingredient	Activity	% of crop treated (Base: 862 ha)	No. of applications		Cumulative dose g ai/ha of crop receiving that ai		
			Range per farm	Ave per ha treated	min	max	ave
chlorpyrifos-e	cif/b	72	1 - 5	2.3	208	2,362	945
azinphos-methyl	ci/b	62	1 - 5	2.3	299	3,125	1,029
deltamethrin	ci/b	56	1 - 10	3.6	3	175	58
dimethoate	ci/b	56	1 - 5	3.1	166	2,087	1,076
fenoxycarb	ci/igr	46	1 - 5	1.9	37	900	239
vamidothion	s/aph	40	1 - 2	1.1	250	1,728	565
cyfluthrin	ci/b	37	1 - 6	2.4	14	899	98
lambda-cyhalothrin	ci/b	35	1 - 3	1.3	<1	90	20
tau-fluvalinate	ci/b	31	1 - 6	1.6	71	576	204
bifenthrin	ci/b	27	1 - 5	1.4	14	300	49
tebufenpyrad	aca	26	1 - 2	1.1	50	800	136
pyridaben	c/aph-aca	25	1	1.0	144	239	155
omethoate	s/b	24	1 - 4	1.2	625	2,500	812
demeton-s-methyl	c/aph-aca	21	2 - 4	2.7	90	600	409
propargite	c/aca	18	1 - 2	1.1	569	3,000	1,643
parathion-methyl	cif/b	16	1 - 3	1.6	100	1,080	526
carbaryl	ci/b	16	1 - 3	2.1	382	2,039	1,167
beta-cyfluthrin	ci/b	11	1 - 7	1.5	2	52	8
oxydemeton-m	cs/b	11	1 - 2	1.2	59	399	189
phosalone	ci/b	10	1 - 6	2.0	599	5,099	1,661
phosphamidon	s/aph	8	1 - 4	1.7	251	1,600	513
imidacloprid	s/aph	7	1 - 2	1.1	19	839	102
fenitrothion	c/b	3	2 - 1	2.0	500	5,000	3,192
cyhexatin	c/aca	4	1 - 3	2.2	125	750	538
fenvalerate	ci/b	4	2 - 3	2.2	150	1,000	862
phosmet	c/b	3.9	2 - 3	3.7	1,000	4,500	2,355
fenazaquin	c/aca	3	1	1.0	20	150	112
Trichogramma	bio	2.8	2 - 3	2.8	4,000	6,000	5,666
hexythiazox	ci/aca	2.1	1	1.0	50	50	50
parathion-ethyl	ci/b	2.1	1	1.0	239	1,350	1,226
methomyl	ci/b	2.0	1 - 5	2.4	740	2,500	1,361
methidathion	ci/b	1.5	1 - 4	1.8	694	1,852	973
methamidophos	s/b	1.4	2	2.0	767	1,119	1,031
amitraz	ci/b	1.3	1 - 2	1.7	800	1,600	945
diflubenzuron	i/igr	1.3	1	1.0	100	100	100
naled	ci/b	1.2	1	1.0	95	2,400	1,017

continued/

Table 6.4.1 Insecticide and acaricide use by active ingredient in Provence/Languedoc/Rhône-Alps (continued)

Active ingredient	Activity	% of crop treated (Base: 862 ha)	No. of applications		Cumulative dose g ai/ha of crop receiving that ai		
			Range	Ave	min	max	ave
fenpropathrin	ci/b	1.0	5	5.0	839	839	839
endosulfan	ci/b	0.9	1 - 2	1.6	839	1,225	1,080
pirimicarb	s/aph	0.9	1 - 2	1.3	16	100	37
teflubenzuron	i/igr	0.8	1 - 2	1.6	54	90	74
Bacillus thuringiensis	bio	0.7	5	5.0	225	225	225
dichlorvos	cif/b	0.7	1	1.0	1,800	1,800	1,800
tebufenozide	i/igr	0.3	1	1.0	230	230	230
DNOC	ci/b	0.3	1	1.0	1,000	1,000	1,000
dicofol	c/aca	0.2	1	1.0	252	252	252
petroleum oil	c/b	3	1	1.0	649	28,500	10,516

Key to abbreviations:

c = contact
f = fumigant
i = ingestion
s = systemic

b = broad spectrum
aca = acaricide
aph = aphicide
igr = insect growth regulator
bio = biological pesticide

6.4.2 Trentino

Table 6.4.2 Insecticide and Acaricide use by active ingredient in Trentino

Active ingredient	Activity	% of crop treated (Base: 213 ha)	No. of applications		Cumulative dose g ai/ha of crop receiving that ai		
			Range per farm	Ave per ha treated	min	max	ave
vamidothion	s/aph	62	1 - 2	1.1	140	1,875	749
pirimicarb	sf/aph	53	1 - 4	1.1	104	2,099	533
diflubenzuron	ci/igr	39	1 - 3	1.8	37	600	287
ethiofencarb	s/aph	22	1 - 2	1.1	165	1,766	713
hexythiazox	c/aca	22	1 - 2	1.0	35	100	68
teflubenzuron	ci/igr	22	1 - 2	1.2	16	217	93
methidathion	b/ci	19	1	1.0	684	712	693
chorpyrifos-	b/cif	18	1 - 2	1.0	132	1,325	676
methyl	b/s	17	1 - 3	1.7	152	1,720	862
acephate	c/aca	11	1	1.0	320	600	485
benzoxymate	c/aca	11	1	1.0	150	300	232
clofentezine	ci/igr	10	1 - 3	1.3	39	3,199	404
triflumuron	ci/agr	6	1 - 2	1.2	75	180	146
fenoxycarb	ci/b	6	1 - 2	1.5	356	944	592
azinphos-methyl	cf/b	6	1	1.0	647	647	647
amitraz	c/aca	6	1	1.0	450	450	450
azocyclotin	ci/b	3	1	1.0	880	880	880
diazinon	c/aca	2	1	1.0	740	740	740
propargite	ci/b	2	1	1.0	791	791	791
phosalone	c/aca	1.4	1	1.0	462	462	462
dicofol	c/aca	1.4	1	1.0	228	228	228
tetradifon	cif/b	0.9	1	1.0	370	796	583
chlorpyrifos-ethyl	c/aca	0.9	1	1.0	344	344	344
cyhexatin	ci/igr	0.9	2	2.0	79	79	79
flufenoxuron	c/aca	0.5	1	1.0	1,440	1,440	1,440
sulphur	c/b	15	1	1.0	11,199	36,000	22,190
petroleum oil							

Key to abbreviations:

c = contact		b = broad spectrum
i = ingestion		aca = acaricide
f = fumigant		aph = aphicide
s = systemic		igr = insect growth regulator

Table 6.4.3 Lerida

Table 6.4.3 Insecticide and Acaricide use by active ingredient in Lerida

Active ingredient	Activity	% of crop treated (Base: 676 ha)	No. of applications		Cumulative dose g ai/ha of crop receiving that ai		
			Range per farm	Ave per ha treated	min	max	ave
imidacloprid	s/aph	61	1 - 3	1.4	44	2,000	162
dimethoate	ci/b	53	1 - 4	2.9	150	9,600	4,350
deltamethrin	ci/b	38	1 - 8	1.7	5	128	59
fenoxycarb	ci/igr	37	1 - 2	1.3	99	899	229
diflubenzuron	ci/igr	36	1 - 2	1.5	125	1,200	715
diazinon	ci/b	36	1 - 4	2.0	449	6,000	1,696
vamidothion	s/aph	32	1 - 2	1.0	48	1,919	818
chlorfenvinphos	ci/b	28	1 - 3	1.5	167	2,180	530
pyridaben	c/aca+aph	28	1 - 3	1.2	105	449	189
DNOC	c/b	25	1	1.0	500	2,000	1,223
azinphos-m	ci/b	21	1 - 5	2.5	250	3,750	1,469
fenitrothion	c/b	20	1 - 6	2.1	500	4,500	1,494
hexythiazox	c/aca	20	1 - 2	2.0	12	120	116
parathion-ethyl	cif/b	19	1 - 3	1.3	87	10,000	1,795
phosmet	ci/b	16	1 - 5	2.5	800	9,375	3,096
phosalone	ci/b	14	1 - 3	1.3	455	1,469	786
demeton-s-m	sc/aca+aph	11	1 - 2	1.5	175	500	370
parathion-m	cif/b	11	1 - 4	1.7	300	3,000	946
omethoate	s/b	11	1 - 2	1.0	500	5,000	738
cypermethrin	ci/b	10	1 - 4	1.7	75	400	131
amitraz	cf/b	10	1 - 3	1.6	200	2,250	727
cyfluthrin	ci/b	9	1 - 2	2.0	50	100	66
azocyclotin	c/aca	8	1	1.0	218	1,125	325
resmethrin	ci/b	7	1 - 3	1.4	2	17	8
methidathion	c/b	6	1 - 4	2.0	419	2,700	1,214
fenpropathrin	ci/b	6	1	1.0	100	135	101
tau-fluvalinate	ci/b	6	1	1.0	95	95	95
oxydemeton-m	cs/b	5	1 - 3	1.9	12	52	32
alphacypermethrin	ci/b	5	1 - 3	1.5	44	562	445
hexaflumeron	ci/igr	4	1 - 2	1.4	100	160	122
fenvalerate	ci/b	3	2 - 6	4.9	450	450	450
fenazaquin	c/aca	3	1	1.0	48	150	59
methamidophos	cs/b	3	1	1.0	450	450	450
permethrin	ci/b	3	2	2.0	229	229	299
chlorpyrifos-m	cif/b	2	1	1.0	442	497	465

continued/

Table 6.4.3 Insecticide and acaricide use by active ingredient in Lerida

(continued)

Active ingredient	Activity	% of crop treated (Base: 676 ha)	No. of applications		Cumulative dose g ai/ha of crop receiving that ai		
			Range per farm	Ave per ha treated	min	max	ave
isoxathion	c/b	2	1	1.0	875	875	875
methomyl	c/b	2	1	1.0	279	279	279
quinalphos	ci/b	2	1	1.0	360	360	360
dicofol	c/aca	1.0	1	1.0	480	1,600	640
pirimiphos-ethyl	cf/b	1.0	2	2.0	2,500	2,500	2,500
tetradifon	c/aca	1.0	1	1.0	180	600	240
pirimiphos-methyl	cf/b	0.4	1	1.0	50	50	50
chlorpyrifos-ethyl	cif/b	0.4	1	1.0	625	625	625
cyhexatin	c/aca	0.1	1	1.0	360	360	360
endosulfan	ci/b	0.1	1	1.0	360	360	360
ethiofencarb	cis/aph	0.3	1	1.0	350	350	350
ethion	c/b	0.3	1	1.0	937	937	937
petroleum oil	c/b	36	1 - 4	1.5	593	57,000	22,404

Key to abbreviations:

c = contact
f = fumigant
i = ingestion
s = systemic
b = broad spectrum
aca = acaricide
aph = aphicide
igr = insect growth regulator

6.4.4 Insecticide active ingredients used - general commentary

The major pests were similar across all three regions though with variation in relative importance. *Carpocapsa pomonella* is one of the most important pests to control if fruit quality is to be ensured. Improvement in timing of applications for control of *Carpocapsa* in recent years has led to reduced treatments in all regions.

There were differences between the three areas in the types of insecticide and acaricides used. Trentino has adopted ICM/IPM methods more widely than the other two regions, thus there was no use of pyrethroid insecticides as they are known to cause mite resurgence on top fruit crops. Organophosphate insecticides were used but to a lesser extent than the other regions. The predominant insecticides in Trentino were insect growth regulators. Specific aphicides and acaricides were used in all three regions. With the increased use of ICM/IPM techniques, acaricide use is declining.

6.5 Insecticide and acaricide use parameters

Table 6.5 Insecticide and acaricide applications

On farms using insecticides	Provence/ Languedoc/ Rhône-Alps (F)	Trentino (I)	Lerida (E)
Number of active ingredients used per farm	5.6	3.7	6.8
Number of active ingredients used per hectare	6.9	3.6	6.5
Number of product applications per hectare	10.8	4.6	9.4
Proportion of farmers spraying parts of their crop	7%	9%	14%
Average volume of active ingredients per hectare of crop treated kg ai/ha			
- insecticides	4.46	1.86	6.36
- petroleum oils	6.1*	22.1	22.6

* including weed control

Volumes of application vary similarly to fungicides and are not presented separately here.

From the comparison in Table 6.5 the differences between the regions is apparent with Trentino standing out in its reduced use of insecticides and acaricides. Farms in Lerida appear to spray their orchards with a more targeted approach with 14% of the farmers spraying parts of their crop.

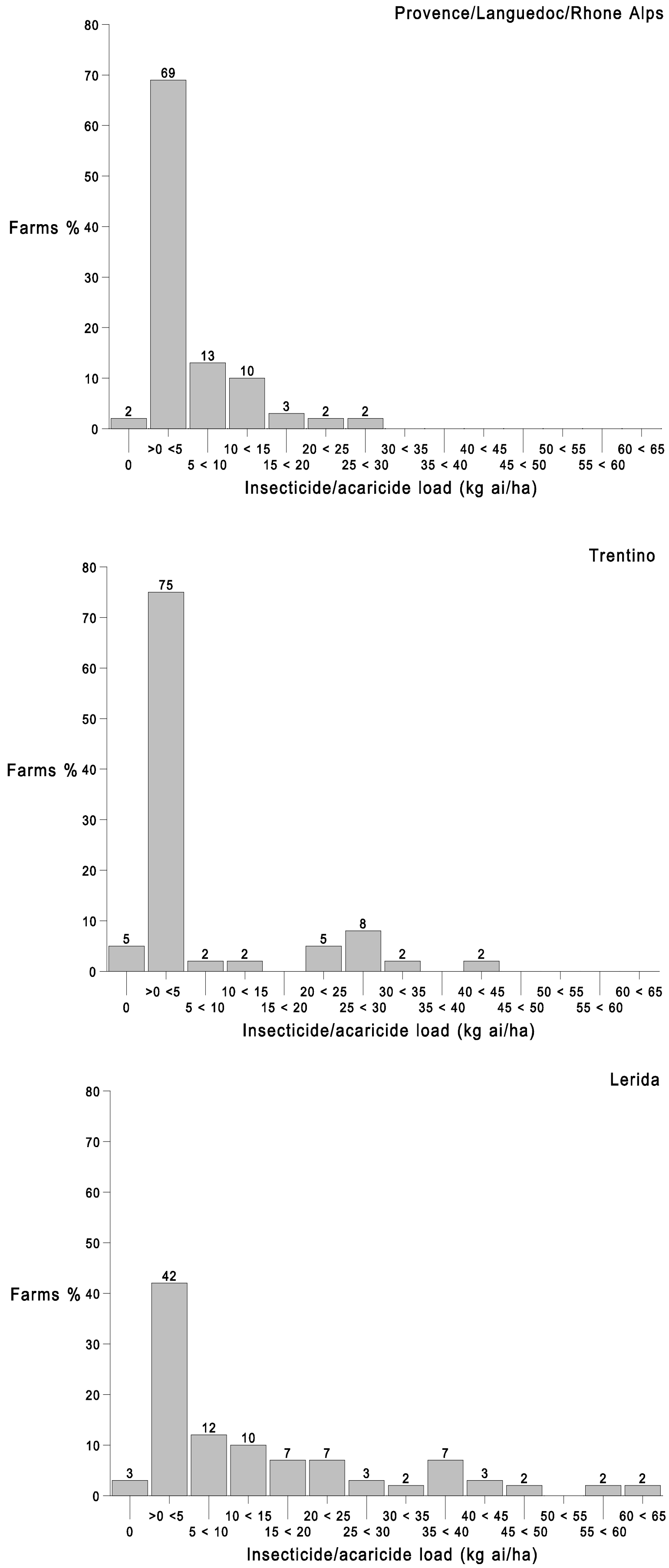
6.6 Insecticide load per farm

Table 6.6 Insecticide and acaricide load per farm

Region	Provence/ Languedoc/ Rhône-Alps (F)	Trentino (I)	Lerida (E)
Number of farms	62	60	60
Insecticide/acaricide load kg ai /ha	Farms %		
0	2	5	3
>0<5	69	75	42
5<10	13	2	12
10<15	10	2	10
15<20	3	-	7
20<25	2	5	7
25<30	2	8	3
30<35	-	2	2
35<40	-	-	7
40<45	-	2	3
45<50	-	-	2
50<55	-	-	-
55<60	-	-	2
60<65	-		2
Range kg ai/ha of crop grown	(0) 0.06 - 28.5	(0) 0.06 - 42.3	(0) 0.1 - 64.6

The farms with higher insecticide/acaricide loads in Trentino and Lerida were due to the high volumes of petroleum oil or petroleum oil/insecticide mixtures being sprayed, typically up to 20-25 kg oil/ha. In Lerida 26 farms adopted this practice, in Tretino 11 and in Provence/Languedoc/Rhône-Alps only four used this method.

Chart 6.6 Variation in insecticide and acaricide load by farm



6.7 Insecticide/acaricide use in the study year (1994) compared with an average year

Table 6.7 Insecticide/acaricide use in the study year (1994) compared with an average year

Region	Provence/ Languedoc/ Rhône-Alps (F)	Trentino (I)	Lerida (E)
Number of farms	62	60	60
Insecticide/acaricide use	Farms %		
Greater quantity	33	8	11
Lesser quantity	4	8	20
Same quantity	58	78	69
Don't know/No reply	5	5	-

Most farmers indicated similar use of these products in 1994, compared with an average year, although quite a few farmers in Provence/Languedoc/Rhône-Alps indicated greater use.

6.8 Factors determining start of insecticide or acaricide applications

The factors considered by farmers are presented in Table 6.8.

Calendar date was less used in Trentino than other regions. Warning systems through the use of pheromone traps are particularly relevant to *Carpocapsa* and there seems to be good utilisation in Trentino and Lerida. The local specialists in Provence/Languedoc/Rhône-Alps indicated that there was widespread use of pheromones in their region but many farmers begin spraying by calendar date even if traps have not yet registered a catch as they were unwilling to risk an uncontrolled attack.

Table 6.8 Factors determining start of insecticide or acaricide application (farms %)

	Calendar dates			Plant stage			Pest stage			Pest Pressure			Warning system			Don't know /no reply		
Region	Pro	Tre	Ler	Pro	Tre	Ler	Pro	Tre	Ler	Pro	Tre	Ler	Pro	Tre	Ler	Pro	Tre	Ler
Aphis pomi green aphid	11	2	22	11	17	17	13	30	30	21	12	43	8	45	40	21	28	4
Carpocapsa pomonella codling moth	47	2	38	19	15	5	11	30	20	29	10	18	27	55	63	11	22	5
Ceratitis capitata Med fruit fly	8	-	27	3	-	5	-	-	12	5	-	23	2	-	57	45	100	17
Dysaphis plantaginea grey aphid	16	2	22	13	22	10	23	42	32	37	18	38	16	57	43	13	10	7
Leucoptera scitella leaf miner	6	-	35	2	-	10	3	2	17	2	2	15	-	3	55	48	87	10
Mites	23	2	15	6	12	10	13	20	38	40	10	40	8	35	42	10	42	4

Pro = Provence/Languedoc/Rhône-Alps Tre = Trentino Ler = Lerida

6.9 Opportunities to reduce insecticide and acaricide load

6.9.1 Comments by region

In Trentino specialists confirmed that most growers were adopting ICM procedures in close collaboration with their cooperatives and thus the art of correct spray timing was well developed. The frequency of spray application is therefore close to optimum, although further fine tuning could lead to minor reductions in pesticide load.

As indicated by some of the pesticides used, full ICM/IPM seems to be less well developed in the other regions. Further improvement in using warning systems and greater adoption of IPM/ICM approved products could lead to reduced spraying.

6.9.2 Other suggestions

Use of certain products such as pyrethroids should be minimised as they are known to cause mite resurgence in some situations which may necessitate further spraying of specific acaricides.

.

The largest volume (heaviest dose rate) products used to control pests are petroleum oil-based sprays. Some Lerida growers were particularly high users of these traditional products. Their use has been more common in other regions but has declined in recent years with the introduction of more modern, but more expensive, insecticides and acaricides. There is a place for spray oils in the apple orchard, but it is suggested that some very high users could consider reduction without major impairment of performance.

Some newer insecticides and acaricides require less frequent treatment and have lower dose rates. This trend is likely to continue with emerging products. Most newer molecules have a better environmental profile than many of the older products. Their disadvantage is price.

7.0 MISCELLANEOUS PESTS AND PESTICIDES

In Lerida specialists claimed widespread use (32% of area) of fosetyl-al and similar products as a root drench for diseases such as *Phytophthora*, a problem that increases with the age of the trees. The survey only found one farmer claiming use on two hectares.

Three farms across all regions indicated that they used rodenticides as part of their apple production system. Some specialists believed that rodenticide use may have been understated in Trentino.

8.0 OTHER AGROCHEMICALS

The only types of products mentioned in this group were plant growth regulators which were mainly used to improve fruit size and quality. They fell into two main categories:

1. High dose products such as sulphur-based sprays or carbaryl which also have other properties (fungicide or insecticide)

2. Low dose plant hormones such as gibberellic acid or naphthylacetic acid.

8.1 Plant growth regulator active ingredient use

8.1.1 Provence/Languedoc/Rhône-Alps

Table 8.1.1 Plant growth regulators used in Provence/Languedoc/Rhône-Alps

Active ingredient	% of crop treated (Base: 862 ha)	No. of applications		Cumulative dose g ai/ha of crop receiving that ai
		Range per farm	Ave per ha treated	Average
Russetting control				
Sulphur+trace elements	13	2 - 8	4.8	11,201
Gibberellic acid	4	1 - 4	3.3	12
Fruit thinning				
2,4-DP	2	1	1.0	31
Alpha-naphthylacetic acid	<1	1	1.0	14
Carbaryl	<1	1	1.0	600

8.1.2 Trentino

Table 8.1.2 Plant growth regulators used in Trentino

Active ingredient	% of crop treated (Base: 213 ha)	No. of applications		Cumulative dose g ai/ha of crop receiving that ai
		Range per farm	Ave per ha treated	Average
naphtoxy-2-acetamide	39	1	1.0	167
naphthalacetic acid	20	1	1.0	9
gibberellic acid	10	1 - 4	2.9	81
carbaryl	10	1	1.0	696
benzyl adenine	1	1	1.0	9
2,4-D	1	1	1.0	14

8.1.3 Lerida

Table 8.1.3 Plant growth regulators used in Lerida

Active ingredient	% of crop treated (Base: 676 ha)	No. of applications		Cumulative dose g ai/ha of crop receiving that ai
		Range per farm	Ave per ha treated	Average
gibberellic acid	58	1 - 4	2.7	38
benzyl adenine	54	1 - 4	2.8	46
amino acid	37	2 - 8	3.1	425
2,4-DP	25	1 - 3	1.2	29
naphtoxy-2-acetamide	3	1 - 2	1.5	23
paclobutrazol	3	1 - 2	1.3	638
alpha-naphthylacetic acid (ANA)	2	1 - 2	1.7	4
chlormequat chloride	2	2 - 4	1.3	2,109
sulphur + trace elements	<1	7	7.0	42,008

There was a higher use of plant growth regulators in Lerida and Trentino than in the French region. Farmers look towards these chemicals to partially replace some of the labour-intensive horticultural operations such as pruning.

Golden Delicious and related varieties are often sprayed with products which reduce russetting as they are very susceptible to this problem. These varieties dominated in all three regions. Several farmers in Provence/ Languedoc/Rhône-Alps regularly used ‘Golclair’ products which contain sulphur and trace elements to combat this problem. In the other regions, plant hormone materials were used more than ‘Golclair’. However, some farmers who used sulphur for *Podosphaera* control it is believed did so in the knowledge that sulphur can reduce russetting.

8.2 Opportunities to reduce plant growth regulator load

Market demand for blemish-free fruit of optimum size determines the use of these products. The dominant variety (Golden Delicious group) needs fruit thinning and russet control. Variety diversification and consumer education could reduce the need for this sector.

9.0 TRENDS IN PESTICIDE USE

9.1 Variation in pesticide use over the last five years

Table 9.1 Variation in pesticide use over the last five years

Region	Provence/Languedoc/ Rhône-Alps (F)				Trentino (I)				Lerida (E)			
Crop area - ha	862				213				676			
Trend	Area %											
	herb	fung	insec	pgr	herb	fung	insec	pgr	herb	fung	insec	pgr
Increased	6	15	31	3	16	28	12	27	20	18	15	30
The same	80	74	47	19	44	30	14	26	11	27	24	37
Reduced	10	9	14	-	30	38	70	2	49	33	39	10
No reply	4	2	8	84	10	4	4	45	19	21	21	23

Farmers' opinions on use trends varied between countries and product types. For insecticides, fungicides and herbicides there was a tendency towards a reduction in Lerida and Trentino, whereas in Provence/Languedoc/Rhône-Alps more farmers felt use had remained the same compared with five years ago. Views on plant growth regulators were less clear, indicating their lower level of use than the other product types.

9.2 Plans to continue or change pesticide use in apples

Table 9.2 Plans to continue or change pesticide use in apples

Region	Provence/ Languedoc/ Rhône-Alps (F)	Trentino (I)	Lerida (E)
Number of farms	62	60	60
Plans	Farms %		
Will change	15	8	10
Possibly change	11	15	20
No change	68	75	57
Don't know	6	2	12

Those farmers who would or possibly would change were questioned on the chemical sectors where they would change and for what reasons.

In the French region, insecticides were cited on grounds of better control followed by fungicide for both better control and economics.

In Italy fungicides, followed by insecticides, would be changed on grounds of better control.

In Lerida all chemical sectors were mentioned by about half these farmers on grounds of economics followed by better control. In order of citation the chemical sectors were:

- Fungicides
- Insecticides
- Herbicides
- PGRs

Though environmental reasons were among the alternatives offered, only in Lerida would a small proportion plan changes on these grounds, here in insecticides and PGRs (11%).

9.3 Change in agrochemical use across all crops in the last five years

Questioned as to broad changes in agrochemical use across all their crops farmers gave the following replies:

Table 9.3 Change in agrochemical use across all crops in the last five years

Region	Provence/ Languedoc/ Rhône-Alps (F)	Trentino (I)	Lerida (E)
Number of farms	62	60	60
	Farms %		
More intensive	24	18	18
The same	63	13	42
Less intensive	11	50	38
No answer	2	18	2

This broadly agreed with the specific views on the apple crop and was generally supported by local specialists. With the marked exception of Trentino, and to a lesser extent Lerida where farmers have reduced their intensity of agrochemicals, the majority have remained the same.

The Trentino responses evidently reflect the success of the local protocol on IPM/ICM methods.

10.0 PESTICIDE/AGROCHEMICAL GENERALITIES

10.1 Sufficiency of choice of products

Table 10.1 Farmers who believed there was sufficient choice of products

Region	Provence/ Languedoc/ Rhône-Alps (F)	Trentino (I)	Lerida (E)
Number of farms	62	60	60
	Farms %		
Fungicides	95	88	92
Herbicides	81	87	93
Insecticides	77	87	93
Plant growth regulators	39	50	83

Apart from plant growth regulators, which were less widely used than the other sectors of agrochemicals, most replies indicated that current product choice was sufficient.

10.2 Attitudes to developments in the pesticide market

Farmers were asked to comment on developments in the pesticide market with regard to availability of new products, increasing efficacy, ease of application and lowering of residue levels. They responded as good, satisfactory or poor. Table 10.2 compares the results of the good and satisfactory results combined.

Table 10.2 Farmers who considered pesticide developments to be good or satisfactory

Region	Provence/ Languedoc/ Rhône-Alps (Fr)	Trentino (I)	Lerida (E)
Number of farms	62	60	60
	Farmers %		
Availability of new products	82	68	92
Increasing efficacy	69	35	88
Ease of application	86	93	95
Lower residue	70	80	75

The only poor response was 'increasing efficacy' from Trentino growers. Does this reflect the view that IPM/ICM systems do not achieve complete control of all pests?

10.3 Attitudes to handling restrictions on the label

Farmers were asked how important handling restrictions on the label were with regard to choice and use of products. They were offered three answers - very important, important and not important. Table 10.3 presents the farmers' answers to these two questions.

Table 10.3 Attitudes to handling restrictions on the label

Region	Provence/ Languedoc/ Rhône-Alps (F)		Trentino (I)		Lerida (E)	
Number of farms	62		60		60	
Attitude	Farmers %					
Importance	very	imp	very	imp	very	imp
On **choice** of product	47	37	73	20	75	23
On **use** of product	60	27	72	23	77	23

Although all farmers felt these aspects were important, there appears a greater degree of importance given to them in Trentino and Lerida.

10.4 Attitudes to environmental restrictions on the label

The same procedure as Section 10.3 was taken with regard to environmental restrictions.

Table 10.4 Attitudes to environmental restrictions on the label

Region	Provence/ Languedoc/ Rhône-Alps (F)		Trentino (I)		Lerida (E)	
Number of farms	62		60		60	
Attitude	Farmers %					
Importance	very	imp	very	imp	very	imp
On **choice** of product	55	31	58	33	72	27
On **use** of product	58	29	57	33	72	27

Considering farmers responses in Sections 10.3 and 10.4, clearly nearly all farmers said they took notice of labelling when making product choice.

In Trentino, farmers' positive attitudes on labelling probably reflected their knowledge of actual ICM protocol restrictions, often it is the cooperatives who advise on choice.

In Lerida, specialists views were that although farmers were very 'correct' in their responses on labelling, their main concern was whether products were registered for the intended uses, their effectiveness, crop safety and cost.

In Provence/Languedoc/Rhône-Alps, specialists were pleasantly surprised at farmers positive attitudes to labelling restrictions.

10.5 Sources of information

Farmers were asked to indicate their sources of information on agrochemicals and to attribute a score of 1 - 5, where 5 was most important.

Table 10.5 Information source

Region	Provence/ Languedoc/ Rhône-Alps (F)		Trentino (I)		Lerida (E)	
Number of farmers	62		60		60	
Information source	Farms %	Average score	Farms %	Average score	Farms %	Average score
Coop representative	61	4.0	30	4.6	28	4.4
Farming press	24	3.7	8	2.1	22	3.6
Manufacturer’s rep	16	4.0	2	5.0	15	2.9
Merchant	32	3.6	8	3.0	42	3.2
Neighbour/colleague	16	4.0	3	3.5	23	3.2
Plant protection advisor	27	3.5	63	4.3	57	4.1
Private consultant	26	4.2	2	3.0	35	4.6
Others	50	2.8	2	5.0	5	3.3

Plant protection advisors and Cooperative representatives featured highly as information sources for agrochemical advice.

11.0 PROFITABILITY AND PESTICIDES

11.1 Profitability of the apple crop

Farmers were asked how they assessed the profitability of their apple crop last year (1994), and five years ago.

Table 11.1 Profitability of apples

Region	Provence/Languedoc/ Rhône-Alps (F)		Trentino (I)		Lerida (E)	
Number of farms	62		60		60	
Profitability	Study year 1994	5 years ago	Study year 1994	5 years ago	Study year 1994	5 years ago
Very good	2	5	0	5	3	2
Good	16	15	10	18	15	3
Satisfactory	15	42	22	53	40	35
Total positive response	33	62	32	76	58	40
Poor	32	15	52	8	33	28
Very poor	35	6	2	0	5	15
Don’t know/no reply	0	18	15	15	4	17

For 1994, only in Lerida did the majority of farmers think profitability was reasonable and then only just. Five years ago the situation was reversed with a large proportion of the farmers in the French region and Trentino claiming profits were satisfactory or above.

11.2 Return and costs of production

Models of returns and costs of production are presented in the individual regional reports. Satisfactory models proved difficult to obtain within the context of this project. The details and terms used vary considerably and comparison is not very satisfactory. Agrochemical costs within the total context are presented in Table 11.2.

Table 11.2 Comparison of agrochemical costs

Agrochemical cost	Provence/ Languedoc/ Rhône-Alps (F)	Trentino (I)	Lerida (E)
As a proportion of variable costs	n/a	14%	n/a
As a proportion of total costs	10%	n/a	10%
As a proportion of gross income	n/a	6%	7%

11.3 Influence of anticipated profit on pesticide use

Farmers were asked to predict their reactions in terms of pesticide use when good or poor profitability was to be anticipated for the crop. A number of choices were offered.

Table 11.3 Influence of anticipated profit on pesticide use

Region	Provence/ Languedoc/ Rhône-Alps (F)		Trentino (I)		Lerida (E)	
Number of farms	62		60		60	
	Farms %					
Anticipated profit	Good	Poor	Good	Poor	Good	Poor
Price of product						
Use more expensive products	10	3	8	7	28	-
Use less expensive products	8	26	5	30	2	18
No influence	79	71	36	30	68	80
Don't know/no reply	3	-	50	35	3	2
Dose rate of product						
Increase dose	5	6	-	-	5	-
Decrease dose	-	6	5	3	-	7
No influence	95	87	49	70	93	92
Don't know/no reply	-	-	46	26	2	2
Age of products						
Use newer products	16	23	-	48	18	5
Use older products	6	5	34	3	3	12
No influence	74	73	20	23	77	82
Don't know/no answer	3	-	46	26	2	2

'No influence' was the most common response to all three categories in Lerida and Provence/Languedoc/Rhône-Alps. In Trentino 'no influence' featured strongly in replies but there was also a large number of 'don't know' or 'no reply'.

11.4 The effects of pesticides on profitability

Table 11.4 Effects of pesticides on profitability

Region	Provence/ Languedoc/ Rhône-Alps (F)		Trentino (I)		Lerida (E)	
Number of farms	62		60		60	
	Farms %					
Effect	Greatest	Least	Greatest	Least	Greatest	Least
Sector						
Fungicides	53	2	40	2	13	3
Herbicides	-	71	-	52	8	17
Insecticides	32	3	32	2	33	7
Plant growth regulators	2	15	2	17	3	8
Other	10	5	23	25	-	-
Don’t know/no reply	5	5	3	3	41	65

As to be expected, farmers believed herbicides to have less influence on profitability than fungicides or insecticides. Fungicides were more important in the Trentino and Provence/Languedoc/Rhône-Alps region than in Lerida. Insecticides were more important in Lerida. This is reflected in the product use patterns seen earlier in the report.

11.5 Possibility to reduce pesticide use without lowering profitability

Farmers were asked if it would be possible to reduce pesticide use without lowering profitability.

Table 11.5i Possibility to reduce pesticide use without lowering profitability

Region	Provence/ Languedoc/ Rhône-Alps (F)	Trentino (I)	Lerida (E)
Number of farms	62	60	60
	Farms %		
Yes	19	32	27
Possibly	8	5	18
No	61	38	48
Don't know/no reply	11	25	5

In each region more farmers indicated that they could not reduce pesticide than thought otherwise. However, others did feel they could or possibly could lower pesticide use without lowering profitability particularly in Trentino and Lerida. These farmers were asked to indicate in which sectors they felt they could make savings. Responses were limited and poor but their replies are recorded for information.

Table 11.5ii Sector where reductions might be possible without affecting profitability

Region	Provence/ Languedoc/ Rhône-Alps (F)	Trentino (I)	Lerida (E)
Number of farms	17	22	27
Sector	Farms %		
Fungicides	53	32	11
Herbicides	24	9	7
Insecticides	65	23	11
PGRs	-	5	4

12.0 ALTERNATIVE PEST CONTROL SYSTEMS

12.1 Awareness of alternative systems that might be equally profitable to conventional methods

Farmers were asked if they were aware of any alternative system of crop protection in apples which might be equally profitable to conventional methods. No prompts were given to them. Those not mentioning a system were then asked specifically if they were aware of Integrated Crop Management (ICM), Integrated Pest Management (IPM) or Organic Production (OP).

Definitions were given to farmers for the different regions (see Appendix I) but local terms and understandings also played a role in these answers. The results need to be interpreted with care.

Table 12.1 Awareness of alternative systems that might be equally profitable to conventional methods (unprompted)

Region	Provence/ Languedoc/ Rhône-Alps (F)	Trentino (I)	Lerida (E)
Number of farms	62	60	60
Unprompted	Farms %		
ICM	61	43	53
IPM	20	77	80
OP	2	57	75
None	8	10	12
Don't know/no reply	9	8	8
After prompting	Awareness amongst farmers which had not mentioned the system Proportion of total sample %		
ICM	19	5	8
IPM	56	5	5
OP	72	3	15

The level of response was highest in Provence/Languedoc/Rhône-Alps. Specialists in this region believed that most farmers would not clearly differentiate between ICM and IPM. ICM (agriculture raisonnée) is what they felt most farmers of this region believed they were practising by following recommendations of cooperatives and officials. From the high level of response it is suspected that farmers may not have understood that the question related to systems that were equally profitable to conventional systems.

Specialists in Trentino were surprised at the low response for ICM as most growers join the cooperative system and follow the recommendations developed by the local fruit growing committee which are ICM compatible. It seems many farmers may be confusing ICM with IPM.

There are very few Organic Production growers in any of the regions though high awareness was demonstrated.

12.2 Interest in developing alternative systems

Farmers were asked for their level of interest in developing the various alternative systems discussed.

Table 12.2 Interest in developing alternative systems

Region	Provence/ Languedoc/ Rhône-Alps (F)	Trentino (I)	Lerida (E)
Number of farms	62	60	60
	Farms giving positive response %		
ICM	63	27	65
IPM	47	66	75
OP	16	23	48

In view of the specialists' comment in Section 12.1 it is difficult to interpret these answers as many farmers, particularly in Trentino, are practising ICM.

Though terminology and definitions were evidently somewhat confusing across countries, there seems a majority interest in developing systems along ICM/IPM principles.

Specialist views were that in the French region farmers were open minded to IPM/ICM systems and were taking up IPM procedures as they became available.

In Trentino, the responses show a somewhat confused picture against the background of most growers following ICM/IPM procedures under the Trentino protocol - perhaps not fully understanding the names of the techniques they are employing.

In Lerida, specialists believed that the interest alleged by farmers was high relative to their experience in trying to enlist farmers into an IPM system that the local advisors have been promoting for five years. This view was supported by the group discussion.

13.0 ENVIRONMENTAL ISSUES

13.1 Farms in restricted areas

In Lerida and Provence/Languedoc/Rhône-Alps very few farmers indicated that they were in restricted areas (2 and 4 farmers respectively). Three of the total (1 and 2 respectively) claimed to be in an environmentally sensitive area. The form of product restriction was not given. Only one farmer indicated difficulties in making pesticide choices.

In Trentino, 25 farms claimed to fall into restricted areas, in all cases environmentally sensitive areas. In addition one farmer said he was in an area of special scientific interest. Eleven farmers of the group said it was difficult or very difficult in choosing products as a consequence of the restriction.

13.2 Considerations influencing the choice of pesticides

Farmers were asked what considerations, from a list of suggestions, they took into account when choosing pesticides.

Region	Provence/ Languedoc/ Rhône-Alps (F)	Trentino (I)	Lerida (E)
Number of farms	62	60	60
Consideration	Farms %		
Soil protection	23	58	17
Ground water	23	55	18
Surface water	11	47	22
Produce quality	35	40	23
Fauna	26	37	22
Flora	19	33	20
None of these	48	12	57
Others Bees	2	-	-
Operator protection	2	2	-
Profitability and product	2	-	-
appearance	-	18	-
Local protocol	-	2	9
Don't know			

Some farmers considered environmental factors when choosing pesticides, but produce quality also ranked high in influencing pesticide choice, as might be expected.

Farmers in the Trentino area appeared to consider a higher proportion of environmental factors than in the other regions reflecting the influence of the local

protocol.

APPENDIX I

DEFINITIONS AND CAVEAT

BACKGROUND

1 Ideally this study should have been conducted on an individual field basis. Economics and practical considerations, however, precluded this. Farmers were therefore asked about their treatments for the entire crop over their whole farm.

2 Typically fields were treated several times for any one pesticide sector (fungicides, insecticides, particularly). Occasionally on certain farms some fields were treated more times than others - though review of the data shows this to be limited.

3 Applications were made with agrochemical products containing one or more active ingredients. While data was collected from the farms at product level the results were required at active ingredient level for calculation of chemical load and to facilitate cross-country comparisons.

4 Presentation of the data as kg ai/ha has been used for simplification. This of course hides the great variation in inherent activity of different chemicals. Attempts are made to cover for this in the text.

DEFINITIONS

Regional level:

Base area treated (for a chemical sector)

That part of the crop which receives any treatment at all for the chemical sector in question. This is represented by Crop Area - Untreated Area = Base Area Treated.

Farm level:

Proportion of crop treated

This is defined as "That portion of crop receiving the active ingredient at least once". Where a series of treatments, of differing areas, had been made on a farm then the assumption has been made that the treatments were made sequentially on the largest area receiving that active ingredient. In practice the largest area was nearly always the complete area of crop on that farm so this is usually correct.

Average number of applications

For a given active ingredient this was calculated as the average number of times an active ingredient was applied on a given farm. Where an active ingredient is applied on different areas then the average number of applications/ha is calculated for the whole farm. This can occasionally underestimate the number of applications on a given field.

Cumulative dose

This is the total volume of an active ingredient used on a farm divided by the area of study crop grown on that farm. In situations where a chemical was not always used on the whole farm this has the effect of underestimating the dose - however, as already indicated these situations were limited.

Product applications

Products may be applied alone or in tank mixes. The latter were not catered for in the questionnaire. The term product applications has therefore been introduced meaning products x applications. As a consequence this can exaggerate the number of applications made on a farm where considerable use was made of tank mixes (possibly mixes of two products at low dose).

ALTERNATIVE CROP PROTECTION

Integrated Pest Management (IPM)

The objective here is control of pests (weeds, disease, insects etc) using a mix of the less aggressive chemicals available and the stimulation of the crop or beneficial organisms to control the pest. Such methods may involve choice of resistant varieties, modifying rotations, use of biological pesticides etc.

Integrated Crop Management (ICM)

The objective here is to manage the growing of crops in such a way as to reduce any negative effects on the environment, typically ground water. As such, the same methods may be used as with IPM, but taken further to include fertilisers and any other ‘contaminating’ inputs and cultural methods.

Organic Production (OP)

The objective here is to produce crops in which chemical pest control or fertilisers have played no part.

APPENDIX II

COLLABORATORS AND CONTACTS

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Alfonso Herrero
Ingeniero Agrónomo (PhD in Agronomy)
Researcher of the IRTA (Instituto of Agronomic Research) and Technical manager of a group of 15 fruit cooperatives

Jose Luis Trilla
Ingeniero Agrícola (Agronomist)
Manager of ACTEL (Cooperatives Association for the purchases and distribution of pesticides)
Advisor of the Cooperatives members of the group

Pedro Moliné and Joaquin Llardén
Ingenieros Agrícolas (Agronomists)
Sales representatives of two agrochemical firms
Farms advisors for agrochemical use

REPORT FOR THE COMMISSION OF EUROPEAN COMMUNITIES
DUTCH MINISTRY FOR THE ENVIRONMENT

REGIONAL ANALYSIS OF USE PATTERNS OF PLANT PROTECTION PRODUCTS IN SIX EU COUNTRIES

PES - A/PHASE 2

A COMPARISON OF AGROCHEMICAL USE ON VINES IN THREE REGIONS IN EUROPE

Bordeaux, France
Rioja, Spain
Verona, Italy

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VINES - CROSS REGIONAL REVIEW

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VINES - CROSS REGIONAL REVIEW

SUMMARY

The study was conducted in mid 1995 on practices employed in 1994. Three regions were reviewed: Bordeaux (Gironde, Charente and Charente Maritime) (F), Rioja (E) and Verona (I). These were covered by farmer surveys and discussions with key specialists in the regions.

General

The three vine growing areas in the study were each different from one another. Vine holding per farm was largest in Bordeaux at 11 ha/farm and smallest in Verona at 0.7 ha/farm. The study samples however, which were designed to review similar farm numbers across the farm holding profile, over-sampled the larger holdings in each region and reduced the variation in average holding size between regions.

Chemical load

The average volumes of active ingredients applied per hectare of crop grown in the samples were:

		Average	(Range)
Bordeaux	(F) -	45 kg ai/ha	(7.9 - 87.3 kg ai/ha)
Rioja	(E) -	17 kg ai/ha	(2.9 - 146.9 kg ai/ha)
Verona	(I) -	34 kg ai/ha	(0.8 - 142.4 kg ai/ha)

There was some evidence that growers in Rioja and Verona had not declared all their sulphur use which if additionally estimated brings all regions to a similar average level.

Weed control - herbicides

Target weeds indicated that perennial broad leaf weeds were seen as most of a problem in the Bordeaux region and least in Verona. The perennial grass weeds were seen as important in Rioja and Verona. Demand for a high level of weed control was highest in Bordeaux and considerably lowest in Verona. This is reflected in herbicide use where 90% of the growers used herbicides in Rioja and Bordeaux while in Verona this was only 43%.

The heaviest load of herbicides was applied in Bordeaux where soil-acting residual herbicides were most used. Farmers in this region, however, also appeared to target the treatments to the greatest degree.

Mechanical cultivations were made in all three regions. These were carried out for other reasons as well as weed control and appeared to have no effect on reducing herbicide load.

Herbicide use has moved substantially to use of contact herbicides which can be used as and when the problems are seen. Herbicide placement through spraying along the rows and spot spraying is also well entrenched. Only limited further load reductions can be envisaged through increased use of contact herbicides as opposed to soil-acting chemicals and increased use of treatments along the rows and spot treatments.

Disease control - fungicides

The two main diseases, *Plasmopara viticola* (downy mildew) and *Uncinula necator* (powdery mildew), determine the necessity to protect the vines throughout the season. *Botrytis cinerea* (grey mould) is also of importance. The relative importance of the two main diseases varies by region with *Plasmopara* the more dominant disease in Bordeaux and Verona and *Uncinula* in Rioja.

The level of disease control expected by growers was virtually 100% except in the Verona region where they were less demanding. There officials indicated that *Plasmopara* only required maximum control early in the season.

Fungicides were overwhelmingly the largest component of chemical load in the three regions owing to the number of treatments required to protect the crops season-long and the low activity (high dose rate) of some of the chemicals employed (eg copper salts and sulphur).

Amongst the most used active ingredients, contact/protectant chemicals were most important in Bordeaux and Verona whilst in Rioja most chemicals were systemic, targeted (as was sulphur) at *Uncinula*.

ICM techniques are being promoted in all regions. In Rioja farm scale trials have shown that a near halving of the number of applications can be achieved with this technique.

Official warning systems are available in all regions to determine the time to start spraying. These were most used in Bordeaux and Rioja. Greater use, particularly in Verona, might help to target applications and reduce any unnecessary use.

Insect and mite control - insecticides and acaricides

The main pest in all regions was the grape berry moth, *Lobesia botrana*. Mite pests used to be important and in the minds of growers still are. They have declined except in Bordeaux. The other important pests were leaf-hoppers, mainly *Empoasca* species, where there were suggestions of their increase.

Programmes of pest control adopted in the three regions were different. The active ingredient list in Bordeaux was a 'modern' one, using products with high levels of activity. Several specific acaricides were amongst the most used products. The active ingredients used in Rioja were essentially 'traditional'. The most used product was a formulated mixture of parathion in petroleum oil. Mites were less important and there were only two specific acaricides mentioned apart from sulphur. The influence of the multiple sulphur applications for disease control in maintaining a low level of mite infestation is discussed. The active ingredients used in Verona were indicative of the influence of IPM in the region but pest infestations may be lower as well because 26% of growers did not apply any insecticide in 1994. This could, though, be a further indication of successful IPM.

IPM is currently practised in all regions, but there are indications in this study that pesticide use could be considerably reduced if IPM techniques were adopted more enthusiastically. Official warning systems are avilable in all regions to determine timing of sprays for some pests. These were most used in Rioja and Bordeaux. Greater use, particularly in Verona, might help to target applications more tightly.

Trends in pesticide use and agrochemical generalities

Growers in Bordeaux felt that use of pesticides had remained the same over the last five years. Growers in Rioja were divided. Half thought the position was the same whilst half thought there had been an increase. There were also mixed opinions in Verona, some believing there had been an increase and others a decrease.

About three-quarters of growers had no plans to change their pesticide/agrochemical use in the near future. Of those who might change, most numerous in Rioja, the main areas for change were in insecticides/acaricides and fungicides, for reasons of 'better control'. A significant minority of growers in Rioja gave 'environment' as a reason for change.

All growers professed that they considered handling and environmental restrictions on the label as important or very important, and a large majority were generally satisfied with developments in the agrochemical market. Specialists did not believe that growers were being perfectly honest in their response concerning environmental restrictions on the label - they felt, particularly in Bordeaux and Rioja, that growers were being polite!

Information sources

In all three regions the most important source of information was the co-operative representative, particularly so in Bordeaux and Verona. In Rioja a wider spread of sources was used, including agrochemical merchants, official plant protection advisors and private consultants - the latter two receiving high scores for the quality of the information they gave. In Verona larger farmers used merchants more than the smaller farmers because they tended not to be members of the local Cantine Sociali (co-operative). It is significant that although the official plant protection advisors achieved high scores in Verona, they were not used by many growers.

Profitability

The majority of growers in all regions said that the profitability of vines was satisfactory (or better) in 1994. Strictly comparable raw data on economic models were not available for each region, but a comparison of factors such as agrochemical costs as a proportion of all variable costs and of gross income was possible. Concerning agrochemical costs as a proportion of gross income, Bordeaux and Rioja were very similar at 8 and 9% respectively whilst, as might be expected, in Verona it was only 4.5%.

The influence of anticipated profit on growers' use and choice of pesticides varied both within and between regions, but the majority would be uninfluenced.

Growers in all regions felt that fungicides were the main sector affecting profitability. Despite this, in all regions, and especially strongly in Rioja, it was felt that reductions in fungicide use could be made without affecting profitability.

Alternative crop protection systems

Growers in Bordeaux showed most general awareness of all the three alternative systems ICM, IPM and OP. In Rioja and Verona IPM and OP were most recognised but by less than half of the growers. Lack of awareness of terminology may have led to an understatement of knowledge in Rioja and Verona although the PPS in Rioja confirmed a lack of interest in that region. In Verona specialists said that growers had been using elements of IPM and ICM for years but would be unaware of the terms. Most interest in developing IPM or ICM on their farms was found in Bordeaux, and most interest in OP in Rioja.

Environmental issues

Only one farm in Bordeaux and four in Verona were in areas with environmental restrictions. Three of the four in Verona said it made their choice of agrochemicals difficult.

In response to questioning of all growers on environmental factors influencing their choice of agrochemicals, over half in Bordeaux and Rioja, and just under half in Verona, were not influenced by any environmental criterion. In Bordeaux 'produce quality' and absence of residues from grapes were the main factors of interest, and in Verona it was 'soil protection'. Specialists in Bordeaux and Rioja confirmed that growers had little interest in or awareness of environmental considerations.

Conclusions

The vine areas of Bordeaux, Rioja and Verona are three quite different climatic and agricultural regions. The problems presented to the growers in each are different.

IPM and ICM techniques appear to be in the process of being implemented in Bordeaux and Verona, and to a lesser degree in Rioja, but from grower answers to questions and the lists of active ingredients used there still seems to be a long way to go in all regions. Trials in Rioja suggest that a substantial reduction in fungicide use could be achieved by following such a regime.

Greater use of the official warning systems available for determining spray timing for disease and insect control might target applications more accurately and reduce any unnecessary use.

1.0 THE REGIONS, METHODOLOGY AND SAMPLES

1.1 The regions

Three well developed vine growing regions were selected. The regions chosen were:

France - the broad Bordeaux region encompassing Gironde, Charente and Charente Maritime

Spain - Rioja

Italy - Verona

1.2 Methodology

The format followed consisted of two group discussions, one in Bordeaux and one in Verona, to determine broad parameters followed by farmer surveys in the three regions using a questionnaire of approximately one hour in length. Fieldwork was conducted in mid 1995 and questions related to agrochemical use in the previous season 1994. Results, having been obtained and partially analysed, were used as the basis of interviews with local specialists in the regions to discuss findings and broaden discussion.

1.3 The survey samples

The objective of the farmer survey was not only to ascertain current agrochemical practices in the region but also to identify differences in agronomic practice between farms.

Patterns of crop distribution by farm in all regions showed the typical pattern of the largest area of crop concentrated in the hands of relatively few larger units.

When designing the sample prior to commencement of research the causal factors of any variation are not fully known. It is often found, however, that one of the main common bases for variation in practice is enterprise size.

Budgetary restraint limited the sample size to around 60 in a region. It was decided that in order to expose variation a sample with as far as practically possible adequate numbers of farms across the crop distribution profile should be represented.

The statistics for the regions are presented in the individual regional reviews but are not easily presented in summary. The samples resulting were the following.

Table 1.3 Farm survey samples

Vine area per farm - ha	Bordeaux (France)		Rioja (Spain)		Verona (Italy)	
	Farms %	Area %	Farms %	Area %	Farms %	Area %
0.2 - 2	-	-	-	-	34	4
2 < 5	-	-	-	-	34	17
1 < 5	2	0.2	23	3	-	-
5 < 10	29	8	29	9	16	16
10+	-	-	-	-	15	64
10 < 20	34	19	23	13	-	-
20+	36	72	-	-	-	-
20 < 50	-	-	16	21	-	-
50+	-	-	10	56	-	-
Total No., ha	59	1,420	62	1,383	61	412
Average per farm - ha	-	24	-	22	-	6.8
Regional average per farm - ha	-	11	-	3	-	0.7

The average crop areas for the sample are compared above to the average for the region as a whole. From this it may be seen that the average areas in the samples were larger than for the regions as a whole, a consequence of spreading the sample as evenly as possible down the farm profile.

2.0 GENERAL RESEARCH FINDINGS

2.1 Farming demographics

2.1.1 Land tenure

Table 2.1.1 Land tenure

Region	Bordeaux (F)	Rioja (E)	Verona (I)
Number of farms	59	62	61
Total crop area - ha	1,420	1,383	412
Ownership	Farms %		
>60% owned	64	94	85
40 - 60% owned	14	3	8
<40% owned	22	3	7

In Bordeaux there was a significant proportion of growers who did not own their complete farm.

2.1.2 Occupational status

Almost all growers in the study were full-time vine growers, although in the Rioja region this was not representative of the area where most farms are smaller than in the study and the growers are mostly part-time.

2.1.3 Farming enterprises

Table 2.1.3 Farming enterprises

Region	Bordeaux (F)	Rioja (E)	Verona (I)
Number of farms	59	62	61
	Farms %		
Crops			
maize	51	8	49
small grain cereals	37	44	36
soya beans	8	2	8
sugar beet	12	11	11
sunflowers	3	2	3
field vegetables	5	18	5
top fruit	31	3	30
soft fruit	2	3	2
temporary grass	15	2	15
permanent grass	19	0	18
Animals			
dairy	14	0	13
beef	14	0	13
veal	15	0	15
pigs	0	2	0
poultry	8	0	8

Verona and Bordeaux appeared to be similar in their type of farming enterprise. Rioja had more small grain cereals and vegetables together with virtually no livestock.

2.2 Agronomy

2.2.1 Varieties

Table 2.2.1 Main grape varieties

Bordeaux (F)		Rioja (E)		Verona (I)	
Crop area 1,420 ha		Crop area 1,383 ha		Crop area 412 ha	
Main varieties Area %					
Uniblanc	34	Tempranillo	49	Corvina	24
Cabernet	33	Garnacha	17	Garganega	14
Sauvignon	24	Viura	11	Cabernet Sauvignon	10
Merlot	2	Mazuelo	7	Rondinella	9
St Emilion	2	Corvina	2	Trebbiano/Castelli	7
Colombar				Romano	
				Pinot varieties	6
				Tocay	6
				Verduzzo	4
				Riesling	4

There was a much greater spread of varieties grown throughout the sample in Verona than in the other two regions. For all regions there were many other varieties grown on small areas.

In Bordeaux, specialists suggested that there were no particular consequences for agrochemical use as a result of growing different varieties. Comments made by specialists in Rioja were that Tempranillo was susceptible to *Uncinula necator* (vine powdery mildew), but resistant to *Plasmopara viticola* (vine downy mildew), and that Garnacha and Viura were susceptible to all diseases.

A fairly detailed assessment was given for Verona for which the disease susceptibility of the varieties mentioned above are as follows:

Disease	Susceptible varieties
Plasmopara	Corvina, Tocay
Botrytis	Trebbiano, Pinot, Tocay
Phoma	Rondinella

2.2.2 Soil types

Table 2.2.2 Soil types - main constituents

Region	Bordeaux (F)	Rioja (E)	Verona (I)
Crop area - ha	1,420	1,383	412
Broad soil type	Area %		
Sand	27	15	10
Silt	4	6	10
Clay	40	54	61
Organic	0	3	12
Other	26	23	8

Clay was the main component, particularly in Verona. There were not thought to be any consequences for agrochemical use.

2.2.3 Fertiliser use

Table 2.2.3 Fertiliser use

Region		Bordeaux (F)	Rioja (E)	Verona (I)
Crop area - ha		1,420	1,383	412
Constituent	Specification kg/ha	Area %		
Nitrogen				
High	> 50	1	2	0
Medium	26 - 50	96	97	56
Low	1 - 25	1	1	41
Nil	0	0	0	0
No answer		2	0	3
Phosphorus				
High	> 50	5	4	1
Medium	26 - 50	36	34	19
Low	1 - 25	36	62	38
Nil	0	0	0	27
No answer		22	0	15
Potassium				
High	> 80	24	86	34
Medium	51 - 80	17	10	8
Low	1 - 50	53	3	26
Nil	0	0	0	20
No answer		1	0	15

With the exception of Verona there was little variation in nitrogen usage, most were firmly in the medium category. The levels of many growers in Verona were in the low category. Specialists in Verona said that these lower rates were applied where growers were following ICM practices - the lower levels minimise the severity of disease attack from *Uncinula necator* and *Botrytis.*

Levels of phosphorus were more varied but again in Verona the spread was widest with many applying low volumes and some none. Larger growers tended to apply the higher rates of both nitrogen and phosphorus in Verona. Specialists in Rioja believed that the rates of phosphorus applied were too low as 72 - 144 kg/ha was the recommendation.

2.3 Commercial issues

2.3.1 Destination of produce

Growers were asked in what form and to whom their produce was sold.

Table 2.3.1 Destination of produce and customers

Region	Bordeaux (F)	Rioja (E)	Verona (I)
Number of farms	59	62	61
Destination	Farms %		
Wine	92	92	54
Grapes	17	48	34
Other	2	11	21
Customer			
Coop/dealer	42	92	70
Direct to consumer	52	6	20
Other	5	2	21

In Bordeaux, growers sold their grapes through co-operatives who then made wine. The produce remains the property of the grower until the wine is sold. In Rioja the grapes were sold by weight of grapes or by weight x alcohol level of the wine. In the region as a whole the majority was sold to co-operatives and about 30% to wine producers.

In Verona, larger growers sold to ‘consumers’, believed to be wine-makers, whilst the smaller growers sold to co-operatives.

2.3.2 Agrochemical restrictions in production contracts

Table 2.3.2 Agrochemical restrictions in production contracts

Region	Bordeaux (F)	Rioja (E)	Verona (I)
Number of farms	59	62	61
	Farms %		
Restrictions	22	5	3

The sectors affected by restrictions were fungicides and insecticides.

Specialists in Bordeaux explained that there were normally two types of restrictions, both related to market requirements. The first was for products which were registered in France but not in the USA. In these cases they may only be used before flowering - examples were pyrimethanil and fludioxonil. The second type of restriction concerned vines from which the grapes were destined for cognac production, and here there were quite a series of restrictions concerning which fungicides and insecticides might be used and when. These are detailed in the country report.

3.0 PESTICIDE USE

3.1 Summary of pesticide use

Regional totals and splits by chemical sector are presented in Table 3.1.

The lowest chemical load was in Rioja and highest in Bordeaux. There are some indications that sulphur was under-reported in Rioja and Verona. If these are adjusted to include extra sulphur use then the regional loads are very similar.

3.1.1 Herbicides

Demand for a high level of weed control was greatest in Bordeaux where the herbicide load was highest. Targeted weed control was highest also in Bordeaux but the high load resulted from greater use of soil-acting residual chemicals.

3.1.2 Fungicides

The fungicide load dominated the total chemical load in all regions. Season long protection against diseases is required and many chemicals are traditional (copper salts and sulphur) with low activity and consequential heavy loads.

3.1.3 Insecticides

This sector shows low levels of chemical load except in Rioja where sulphur and petroleum oils were used. Removing these provides a chemical load similar to the other regions.

3.1.4 Other pesticides and agrochemicals

Minimal use.

Table 3.1 Summary of chemical use

Region	Bordeaux (F)			Rioja (E)			Verona (I)		
Area grown (ha)	1,420			1,383			412		
	Proportion of crop treated %	Average volume of active ingredient kg/ha		Proportion of crop treated %	Average volume of active ingredient kg/ha		Proportion of crop treated %	Average volume of active ingredient kg/ha	
		on crop treated	on crop grown		on crop treated	on crop grown		on crop treated	on crop grown
Herbicides	85	4.1	3.5	80	2.4	1.9	52	1.7	0.9
Fungicides									
1 Grower responses	100	40.5	40.5	99	10.4	10.2	100	31.8	31.8
2 Grower responses and computed	n/a	n/a	n/a	100	35.4	35.4	100	40.8	40.8
sulphur	100	22.9	22.9	99	0.7	0.7	100	24.1	24.1
3 Grower responses excluding all sulphur									
Insecticides	96	1.1	1.0	99	4.7	4.6	62	1.4	0.9
1 As declared in survey	n/a	n/a	n/a	98	1.4	1.3	n/a	n/a	n/a
4 Excluding sulphur and oil adjuvant	1	0.02	<0.01	<1	0.2	<0.01	0	0	0
Other pesticides	0	0	0	1	0.5	<0.01	0	0	0
Other agrochemicals									
All sectors									
1 Grower responses	**100**	*	**45.0**	**100**	*	**16.8**	**100**		**33.6**
2 Grower responses excluding fungicide sulphur	**n/a**		**27.4**	**100**		**7.2**	**100**		**25.9**

Notes: * Treatments were not applied to the same areas of crop in each class of agrochemical and so no total is provided for this column.

Notes to Table 3.1

Fungicides and sulphur use (Rioja and Verona particularly):

1 Specialists commented that sulphur would have been applied in multiple treatments on all farms. It is believed farmers barely regard sulphur as a pesticide and therefore did not mention it.

2 As a consequence to determine the likely real load, sulphur has been added at an average load to those farms not declaring it in order to provide an overall load that is more realistic.

3 Sulphur is, however, a low activity high volume fungicide and so in this line sulphur has been stripped out completely to show the load of remaining fungicides.

4 Sulphur is also used as an insecticide. In addition a number of applications were made with mineral oil in the formulations with certain insecticides. Both these chemicals are used at substantial dose rates and so to give an indication of chemical load without them, the sulphur and mineral oil elements have been stripped out.

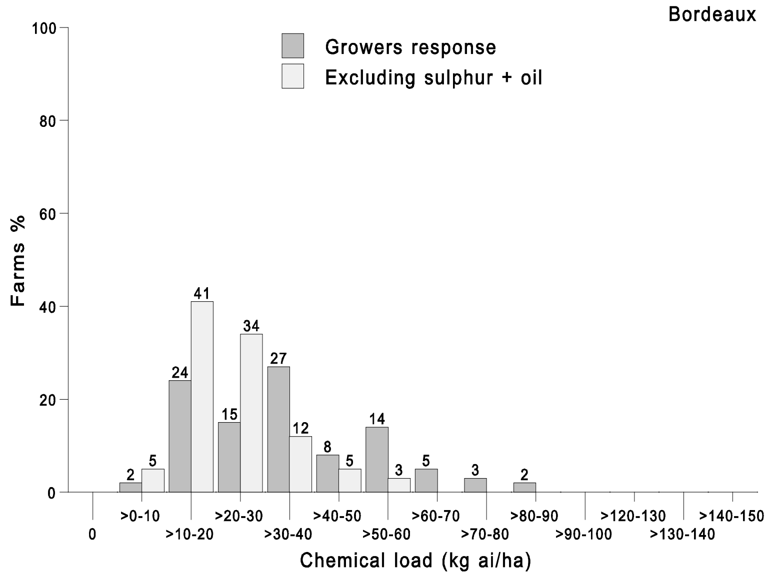
3.2 Variation in chemical load between farms and regions

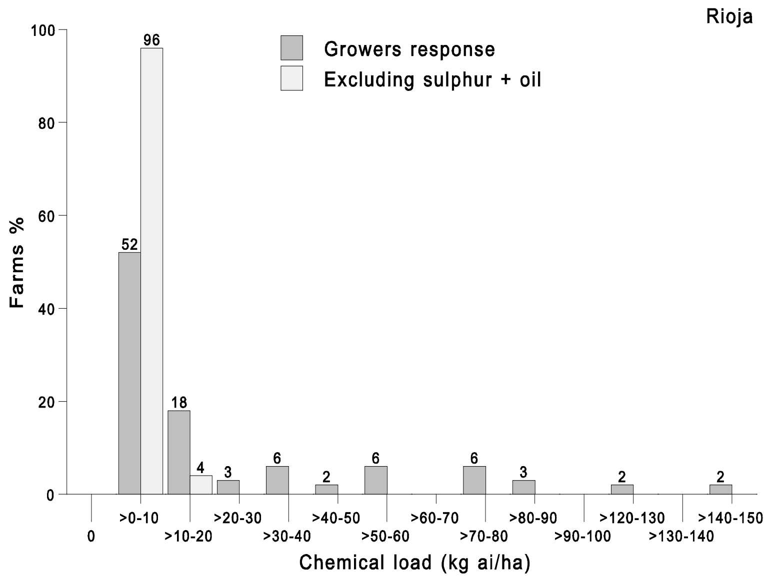
The variation in chemical load as indicated by the grower replies and stripped of sulphur and mineral oil are presented in the tables and graphs below.

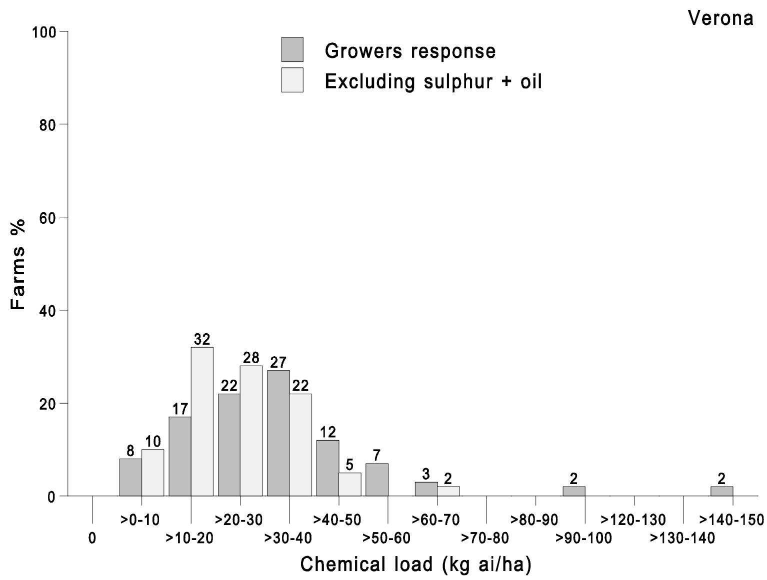
Table 3.2 Variation in chemical load between farms and regions

Region	Bordeaux (F)		Rioja (E)		Verona (I)	
Number of farms	59		62		61	
Chemical load kg ai/ha	Farms %					
	Growers response	Excluding sulphur + oil	Growers response	Excluding sulphur + oil	Growers response	Excluding sulphur + soil
0	-	-	-	-	-	-
>0 - 10	2	5	52	96	8	10
>10 - 20	24	41	18	4	17	32
>20 - 30	15	34	3	-	22	28
>30 - 40	27	12	6	-	27	22
>40 - 50	8	5	2	-	12	5
>50 - 60	14	3	6	-	7	-
>60 - 70	5	-	-	-	3	2
>70 - 80	3		6		-	
>80 - 90	2		3		-	
>90 - 100	-		-		2	
>120 - 130	-		2		-	
>130 - 140	-		-		-	
>140 - 150	-		2		2	
Range kg ai/ha of crop grown	7.9-87.3		2.9-146.9		0.8-142.4	

Chart 3.2 Variation in chemical load between farms and regions







4.0 WEEDS AND WEED CONTROL

4.1 Target weeds

Table 4.1 Main target weeds

Region	Bordeaux (F)	Rioja (E)	Verona (I)
Number of farms	59	62	61
	Farms %		
Dicotyledons			
Amaranthus retroflexus	49	31	38
Artemesia spp	-	13	13
Chenopodium album	24	35	20
Chrysanthemum spp	-	-	3
Cirsium arvense *	52	30	7
Convolvulus arvensis *	83	94	36
Diplotaxis muralis	-	ss	-
Equisetum spp *	12	-	-
Erigeron canadensis	-	s	-
Fumaria oficinalis	+	ss	-
Malva neglecta	7	13	15
Papaver spp	+	-	8
Portulaca oleracea	8	+	13
Raphanus raphanistrum	+	ss	-
Rubus spp *	7	-	3
Rumex spp *	17	-	3
Salsola kalli	-	8	-
Senecio vulgaris	10	-	-
Sinapis arvensis	-	ss	-
Sonchus asper	-	ss	-
Urtica spp *	-	-	8
Veronica hederifolia	-	ss	-
Monocotyledons			
Alopecurus myosuroides	5	-	7
Cynodon dactylon *	7	56	69
Digitaria sanguinalis	14	-	3
Echinochloa crus-galli	12	-	3
Lolium perenne *	44	ss	-
Poa spp	14	+	3
Setaria glauca	-	s	-

Sorghum halepense *	+	18	39

Key: * = perennial
- = not mentioned
+ = mentioned by growers
s = mentioned by specialists
ss = believed by specialists to be important

A similar weed flora was claimed for most regions. Differences were most marked in the perennial weeds. The dicotyledons appeared worst in Bordeaux and least in Verona, while the difficult grass perennials were most prevalent in Rioja and Verona.

4.2 Weeds claimed to be resistant to herbicides

Growers in all three regions (up to 35% in Rioja) claimed to have experienced cases of weeds resistant to herbicides. In the vast majority of cases, specialists refuted these as being the result of using inappropriate herbicides or of badly managing the application process. There were some cases with which they agreed:

Bordeaux - *Amaranthus, Agropyron* and several other species may be resistant to triazines.

Rioja - *Cynodon* and *Convolvulus* may be resistant to simazine.

Verona - Specialists believed there was no genuine resistance in the region.

4.3 Levels of weed control sought

Table 4.3 Levels of weed control sought

Region	Bordeaux (F)	Rioja (E)	Verona (I)
Number of farms	59	62	61
% control	Farms %		
< 70%	2	2	11
71 - 80%	3	0	18
81 - 90%	12	5	30
91 - 100%	83	79	25
No answer	0	14	16

The level of control sought was high in Bordeaux and Rioja, especially in the former with respect to dicotyledons. The apparent low requirement in Verona should be set

against the fact that only 43% of growers used herbicides in 1994.

4.4 Herbicide use

4.4.1 Bordeaux

Crop area treated: 85%.

Table 4.4.1 Herbicide active ingredients used in Bordeaux

Active ingredient	Activity	% of crop treated	No. of applications where used		Cumulative dose on crop receiving that ai g ai/ha		
		(Base area 1,420 ha)	Range per farm	Ave per ha treated	min	max	ave
glyphosate	c	63	1 - 2	1.5	21	4,800	998
diuron	s	57	1 - 2	1.3	71	4,560	1,214
terbuthylazine	s	54	1 - 2	1.3	71	4,828	1,469
amitrole	cs	35	1 - 2	1.2	47	6,000	1,662
ammonium-thiocyanate	c	17	1 - 2	1.0	225	1,800	1,166
oryzalin	s	12	1	1.0	1,176	3,359	2,873
simazine	s	11	1 - 2	1.0	45	2,100	525
paraquat	c	11	1 - 2	1.1	83	400	193
glufosinate	c	6	1 - 2	1.3	104	1,500	598
isoxaben	s	6	1	1.0	262	556	524
terbumeton	c	4	1 - 2	1.5	813	1,162	987
diquat	c	1	1	1.0	200	200	200
glyphosate-trimesium	c	1	1	1.0	590	590	590

Key to abbreviations:

c = contact post-emergence s = soil acting residual

4.4.2 Rioja

Crop area treated = 80%.

Table 4.4.2 Herbicide active ingredients used in Rioja

Active ingredient	Activity	% of crop treated	No. of applications where used		Cumulative dose on crop receiving that ai g ai/ha		
		(Base area: 1,383 ha)	Rang e per farm	Ave per ha treated	min	max	ave
terbumeton	s	43	1 - 2	1.1	250	2,312	791
terbuthylazine	s	43	1 - 2	1.1	250	2,312	791
simazine	s	27	1 - 2	1.0	625	5,000	2,214
glyphosate	c	26	1 - 2	1.0	108	3,039	717
paraquat	c	14	1	1.0	40	1,200	440
glyphosate-	c	9	1	1.0	719	3,840	3,235
trimesium	c	4	1	1.0	451	451	451
glufosinate	s	2	1	1.0	100	100	100
oryzalin	sc	2	1	1.0	2,000	3,600	3,280
amitrole	s	0.4	1	1.0	2,000	2,000	2,000
diuron	c	0.1	1	1.0	156	156	156
fluazifop-p-butyl							

Key to abbreviations:

c = contact post-emergence s = soil acting residual

4.4.3 Verona

Crop area treated 52%.

Table 4.4.3 Herbicide active ingredients used in Verona

Active ingredient	Activity	% of crop treated	No. of applications where used		Cumulative dose on crop receiving that ai g ai/ha		
		(Base area: 412 ha)	Range per farm	Average per ha treated	min	max	ave
glyphosate	c	25	1 - 3	1.6	119	4,920	1,961
paraquat	c	21	1 - 2	1.0	23	650	131
diquat	c	18	1 - 2	1.0	12	147	35
terbumeton	c	15	1	1.0	766	766	766
terbuthylazine	c	15	1	1.0	766	766	766
glyphosate-trimesium	c	7	1 - 2	1.1	256	960	756
metolachlor	s	3	1	1.0	1,370	1,370	1,370
glufosinate	c	2	1 - 2	1.1	112	360	179
MCPA	c	1	2	2.0	144	144	144
bensulfuron-methyl	cs	1	2	2.0	60	60	60
rimsulfuron	c	1	2	2.0	15	15	15

Key to abbreviations:

c = contact post-emergence s = soil acting residual

The lists of active ingredients were broadly what specialists in each region expected.

In Bordeaux typically a contact/systemic such as glyphosate was used, possibly mixed with or followed by a soil-acting residual such as diuron. In both Rioja and Verona formulated mixtures of the soil-acting terbumeton and terbuthylazine were very popular. The lists from each region were generally similar, as might be expected in a perennial crop such as vines in climatically similar zones.

Specialists in Rioja expected that oxyfluorfen and pendimethalin would have been mentioned, and those in Verona felt that glyphosate-trimesium was in general used less than suggested. The latter also pointed out that metolachlor and rimsulfuron are maize herbicides and that bensulfuron-methyl is a rice herbicide.

Dose rates used in all regions were low. In Rioja and Verona around the lower end of any recommended rate range, and in Bordeaux below recommended label rates. Some of the dose rate ranges recommended on the label are very wide, particularly for cross-spectrum soil-acting residual herbicides such as the triazines, and the post-emergence total weed killers, such as glyphosate. This factor coupled with the variability resulting from different herbicide placements, detailed in Section 5.2, means that there are wide variations in cumulative doses in Tables 4.4.1 - 4.4.3.

4.5 Herbicide use parameters

4.5.1 Average number of herbicide applications

Table 4.5.1 Average number of herbicide applications

Region	Bordeaux (F)	Rioja (E)	Verona (I)
Proportion of crop treated	85%	80%	52%
On vineyards using herbicides			
No. of active ingredients used per farm No. of active ingredients used per ha No. of product applications per ha	4.3 2.8 2.8	2.6 1.7 1.6	1.7 1.1 1.6
Proportion of growers spraying parts of their vineyard - %	44%	34%	19%
Average herbicide load kg ai/ha	3.5	1.9	0.9

It must be presumed that weeds present a more difficult problem in Bordeaux than in Rioja and in Verona.

4.5.2 Herbicide placement

Table 4.5.2i Herbicide placement

Region	Bordeaux (F)	Rioja (E)	Verona (I)
Number of farms	59	62	61
	Farms %		
Overall	32	55	13
Between the rows			
- only	3		8
- as a supplement		3	
Along the rows			
- only	59	42	10
- as a supplement		5	
Spot treatment			
- only	5	2	16
- as a supplement	17	2	

Growers in Bordeaux appeared to make more directed sprays than in Rioja.

Specialists were consulted in each region about the actual area covered by each of these placements, bearing in mind different row widths and local custom. These could be very variable within a region but the following averages were taken.

Table 4.5.2ii Proportion of vineyard surface treated under different herbicide placement methods

Region	Bordeaux (F)	Rioja (E)	Verona (I)
	Proportion of vineyard surface treated %		
Overall	100	100	100
Between the rows	70	60	60
Along the row	33	25	30
Spot	5	5	5

The reason for such wide variability in single and cumulative doses, as recorded in Tables 4.4.1 - 4.4.3, can be interpreted with the information in Tables 4.5.2i and 4.5.2ii in mind.

4.6 Herbicide load per farm

Table 4.6 Herbicide load per farm

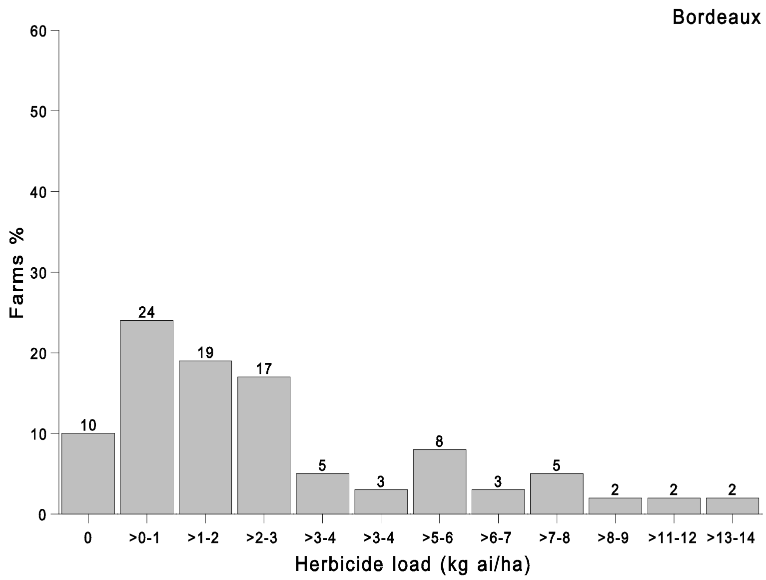
Region	Bordeaux (F)	Rioja (E)	Verona (I)
Number of farms	59	62	61
Chemical load kg ai/ha	Farms %		
0	10	5	57
>0 - 1	24	18	27
>1 - 2	19	23	7
>2 - 3	17	37	3
>3 - 4	5	5	5
>4 - 5	3	6	2
>5 - 6	8	3	
>6 - 7	3	2	
>7 - 8	5	2	
>8 - 9	2		
>11 - 12	2		
>13 - 14	2		
Load kg ai/ha Average Range	3.5 kg/ha (0)0.01 - 13.3	1.9 kg/ha (0)0.03 - 7.6	0.9 kg/ha (0)0.01 - 4.9

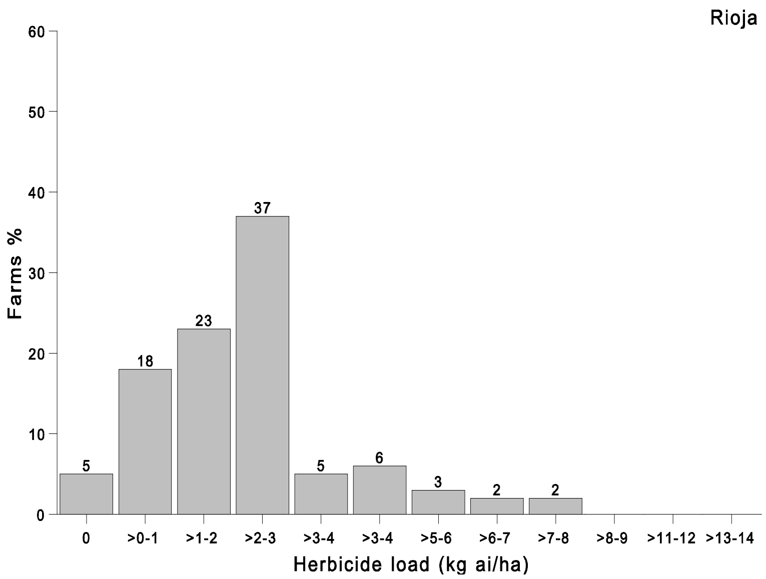
In all regions the reason for heavier loads was the use of dose rates which were higher than average for that region, although still within the recommended label rate range. In addition, in Bordeaux and Rioja heavier loads occurred on vineyards where the whole surface was sprayed - a factor which was not as evident among the heavier users in Verona. In Verona an additional factor was a higher number of repeat applications.

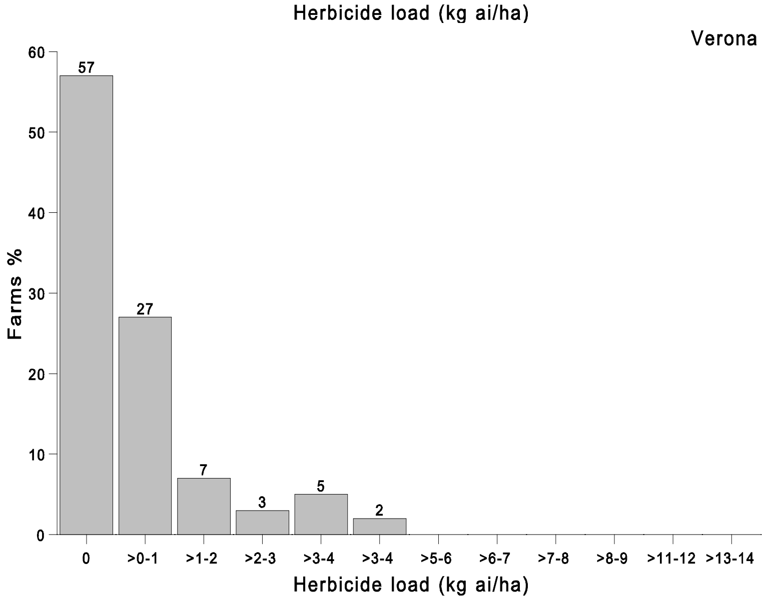
Lighter loadings were mainly the result of herbicide placement only along, or between, rows. It was also the consequence of the use of lower than average doses.

The regional comparison shows the extremes of Bordeaux (high) and Verona (low), with Rioja in between. Farmers in Bordeaux made the highest use of directed spraying along the rows and targeted spraying through spraying only parts of their vineyards and use of spot spraying. Their higher load appears to be linked to a more troublesome weed flora particularly perennial dicotyledons. Specialists in Bordeaux commented that 1994 had been a wetter year than normal.

Chart 4.6 Herbicide load per farm


Bordeaux
Farms %
60
50
40
30
20
10
0
10
24
19
17
5
3
8
3
5
2
2
2
0
>0-1
>1-2
>2-3
>3-4
>3-4
>5-6
>6-7
>7-8
>8-9
>11-12
>13-14
Herbicide load (kg ai/ha)


Rioja
Farms %
60
50
40
30
20
10
0
5
18
23
37
5
6
3
2
2
0
>0-1
>1-2
>2-3
>3-4
>3-4
>5-6
>6-7
>7-8
>8-9
>11-12
>13-14
Herbicide load (kg ai/ha)


Verona
Farms %
60
50
40
30
20
10
0
57
27
7
3
5
2
0
>0-1
>1-2
>2-3
>3-4
>3-4
>5-6
>6-7
>7-8
>8-9
>11-12
>13-14
Herbicide load (kg ai/ha)

4.7 Mechanical weed control

Mechanical treatment of the soil in vineyards was common. Shallow harrowing between the rows to aerate the soil controls weeds to some extent, and some cognac producers in Bordeaux plant grass between the rows to deplete soil nitrogen. The grass is subsequently mown. There is often manual hoeing between plants in the row, especially specifically directed to certain weeds.

Table 4.7 Mechanical weed control and herbicide use

Region	Bordeaux (F)		Rioja (E)		Verona (I)	
Number of farms	59		62		61	
Number of mechanical passes	% farms	herbicide kg ai/ha	% farms	herbicide kg ai/ha	% farms	herbicide kg ai/ha
0	25	4.4	10	1.9	43	0.3
1	19	2.0	18	3.3	8	1.0
2	24	2.5	19	0.9	15	0.1
3	19	4.7	13	2.8	13	0.3
4	7	0.4	10	2.1	16	1.2
5	0	0	18	2.9	2	
6	2	n/a	5	1.4	2	
7	2	2.1	6	1.1	0	
8	2	6.4	0	0	0	
9	0	0	0	0	0	
10	2	1.8	2	1.1	2	

Note: It has been assumed that the whole vineyard received the mechanical treatment.

There are no clear relationships between the amount of mechanical weed control performed and the corresponding herbicide load. There are some indications however:

- In Bordeaux, the average of all farms which used mechanical methods was 3.1 kg ai/ha compared with 4.4 kg ai/ha for those which did not.

- In Rioja, the figures were the same for those who used mechanical methods and the same for those who did not.

- In Verona, figures suggest that a greater herbicide load was used on the few farms who used both mechanical methods and herbicides.

- It was suggested that making only one pass brings weed seed to the soil surface, and allows them to germinate.

A larger sample size would be needed to elucidate the true value of mechanical treatments in controlling weeds in vineyards. However, it is of relevance that such practices are not necessarily carried out solely or even primarily for weed control, and this might explain the lack of a relationship.

4.8 Herbicide use in the study year (1994) compared with an average year

Table 4.8 Herbicide use in the study year (1994) compared with an average year

Region	Bordeaux (F)	Rioja (E)	Verona (I)
Number of farms	59	62	61
Herbicide use	Farms %		
Lower use	25	10	34
Greater use	71	89	59
No answer	3	2	7

It is very interesting that the majority of growers in all regions felt 1994 had been a year of high use. Specialists in Bordeaux put this down to it being a wetter year than normal, while those in Verona wondered whether the area being sprayed was increasing as dose rates were lowered. Those in Rioja did not feel that the increase in 1994 represented a trend.

4.9 Opportunities to reduce herbicide load

The reasons for low herbicide use in Verona do not appear to lie within agricultural practices adopted there, rather it appears to be the result of low weed pressure consequent upon a comparatively dry climate. The weed spectrum includes low levels of the two difficult dicotyledon weeds, *Convolvulus arvensis* and *Cirsium arvense*, which in the other two regions are of much greater importance.

Spot spraying appears to be the most practical means of directly reducing the amount of herbicide applied per unit area. There are now available a wide range of highly-active post-emergence herbicides capable of dealing with most species and so the tools for spot spraying exist. Spot spraying is not a panacea, however. As was implied in the comments of specialists in Verona, the result can be a requirement to use several active ingredients and the cost-efficacy may be poor compared with a more general and simple application of a broad-spectrum product. In addition, the low levels of weeds not treated in the area outside the spot treatment gradually build a seed bank in the soil which may be difficult to control in future years.

Mechanical methods of weed control occurred in most vineyards though the process was often used for soil aeration. The data found in this study do not show that mechanical cultivation reduces the use of herbicides. In general this is surprising though less if the objective is to achieve soil aeration rather than weed control.

5.0 DISEASE AND FUNGICIDES

5.1 Target diseases

Table 5.1 Target diseases in vines

Region	Bordeaux (F)		Rioja (E)		Verona (I)	
Number of farms	59		62		61	
Target diseases	Farms %	Spec	Farms %	Spec	Farms %	Spec
Plasmopara viticola (downy mildew)	63	++	76		89	
Uncinula necator (powdery mildew)	41		92		77	
Botrytis cinerea (grey mould)	32	++	58	-	43	
Phompsis viticola (excoriose)	10		48	--	0	+
Guignardia bidwellii (black rot)	7		6	--	3	
Stereum hirsutum (yesca)				++		
Eutypa lata (esca)						+

Key: Specialists comments ++ = should be much higher than stated
+ = should be higher than stated
-- = should be much lower than stated
- = should be lower than stated

Specialists agreed with the farmers responses with the above exceptions.

In 1994 in Bordeaux, *Plasmopara* and *Botrytis* were worse than normal as result of wet weather. In Verona, *Plasmopara* had increased in recent years, as had *Phomopsis* due to the reduced use of protectant fungicides and the increasing adoption of ICM.

5.2 Diseases claimed to be resistant to fungicides

Some growers in each region (12% in Bordeaux, 21% in La Rioja, and 28% in Verona) claimed to have experienced disease resistance. Specialists in each region disagreed with the majority suggesting that they were due to inappropriate fungicides or more likely, poor application. *Botrytis* resistance to vinclozolin and procymidone and *Plasmopara* resistance to folpet/ofurace was accepted as occurring in Bordeaux, and *Plasmopara* resistance to cymoxanil in Verona.

5.3 Levels of disease control sought

Table 5.3 Levels of disease control sought

Region	Bordeaux (F)	Rioja (E)	Verona (I)
Number of farms	59	62	61
	Farms %		
< 70%	0	0	0
71 - 80%	2	0	5
81 - 90%	0	2	52
91 - 100%	98	98	40

There is a clear regional difference with growers in Verona seeking less than perfect control. In Verona, *Plasmopara* was said by specialists to require 100% control only early in the season, and the other diseases do not normally require this level either.

5.4 Fungicide use by active ingredient

5.4.1 Bordeaux

Crop area treated 100%.

Table 5.4.1 Fungicide active ingredients used in Bordeaux

Active ingredient	Activity	% of crop treated (Base area 1,420 ha)	No. of applications where used		Cumulative dose on crop receiving that ai g ai per ha		
			Range per farm	Ave per ha treated	min	max	ave
folpet	c/b	94	1 - 8	5.9	750	15,819	5,817
fosetyl-al	s/b	89	1 - 8	4.9	875	15,700	8,067
sulphur	c/*Unc*	80	1 - 9	4.0	1,600	72,000	22,011
cymoxanil	cs/*Plas*	71	1 - 8	3.7	11	1549	472
mancozeb	c/b	60	1 - 9	3.4	875	15,100	6,016
copper	c/*Plas*	50	1 - 8	1.9	500	10,500	3,896
thiram	c/*Bot*	25	1 - 2	1.5	3,192	6,392	4,894
copper oxychloride	c/*Plas*	22	1 - 6	2.4	750	18,000	3,953
iprodione	c/*Bot*	20	1 - 2	2.0	467	1,968	1,254
flusilazole	s/b	20	1 - 3	2.4	4	18	10
carbendazim	s/*Bot*	17	1	1.0	500	550	523
diethofencarb	s/*Bot*	17	1	1.0	500	550	523
difenoconazole	s/b	15	2 - 4	3.0	59	120	91
myclobutanil	s/*Unc*	15	2 - 4	3.0	57	612	130
procyimdone	s/*Bot*	15	1	1.0	500	750	644
vinclozolin	c/b	14	1 - 2	1.2	500	1,500	841
dinocap	c/*Unc*	13	1 - 8	2.6	97	1,120	424
dimethomorph	s/*Plas*	12	1 - 8	2.2	44	600	201
hexaconazole	s/*Unc+Gui*	10	3 - 4	3.1	5	15	7
dichlofluanid	c/b	8	1	1.0	200	264	226
maneb	c/*Plas*	8	1 - 5	1.8	300	6,400	1,674
metiram	c/b	8	1 - 3	2.0	160	4,800	2,779
pyrifenox	s/*Unc*	7	1 - 4	1.9	40	160	74
triadimefon	s/*Unc+Gui*	7	2	2.0	150	150	150
captafol	c/b	3	1 - 3	4.0	334	902	673
copper hydroxide	c/*Plas*	2	4	4.0	899	899	899
zineb	c/*Plas*	2	1	1.0	300	300	300
tebuconazole	s/b	1	3	3.0	300	300	300
oxadixyl	s/*Plas*	1	2 - 4	2.4	400	600	476
penconazole	s/*Unc*	1	1	1.0	18	18	18

Key to abbreviations:

c	=	contact	b	=	broad-spectrum
s	=	systemic	*Bot*	=	*Botrytis*
			Plas	=	*Plasmopara*
			Unc	=	*Uncinula*
			Gui	=	*Guignardia*

5.4.2 Rioja

Crop area treated = 100%.

Table 5.4.2 Fungicide active ingredients used in Rioja

Active ingredient	Activity	% of crop treated	No. of applications where used		Cumulative dose on crop receiving that ai g ai/ha		
		(Base area 1,383 ha)	Range	Ave per ha treated	min	max	ave
metalaxyl	s/*Plas*	65	1 - 5	2.2	80	2,500	462
folpet	c/b	54	1 - 3	2.2	287	2,430	793
penconazole	s/*Unc*	52	1 - 4	2.2	15	188	44
triadimenol	s/*Unc*	48	1 - 4	1.5	25	250	55
pyrifenox	s/*Unc*	43	1 - 4	1.5	16	320	34
myclobutanil	s/*Unc*	37	1 - 3	1.3	18	294	29
sulphur	c/*Unc*	23	1 - 4	2.6	1,600	96,000	34,780
fenarimol	s/*Unc*	23	1 - 5	1.9	14	150	39
copper sulphate	c/*Plas*	17	1 - 4	1.7	31	2,351	1,479
cymoxanil	cs/*Plas*	13	1 - 3	1.5	25	750	104
copper	c/*Plas*	13	1 - 2	1.7	41	1,200	370
oxychloride	c/*Plas*	6	1 - 4	2.3	11	447	283
maneb	c/b	6	1 - 3	2.1	140	1,728	1,166
mancozeb	s/b	5	1 - 2	1.2	59	120	71
ofurace	s/*Plas*	4	1 - 2	1.4	5	160	74
benalaxyl	s/*Unc+Gui*	4	1 - 2	1.9	12	34	22
hexaconazole	c/*Plas*	3	1	1.0	400	1,600	1,443
diclofluanid	c/b	3	1 - 3	1.4	200	750	308
vinclozolin	s/b	2	1 - 3	1.7	112	450	316
benomyl	c/*Plas*	2	1 - 4	3.0	120	839	599
copper	c/*Plas*	2	2	2.0	320	320	320
zineb	c/b	1	4	4.0	1,679	1,679	1,679
propineb	s/*Plas*	1	1 - 2	1.1	99	100	99
oxadixyl	s/*Unc*	1	1	1.0	62	62	62
bupirimate	s/b	1	1	1.0	575	575	575
fosetyl-al	s/*Unc*	<1	1	1.0	45	45	45
diclobutrazol	c/b	<1	4	4.0	6,300	6,300	6,300
metiram	c/*Pho+Ster*	<1	1	1.0	2,500	2,500	2,500
sodium arsenite							

Key to abbreviations:

c = contact
s = systemic

Plas = *Plasmopara* (Downy mildew)
Unc = *Uncinula* (Powdery mildew)
Gui = *Guignardia* (Black rot)
Pho = *Phoma* (Escoriose)
Ster = *Stereum hirsutum* (yesca)

5.4.3 Verona

Crop area treated = 99%.

Table 5.4.3 Fungicide active ingredients used in Verona

Active ingredient	Activity	% of crop treated	No. of applications where used		Cumulative dose on crop receiving that ai g ai/ha		
		(Base area: 412 ha)	Range per farm	Ave per ha treated	min	max	ave
mancozeb	c/b	78	1 - 12	4.3	639	38,400	6,141
cymoxanil	cs/*Plas*	74	1 - 12	4.1	104	15,000	859
copper	c/*Plas*	60	1 - 17	5.4	1,200	34,500	12,359
oxychloride	c/*Unc*	53	1 - 17	8.4	1,440	104,000	15,267
sulphur	c/*Plas*	47	1 - 12	6.0	1,600	32,400	11,903
copper sulphate	s/*Plas*	35	1 - 4	1.7	360	1,500	869
metalaxyl	c/b	28	1 - 6	3.2	503	2,880	2,218
folpet	s/*Unc*	18	2 - 3	2.1	94	472	442
penconazole	s/*Plas*	15	2	2.0	479	479	479
oxadixyl	c/*Plas*	13	1 - 9	6.8	1,192	45,000	27,179
copper	c/*Plas*	10	3 - 13	5.6	2,880	11,339	9,477
metiram	s/*Unc*	5	2 - 15	3.2	40	1,687	189
triadimenol	c/*Bot+Ph*	5	1	1.0	765	765	765
iprodione	c/*Plas*	3	2 - 17	3.3	767	3,599	2,077
zineb	c/b	3	4 - 15	5.7	4,199	18,375	7,015
propineb	s/b	2	1 - 4	2.7	1,299	4,679	3,770
fosetyl-al	c/b	2	1	1.0	74	74	74
vinclozolin	s/*Bot*	1	4 - 15	8.4	1,600	11,250	5,459
carbendazim	s/*Plas*	1	2	2.0	360	360	360
benalaxyl	s/*Unc*	1	3	3.0	108	108	108
myclobutanil	s/*Unc*	1	15	15.0	505	505	505
nuarimol	s/*Bot*	<1	4	4.0	3,380	3,380	3,380
procymidone							

Key to abbreviations:

c = contact
s = systemic

b = broad spectrum
Bot= *Botrytis*
Ph = *Phoma*
Plas = *Plasmopara*
Unc = *Uncinula*

5.4.4 Fungicide active ingredients used - general commentary

The basic pattern of treatments in vines revolved around control of the two main diseases, *Plasmopara viticola* and *Uncinula necator*. A continuous programme of treatments was made for these two on the back of which were applied treatments for *Botrytis* and *Phomopsis*. Copper-based products were commonly applied to control *Plasmopara*.

There are large differences between the active ingredient lists of each of the regions shown in Tables 5.4.1 - 5.4.3. The most obvious of these are as follows:

- All except one of the dominant fungicides used in Bordeaux were of low activity, and high dose rate, the more active fungicide being cymoxanil. Of the six active ingredients, which were used on 50% or more of the vine crop, only two were systemic, fosetyl-al and cymoxanil, and of the top ten there were only three systemic actives. Products used would have controlled all the main diseases especially *Plasmopara* and *Uncinula*.

- A similar though less obvious situation occurred in Verona. Apart from the two systemics, cymoxanil and metalaxyl used for *Plasmopara* control, all of the seven dominant fungicides were low activity, high dose protectants.
  In both Bordeaux and Verona traditional sulphur and copper-based products were very important.

- Rioja was strikingly different from the other two regions. Of the dominant seven fungicides (including sulphur which is believed to have been grossly understated by growers - see below) only two were contact, folpet and sulphur, all the rest being systemic. This range of products, with the major exception of metalaxyl, was predominantly targeted towards control of the main disease, *Uncinula*.

Other comments on the active ingredient lists by country are:

Bordeaux - The systemic triazoles are recommended in a fixed three-spray programme for the control of *Uncinula* and *Guignardia* as a strategy to prevent resistance occurring, and there is good evidence that this is adhered to. Specialists noted that captafol had not been registered for several years.

Rioja - Specialists thought that folpet was less used in the region as a whole than was represented in the study sample. They also said that all growers used sulphur several times during the season. It is believed that because sulphur is such a basic part of vine cultivation in the region, important for its effect primarily on *Uncinula*, but also for its acaricidal and foliar fertiliser effects, many farmers forget to specifically consider it. Accordingly, based on the rates of use of those who did mention it, calculations have been made in order to produce a sulphur treatment for all growers. This data is presented in Section 5.6.1.

Verona - Copper use was higher in the study sample than in the region as a whole and specialists also thought that triadimenol, fosetyl-al and myclobutanil were under-rated. The same comments regarding sulphur applied to Verona as in Spain. The data appears in Section 5.6.1.

5.5 Fungicide use parameters

Table 5.5i Average number of fungicide applications

On vineyards using fungicides (100% in all except Verona - 99%)	Bordeaux (F)	Rioja (E)	Verona (I)
No. of active ingredients used per farm	8.4	3.8*	4.0*
No. of active ingredients used per hectare	7.1	4.3	4.6
No. of product applications per hectare	13.5	5.3*	16.2*
Proportion of growers spraying parts of their vineyard %	8%	24%	0%
Average load kg ai/ha as declared	40.5	10.4	31.8

* These data do not include the calculations of extra sulphur usage.

Table 5.5ii Fungicide spray volumes

Region	Bordeaux (F)	Rioja (E)	Verona (I)
Number of farms	59	62	61
Spray volume l/ha	Farms %		
100	42		
200	40		
300	10	6	
400	3	57	3
500		33	3
600		2	3
700			15
800			3
900			2
1,000			43
1,200			7
1,300			3
1,500			13
1,600			2
1,800			3

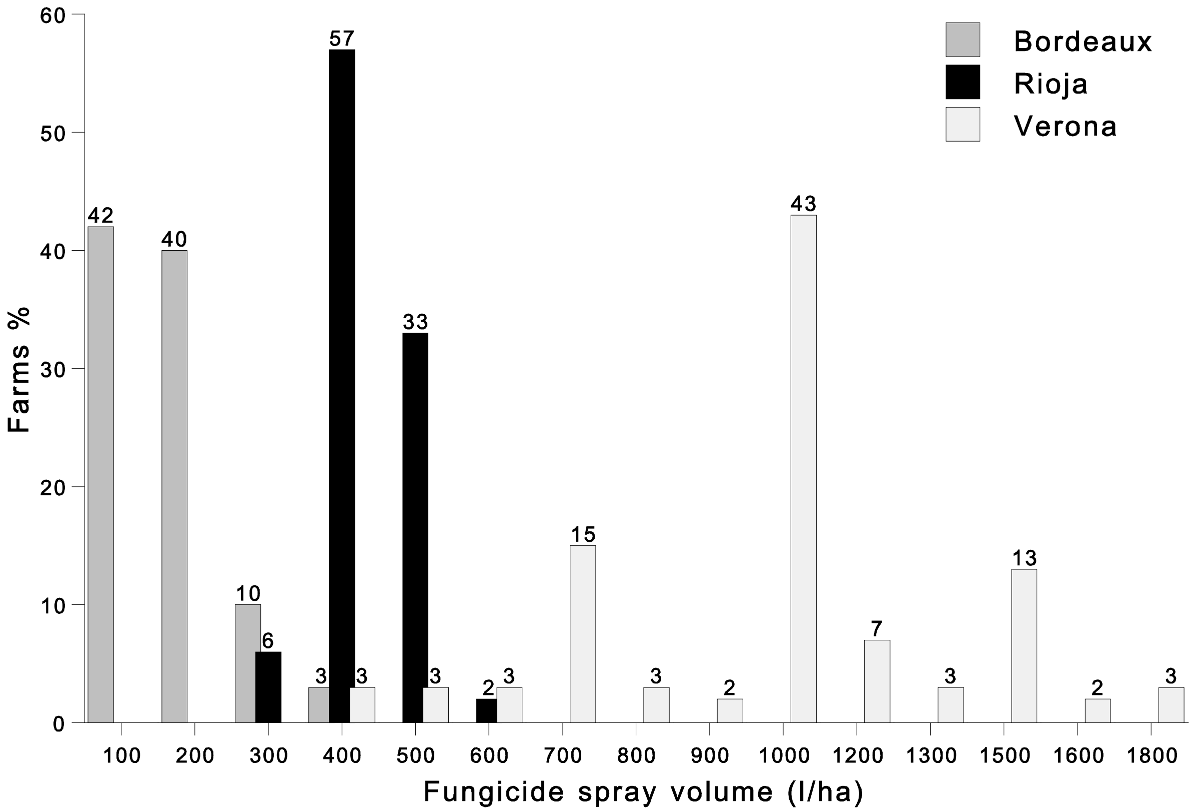


Chart 5.5ii Fungicide spray volumes

Growers in Bordeaux were using 'low' volumes for their fungicide applications. Given the relative similarity of the lists of fungicides and of the disease spectra for these two regions the reasons for the large difference in spray volumes must be connected with the architecture of the crop/vineyard or local tradition.

Variation in spray volume in turn effects chemical dose rate per hectare. In Italy (Verona) and Spain (Rioja) dose rates are all given as concentration per hectolitre of spray. This occurs also in France (Bordeaux) although there 60 - 70% of the dose rates are given per hectare.

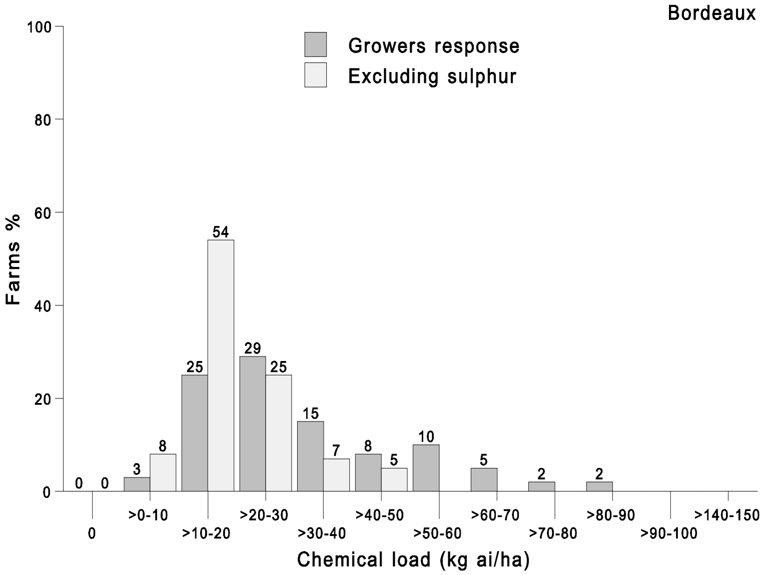
5.6 Fungicide load per farm

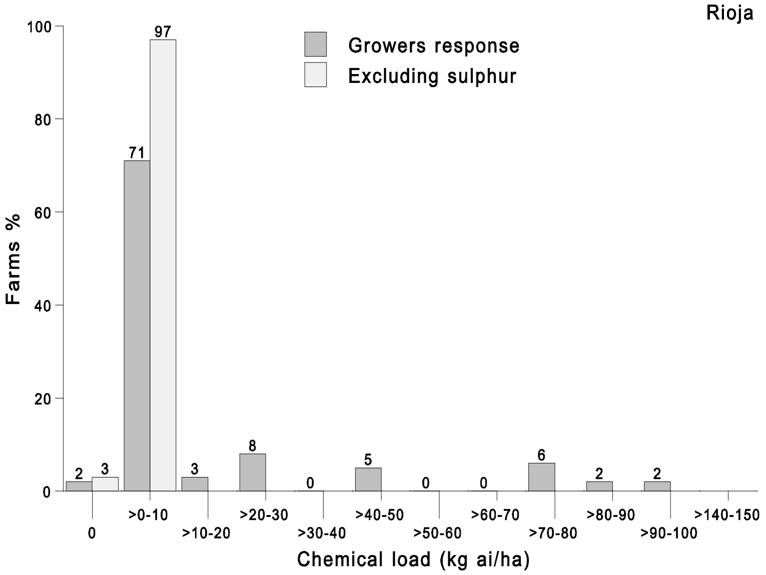
Table 5.6i Fungicide load per farm

Region	Bordeaux (F)		Rioja (E)		Verona (I)	
No. of farms	59		62		61	
	Farms %					
Fungicide load kg ai/ha	Grower responses	excl. sulphur	Grower responses	excl. sulphur	Grower responses	excl. sulphur
0	0	0	2	3	0	0
>0 - 10	3	8	71	97	11	13
>10 - 20	25	54	3		23	43
>20 - 30	29	25	8		20	25
>30 - 40	15	7	0		27	12
>40 - 50	8	5	5		8	5
>50 - 60	10		0		3	0
>60 - 70	5		0		3	2
>70 - 80	2		6		2	
>80 - 90	2		2		0	
>90 - 100			2		0	
>140 - 150					2	
Load kg ai/ha of crop grown						
Average Range	40.5 4.3 - 85.4	22.9	10.4 (0)0.03-96.4	0.7	31.8 0.6-142.4	24.1

Rioja was very different from the other two regions. The spread of loads below 5.0 kg ai/ha is shown in Table 5.6ii.

Chart 5.6.i Fungicide load per farm





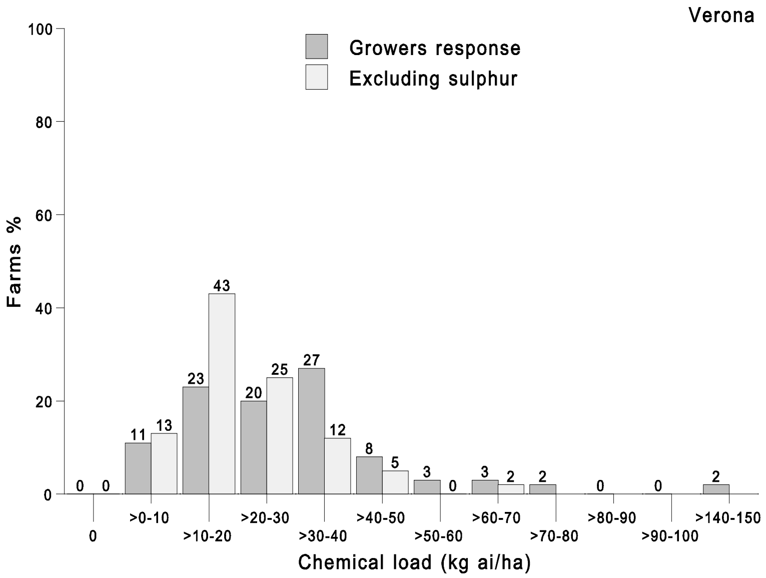


Table 5.6ii Fungicide load per farm in Rioja (extract)

Fungicide load kg ai/ha	Farms %	
	Growers response	excluding sulphur
0	2	3
>0 - 0.5	24	40
>0.5 - 1.0	11	13
>1 - 2	15	19
>2 - 3	8	13
>3 - 4	6	8
>4 - 5	3	2

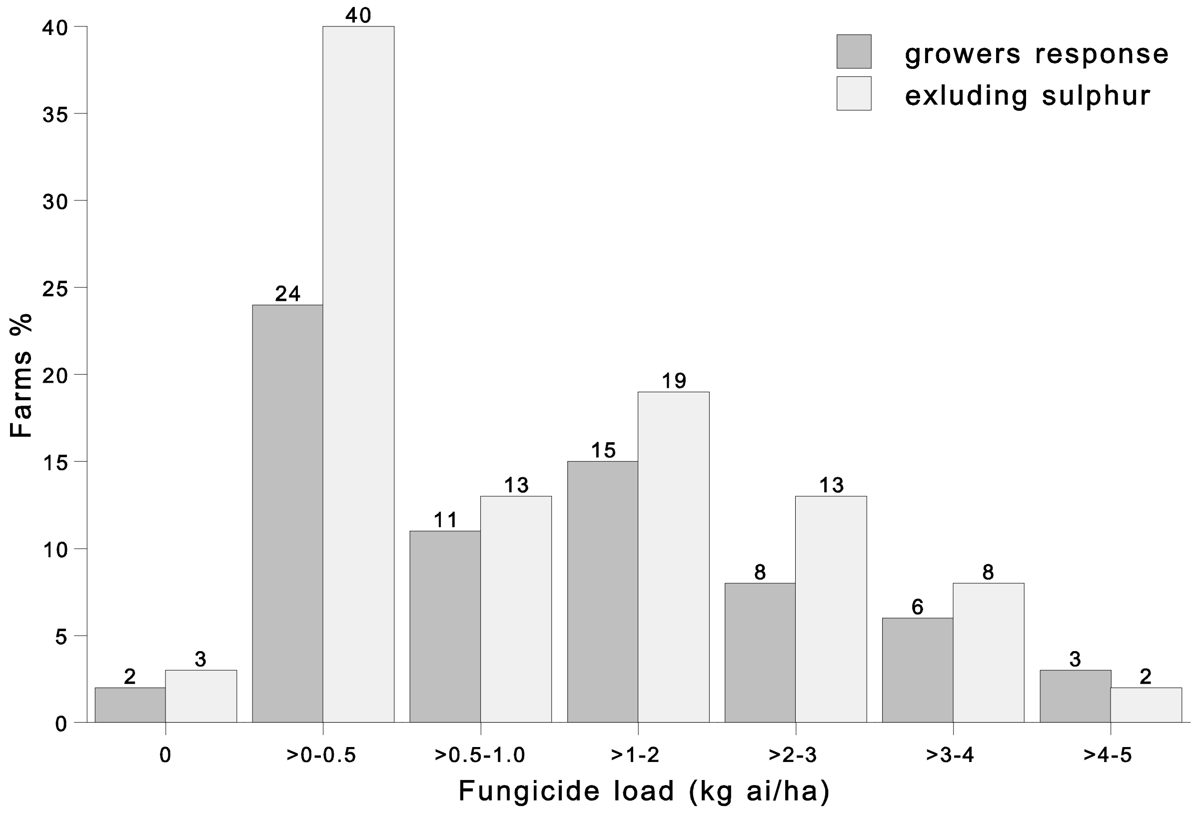


Chart 5.6ii Fungicide load per farm in Rioja (extract)

5.6.1 Sulphur

The average load of sulphur per hectare was:

-	Bordeaux	Growers' response	17.6 kg ai/ha
-	Rioja	Growers' response	9.5 kg ai/ha
		As calculated for all growers	34.7 kg ai/ha
-	Verona	Growers' response	7.7 kg ai/ha
		As calculated for all growers	16.7 kg ai/ha

If specialists were correct in advising that extra sulphur usage should be added to growers' replies in Verona and Rioja, then two observations may be made.

- the similarity in sulphur load between Bordeaux and Verona is remarkable
- there is a much greater use of sulphur in Rioja than in the other two regions (given the greater importance of *Uncinula*).

General

Dose rates in all regions appeared to be around the recommended levels, the variability resulting from different water volumes. There do not appear to be any practices operating in one region which may be considered of use in another.

The heaviest loads in all regions, ignoring sulphur use, were the result of making more product applications (product x number of sprays) than the norm.

Lightest loads were the result of fewer product applications. Additionally in Rioja a greater degree of partial spraying was apparent than in the other regions.

5.7 Fungicides use in the study year (1994) compared with an average year

Table 5.7 Fungicide use in the study year (1994) compared with an average year

Region	Bordeaux (F)	Rioja (E)	Verona (I)
Number of farms	59	62	61
Fungicide use	Farms %		
Lower use	15	16	16
Greater use	8	5	8
The same	76	73	74
No answer	0	7	2

Three quarters of the growers in all regions thought 1994 had been an average year, while most of the remainder (in Verona, mainly larger farmers) felt use had been less than normal.

In Verona, specialists felt that *Botrytis* had reduced over the last ten years as a result of lower nitrogen levels being used - an ICM measure. However, they thought that *Phomopsis* was increasing.

5.8 Factors determining the start of fungicide application

There are some interesting points of comparison in the factors triggering fungicide application as shown in Table 5.8.

Plasmopara. In the two regions having the most severe *Plasmopara,* Bordeaux and Verona, it appears that growers in Bordeaux used the local warning system, in addition to the stage of plant development and the weather whereas those in Verona used only the external signals such as 'date' and 'weather'. The suggestion is that in Verona growers were less inclined than in Bordeaux to base their spray decisions on the presence of the disease itself, and as mentioned earlier, specialists said that they recommend 100% control early in the season.

Uncinula. This disease occurred in all three regions, and was the predominant disease in Rioja. The main factors used in Verona were both external pointers - the date and weather. In the other two regions the stage of plant development was used backed up by use of a warning system and, in the case of Rioja, weather conditions. In spite therefore of strong promotion of ICM in Verona the growers appeared to persist in adopting a prophylactic approach to *Uncinula* control, the same strategy as for *Plasmopara.*

Botrytis. Bordeaux growers appeared to suffer this disease most. The most important trigger for control measures there was the stage of plant development, although some used a warning system. Growers in Rioja whose vineyards suffered the disease used several factors more or less equally, including the stage of development of the disease itself.

Guignardia. Only in Bordeaux was this disease important. There the growers used all the external factors, including a warning system, but particularly plant stage and weather.

Phomopsis. Only in Rioja did growers provide answers for this disease. As for *Guignardia* in Bordeaux, all the external factors were used.

Table 5.8 Factors determining the start of fungicide application (Farms %)

Factor	Date			Plant stage			Disease stage			Weather			Warning system			Don't know			No disease		
Region	B	R	V	B	R	V	B	R	V	B	R	V	B	R	V	B	R	V	B	R	V
Disease																					
Plasmopara	10	6	46	47	48	16	14	26	11	56	32	62	53	40	10	-	-	2	0	23	7
Uncinula	8	6	34	47	63	11	12	21	10	12	35	46	46	37	11	-	2	2	3	8	18
Botrytis	10	5	7	36	23	2	5	27	5	15	19	11	19	16	-	-	3	5	5	40	70
Guignardia	5	-	3	31	-	-	7	-	2	29	-	8	22	-	-	-	-	5	12	-	77
Phomopsis	-	3	-	-	31	-	-	2	-	-	19	-	-	19	-	-	2	-	-	52	-

Region abbreviations: B = Bordeaux, R = Rioja, V = Verona

5.9 Opportunities to reduce fungicide load

The difference between Rioja and the other two regions is remarkable. In the absence of sulphur the fungicide load drops to less than 1 kg ai/ha in Rioja compared with about 23 and 24 kg ai/ha for Bordeaux and Verona respectively. The reason for this is the absence of significant levels of *Plasmopara* in Rioja.

The fungicide load in Rioja is devoted almost entirely to the control of *Uncinula,* and, if the extra calculated sulphur applications are included, then about 35 kg ai/ha are applied for that purpose. It can be deduced that in Bordeaux 17.6 kg ai/ha and in Verona 7.7 kg ai /ha. are used for the same purpose. This is a grossly simplistic assumption but one worthy of consideration.

ICM practices are being promoted in all regions, and specialists, particularly in Rioja, believe that these will reduce the number of applications of fungicides. The PPS in Rioja has shown in farm-scale trials that almost a halving in the number of applications may be achieved. This supports the contention above that there appears some unnecessary use of fungicides (sulphur) in Rioja. Greater use of the warning systems, particularly in Verona, would appear to offer opportunities for closer targeting of applications.

6.0 INSECTS AND INSECTICIDES (INCLUDES MITES)

6.1 Target insects

Table 6.1 reflects farmers' opinions and is no doubt somewhat exaggerated in terms of generation number extremes (*Clysia* - 11 in Verona). In Rioja and Verona the tortrix moths *Lobesia* and *Clysia* were not well separated and farmers undoubtedly placed the two together.

From specialists' observations the grape berry moth, *Lobesia botrana*, was the main pest across all regions. In France leaf hoppers, *Empoasca* spp, were of similar importance.

Mites have declined in recent years. Specialists indicated that they are less of a problem than growers claimed in both France and Rioja, and are of very minor importance in Verona.

Table 6.1 Target insects - grower responses

Region	Bordeaux (F)			Rioja (E)			Verona (I)		
Insect species	Farms % (Base: 59)	No. of generations		Farms % (Base: 62)	No. of generations		Farms % (Base: 61)	No. of generations	
		Range	Average		Range	Average		Range	Average
Empoasca flavescens (leaf hopper)	62	1 - 3	1.85	-	-	-	38	1 - 3	1.76
Clysia ambiguella (grape berry moth)	55	1 - 3	1.55	97	1 - 5	2.56	60	1 - 11	2.10
Lobesia botrana (grape berry moth)	47	1 - 3	2.13	} -	-	-	37	1 - 3	1.86
Eulia (leaf roller)	3	1 - 5	3.00	-	-	-	-	-	-
Frankliniella occidentalis (thrips)	2	-	-	-	-	-	7	1	1.00
Caterpillars of night flying moths	9	1 - 3	1.75	-	-	-	-	-	-
Sparganothis pilleriana (pyralid moth)	8	1	1.00	37	1 - 3	1.52	-	-	-
Haltica lythri/Ampelophaga (grape leaf beetle)	2	1	1.00	-	-	-	-	-	-
Panonychus ulmi *Metatetrynichus* spp (spider mites) *Tetranychus urticae*	73	1 - 5	2.18	50	1 - 4	1.65	7	1 - 2	1.67
Eotetranychus carpini (spider mites)	42	1 - 3	1.92	27	1 - 2	1.20	2	-	-
Eriophyes vitis (Eriophyid mites)	9	1 - 2	1.50	8	1 - 2	1.25	-	-	-

6.2 Insects exhibiting resistance

Some growers in each of the samples noted that they had experienced resistant insects or mites - 10% in Bordeaux, 29% in Rioja, and 16% in Verona. There was no corroboration of these views from specialists except in the case of mites, *Panonychus* spp to the acaricide dicofol in Bordeaux.

6.3 Level of insect and mite control sought

Table 6.3 Level of insect and mite control sought

Region	Bordeaux (F)	Rioja (E)	Verona (I)
Number of farms	59	62	61
Level of control	Farms %		
< 70%	2	-	10
71 - 80%	-	-	7
81 - 90%	3	-	38
91 - 100%	83	98	25
No answer	12	2	21

In Bordeaux and Verona a few growers did not apply insecticides/acaricides in 1994, 8% and 26% respectively, whilst in Rioja all did. These degrees of need are reflected in the Table 6.3.

6.4 Insecticide and acaricide use

6.4.1 Bordeaux

Crop area treated 96%.

Table 6.4.1 Insecticide and acaricide active ingredients used in Bordeaux

Active ingredient	Activity	% of crop treated (Base area 1,420 ha)	No. of applications where used		Cumulative dose on crop receiving that ai g ai per ha		
			Range per farm	Ave per ha treated	min	max	ave
clofentezine	c/aca	31	1 - 2	1.0	99	352	186
flufenoxuron	igr/b	30	1 - 2	1.3	37	200	68
fenpropathrin	ci/b	24	1	1.1	15	199	85
quinalphos	ci/b	23	1 - 2	1.5	239	481	357
methomyl	ci/b	23	1 - 4	1.7	300	1,600	666
hexythiazox	ci/aca	22	1	1.0	5	50	11
lambda-cyhalothrin	ci/ins	21	1	1.0	6	29	16
propargite	c/*Tet*	19	1	1.0	570	1,425	740
chlorpyrifos-e	cif/ins	12	1 - 2	1.8	359	600	544
bromopropylate	c/*Ery+Tet*	10	1	1.0	500	562	505
acrinathrin	ci/b	9	1	1.0	29	300	230
deltamethrin	ci/ins	8	1	1.0	1	75	22
dicofol	c/aca	7	1 - 2	1.0	35	423	202
*Bacillus thuringiensis**	i/ins	6	1	1.0	1,500	1,500	1,500
cyhexatin	c/*Tet*	6	1	1.0	37	100	54
sulphur	c/*Ery+Tet*	5	1	1.0	899	1,349	1,007
fenbutatin-oxide	c/*Ery+Tet*	4	1	1.0	99	1,100	553
chlorpyrifos-methyl	cif/b	4	1	1.0	200	218	207
fenoxycarb	igr/b	3	1	1.0	150	150	150
thiodicarb	ci/ins	3	1 - 2	1.3	37	750	414
tetradifon	c/*Tet*	2	1 - 3	1.0	80	160	120
parathion-m	cif/ins	2	1	1.0	300	300	300
cypermethrin	ci/ins	2	1	1.6	16	20	17
tralomethrin	ci/ins	2	1 - 2	1.0	23	23	23
tebufenozide	igr/ins	1	1	1.0	95	144	133
bifenthrin	ci/b	1	1	1.0	30	30	30
fenitrothion	ci/ins	1	1	1.0	250	250	250
malathion	cif/b	1	1	1.0	250	250	250
dioxathion	c/b	<1	1	1.0	200	200	200
parathion-ethyl	cif/b	<1	1	1.0	300	300	300

* a biopesticide

Key to abbreviations - see next page

Key to abbreviations:

c	=	contact
f	=	fumigant
i	=	ingested
aca	=	acaricide
b	=	broad spectrum
Ery	=	*Eryiophyes* spp
igr	=	insect growth regulator
ins	=	insecticide
Tet	=	*Tetranychid*/red spider mites

6.4.2 Rioja

Crop area treated 99%.

Table 6.4.2 Insecticide and acaricide active ingredients used in Rioja

Active ingredient	Activity	% crop treated (Base area: 1,383 ha)	No. of applications where used: Range per farm	Ave per ha treated	Cumulative dose on crop receiving that ai g ai/ha: min	max	ave
parathion-ethyl	cif/b	56	1 - 2	1.2	175	400	246
fenitrothion	ci/ins	43	1 - 4	1.4	250	2,250	476
thiodicarb	ci/ins	35	1 - 2	1.2	225	750	278
endosulfan	c/b+*Ery*	19	1 - 5	1.7	158	1,750	415
dicofol	c/aca	14	1 - 2	1.7	72	216	146
fenthion	cif/ins	13	1 - 2	1.4	1,200	2,400	1,686
deltamethrin	ci/ins	12	1 - 3	2.1	4	12.5	8
bromopropylate	c/*Ery+Tet*	10	1 - 2	1.6	262	900	517
chlorpyrifos-ethyl	cif/ins	10	1 - 2	1.5	174	500	295
sodium-arsenite	c/*Spar*	8	1	1.0	2,250	3,972	2,296
lambda-	ci/ins	7	2 - 4	3.5	12	40	30
cyhalothrin	c/*Ery+Tet*	5	2 - 3	2.3	40,000	72,000	49,509
sulphur	cif/ins	4	1 - 2	1.3	280	700	413
parathion-methyl	cif/b	2	2 - 4	3.0	2,000	3,000	2,381
malathion	ci/b	1	1 - 4	1.4	99	600	162
quinalfos	ci/b	1	1 - 2	1.4	268	855	488
methidathion	ci/ins	1	2	2.0	1,200	1,200	1,200
azinphos-methyl	c/b	1	2	2.0	600	600	600
phosmet	ci/ins	1	2	2.0	1,500	1,500	1,500
trichlorfon	s/b	0.1	2	2.0	340	340	340
acephate	adj	56	1 - 2	1.2	2,274	5,200	3,154
petroleum oil							

Key to abbreviations:

c = contact
aca = acaricide
f = fumigant
b = broad spectrum
i = ingested
Ery = Eriophyid mites
adj = adjuvant
ins = insecticide
s = systemic
Spar = *Sparganothis*
Tet = *Tetranychid*/red spider mite

6.4.3 Verona

Crop area treated 62%.

Table 6.4.3 Insecticide and acaricide active ingredients used in Verona

Active ingredient	Activity	% of crop treated (Base area: 412 ha)	No. of applications where used		Cumulative dose on crop receiving that ai g ai/ha		
			Range per farm	Ave per ha treated	min	max	ave
fenitrothion	ci/ins	22	1 - 4	2.0	231	4,500	1,613
methidathion	ci/b	18	2 - 3	2.0	94	1,424	852
dimethoate	s/b	7	1 - 3	2.6	400	1,440	1,217
phosalone	ci/b	6	1 - 3	1.5	335	1,620	625
azinphos-methyl	ci/ins	5	1 - 3	2.2	449	1,728	1,233
parathion-methyl	cf/ins	4	1 - 5	2.2	399	1,620	874
parathion-ethyl	cif/b	3	1 - 2	1.1	342	1,008	706
quinalphos	ci/b	3	1 - 3	1.8	324	1,687	997
chlorpyrifos-methyl	cif/b	2	1 - 4	2.6	331	1,325	857
acephate	s/b	2	2	2.0	917	1,223	1,019
deltamethrin	ci/ins	1	1	1.0	12	12	12
lambda-cyhalothrin	ci/ins	1	1	1.0	50	50	50
carbaryl	ci/ins	1	2 - 4	3.0	2,236	5,159	3,697
cyfluthrin	ci/ins	1	2	2.0	39	39	39
petroleum oil	adj	1	1	1.0	1,975	1,975	1,975

Key to abbreviations:

c = contact
f = fumigant
i = ingested
adj = adjuvant
b = broad-spectrum
ins = insecticide

6.4.4 Insecticides and acaricides used - general commentary

Specialists said the lists of active ingredients used matched the target pests of the respective regions.

The list from Bordeaux had a very strong acaricidal bias with several specific acaricides amongst the top ten active ingredients which reflects farmers attitudes to mites. Some of the top insecticides such as flufenoxuron and fenpropathrin also have acaricidal activity. By and large it is a ‘modern’ list, comprised of active ingredients which are used in more sophisticated crop protection, but it includes considerable use of synthetic pyrethroids which have a negative effect on beneficial mite predators.

The active ingredients used in Rioja were comprised almost entirely of insecticides, there being only two specific acaricides mentioned apart from sulphur. In contrast with Bordeaux the list is more traditional, being headed by a parathion-ethyl/petroleum oil formulation. The heavy use of sulphur as a fungicide may account for the absence of acaricides.

Active ingredients used in Verona were all organophosphates except for very low usage of two synthetic pyrethroids and a carbamate. There were no specific acaricides used. It is a list indicative of IPM being practised, although specialists were disappointed in the high use of methidathion (in fact mostly used on one very large farm) and the low use of quinalphos and chlorpyrifos-methyl. Cumulative average dose rates of the main active ingredients were higher than those in the other two regions. Specialists mentioned that as a result of reduced insecticide usage because of IPM a scale insect, *Planococcus citri*/*Pulvinaria vitis*, had increased. Methidathion is particularly recommended for such pests.

6.5 Insecticide and acaricide use parameters

Table 6.5 Insecticide/acaricide applications

Region	Bordeaux (F)	Rioja (E)	Verona (I)
Crop area treated	96%	99%	62%
On vineyards using insecticides/acaricides			
No. of active ingredients used per farm	2.7	2.4	1.3
No. of active ingredients used per hectare	2.8	3.0	0.8
No. of product applications per hectare	2.5	3.7	2.0
Proportion of growers spraying part of their vineyard %	31%	21%	20%
Insecticide load kg ai/ha	1.0	4.6	0.9

More growers in Bordeaux sprayed only part of their vineyard than in the other two regions. The lower intensity of pest control in Verona is evident.

6.5.1 Application volumes

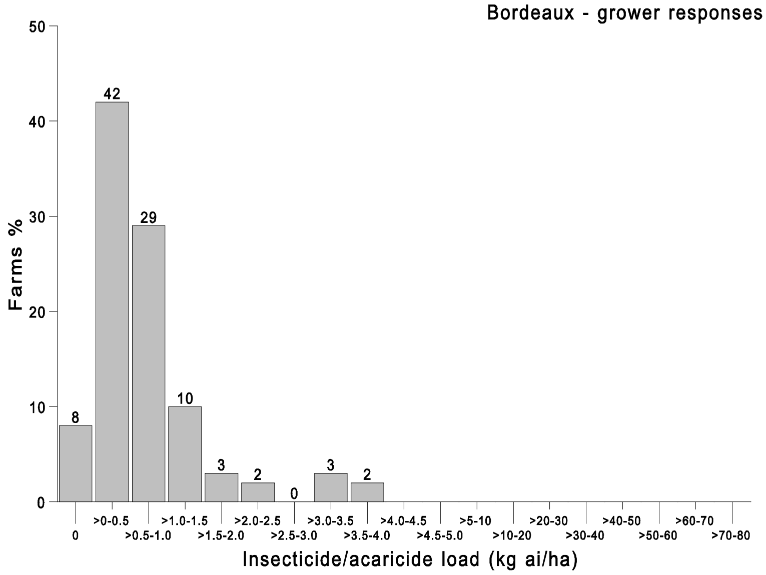
These varied in the same way as fungicides with the same consequences on varying the dose per hectare.

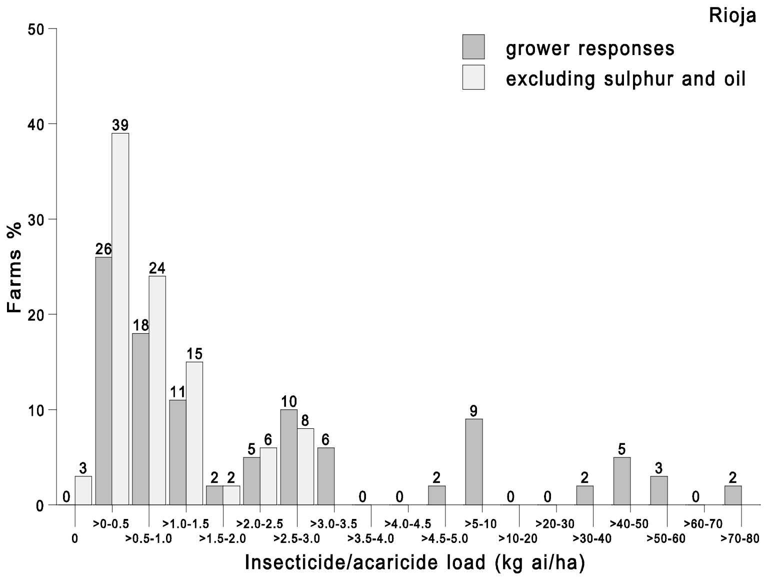
6.6 Insecticide/acaricide load per farm

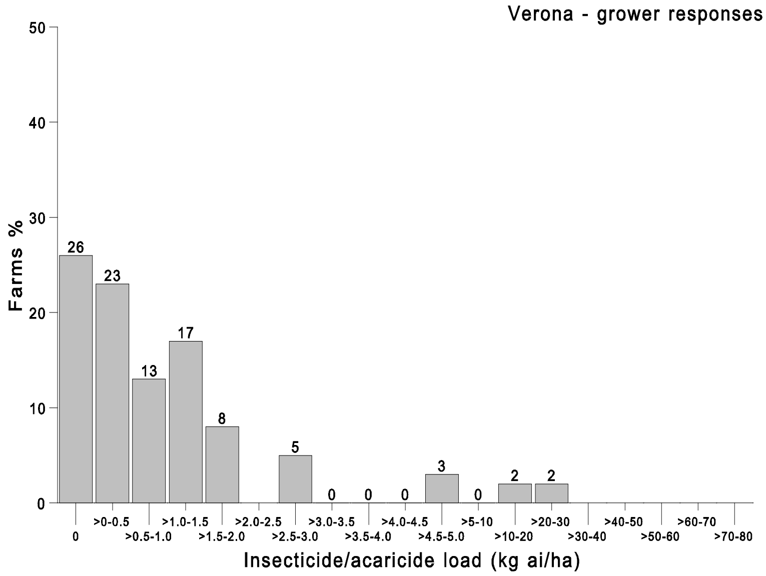
Table 6.6 Insecticide/acaricide load per farm

Region	Bordeaux (F)	Rioja (E)		Verona (I)
Number of farms	59	62		61
	Farms %			
Insecticide/acaricide load kg ai/ha	Grower responses	Grower responses	excl. sulphur and oil	Grower responses
0	8	0	3	26
>0 - 0.5	42	26	39	23
>0.5 - 1.0	29	18	24	13
>1.0 - 1.5	10	11	15	17
>1.5 - 2.0	3	2	2	8
>2.0 - 2.5	2	5	6	5
>2.5 - 3.0	0	10	8	0
>3.0 - 3.5	3	6		0
>3.5 - 4.0	2	0		0
>4.0 - 4.5		0		3
>4.5 - 5.0		2		0
>5 - 10		9		2
>10 - 20		0		2
>20 - 30		0		
>30 - 40		2		
>40 - 50		5		
>50 - 60		3		
>60 - 70		0		
>70 - 80		2		
Load kg ai/ha of crop grown — Average Range	1.0 (0)0.02-3.6	4.6 0.01-72.0	1.3	0.9 (0)0.02-17.7

Chart 6.6 Insecticide/acaricide load per farm







Sulphur was uniquely used as an acaricide (in addition to its use as a fungicide) in Rioja and to allow better comparison with other regions it has been stripped from the data in Table 6.6. Petroleum oil, the carrier for parathion-ethyl, has also been stripped out.

On this basis the load per hectare **grown** is higher in Rioja than the other two regions. However, on the basis of load per hectare **treated** the load in Verona increases to about the same as Rioja - 1.4 kg ai/ha. The region with the lowest load per hectare treated was Bordeaux. This is interesting given the broadly similar pest problems and the fact that Bordeaux had the additional problem of mites. A perusal of the active ingredients used reveals that they are surprisingly different, even discounting the acaricides. Those used in Bordeaux were insecticides which are used at lower dose rates.

Reasons for variation in load vary from region to region. In Bordeaux the main reason for higher loads was the simple application of more products on more occasions, coupled with the use of low activity active ingredients. The latter was the only reason for higher loads in Rioja. In Verona, higher loads were the result of low activity active ingredients coupled with higher than average doses. The lighter loads were also achieved through the use of partial spraying.

The three regions appear to have quite different strategies for pest control. Ignoring the loading *per se*, which is not itself a good indicator of environmental impact, it is tempting to believe that the position in Verona is perhaps the most superior. If more IPM was practised in Bordeaux it is conceivable that mites would reduce and fewer products and sprays would be needed although specialists did indicate that mites were less of a problem than farmers believed.

6.7 Insecticide/acaricide use in the study year (1994) compared with an average year

Table 6.7 Insecticide/acaricide use inthe study year (1994) compared with an average year

Region	Bordeaux (F)	Rioja (E)	Verona (I)
Number of farms	59	62	61
	Farms %		
Lower use	20	13	17
Greater use	7	5	7
The same	64	77	61
No answer	8	5	16

All regions responded similarly, the same or lower use than in 1994.

6.8 Factors determining the start of insecticide/acaricide applications

There was a poor response to this question generally (see Table 6.8). Pests eliciting the most response from growers were the insects *Lobesia botrana* and *Empoasca* (the latter not in Rioja), and the mites *Eriophyes* and *Panonychus*.

Growers in Rioja appeared to use most factors for *Lobesia* control. They were the greatest users of a warning system and also considered plant stage and pest stage important. Growers in Bordeaux gave only moderate responses but the use of a warning system backed up by pest stage and pest pressure monitoring were most important. Interestingly the specialists in Verona said these practices were essential for a warning system to function but it appears that relatively few growers in Verona claimed to adhere to them.

For *Empoasca* control, some growers in Bordeaux used a warning system, whilst in Verona inspection of the crop for pest stage and pressure were important.

Mites produced most responses from Bordeaux and a warning system together with the date appeared to be most common factors used for both species. In Rioja, for tetranychid mites, a warning system and plant stage seemed to be the key factors.

Table 6.8 Factors determining the start of insecticide/acaricide applications (Farms %)

Factor	Date			Plant stage			Pest stage			Pest pressure			Warning system			Don't know		
Region	B	R	V	B	R	V	B	R	V	B	R	V	B	R	V	B	R	V
Insects																		
Empoasca spp	7	-	13	7	-	2	7	2	22	2	2	19	24	2	7	31	98	38
Haltica spp	7	-	-	5	-	-	5	-	8	-	-	-	14	-	-	24	-	74
Lobesia botrana	17	13	16	10	39	2	20	42	23	22	24	16	32	60	18	8	-	31
Sparganothis spp	8	2	-	5	10	-	5	11	8	3	5	-	19	24	-	25	65	74
Mites																		
Eriophyes vitis	17	6	-	10	5	8	10	2	8	7	-	-	29	5	-	-	24	74
Panonychus ulmi	25	19	-	12	26	-	15	18	10	14	8	5	42	27	-	-	15	69

Region abbreviations: B = Bordeaux, R = Rioja, V = Verona

6.9 Opportunities to reduce the insecticide/acaricide load

There appear to be three points of interest:

- the level of mite infestation and the use of acaricides in Bordeaux
- the use of parathion plus oil in Rioja, and the impact of high sulphur fungicide use on mite levels
- the low level of *Lobesia* control in Verona, and again the impact of high sulphur use on mite levels.

There is a simplistic conclusion to be drawn - that where sulphur is used throughout a region there are no or lower mite problems, in other words in both Rioja and Verona.

Parathion plus oil controls the overwintering stages of mites as well as *Lobesia botrana*. This is a contributory factor to the low levels of mites in Rioja.

The generally low level of pest incidence and pressure in Verona is likely to be the result of natural regional variation but also fostered by the use not only of IPM - growers did not convincingly indicate much use of it in this study - but also ICM.

IPM is practised in all regions, nevertheless there were indications in this study that insecticide and acaricide use could be further reduced in all three, particularly Rioja. Wide use of the warning system, particularly in Verona, would appear to offer possibilities of increasing the targeting of applications.

7.0 MISCELLANEOUS PESTS AND PESTICIDES

There were no other pests mentioned.

8.0 OTHER AGROCHEMICALS

Other agrochemicals represented by growth regulators were only applied in Rioja. They were applied by 6% of growers who have Garnacha variety grapes, covering only 1% of the area grown. The chemicals were a chlormequat-chloride/choline-chloride mixture and paclobutrazol used to enhance fruit formation.

9.0 TRENDS IN PESTICIDE USE

9.1 Variation in pesticide use over the last five years

9.1.1 Herbicides

Table 9.1.1 Variation in herbicide use over the last five years

Region	Bordeaux (F)	Rioja (E)	Verona (I)
Number of farms	59	62	61
Usage	Farms %		
Increased	12	40	21
The same	68	44	28
Reduced	14	16	31
No answer	7	0	20

The most static position on herbicides was held by growers in Bordeaux, who generally felt that usage had remained the same. Opinions were divided in Verona, although specialists there felt there had been a steady increase.

9.1.2 Fungicides

Table 9.1.2 Variation in fungicide load over the last five years

Region	Bordeaux (F)	Rioja (E)	Verona (I)
Number of farms	59	62	61
Usage	Farms %		
Increased	5	42	23
The same	76	47	51
Reduced	17	10	21
No answer	2	2	5

Bordeaux growers believed that fungicide usage had remained the same, with opinion in Verona again being divided. In Rioja about 40% felt there had been an increase, and specialists agreed, this apparently being the result of weather more suitable for diseases.

9.1.3 Insecticides/acaricides

Table 9.1.3 Variation in insecticide/acaricide use over the last five years

Region	Bordeaux (F)	Rioja (E)	Verona (I)
Number of farms	59	62	61
Usage	Farms %		
Increased	5	45	25
The same	64	48	39
Reduced	17	5	15
No answer	14	5	21

The comments made concerning fungicides are also appropriate for insecticide/acaricide use. Bordeaux growers mostly felt there had been no change, whilst those in Verona were fairly evenly divided. Specialists in Verona felt that although usage in 1994 had been higher the trend was downward. In Rioja, growers were evenly divided between those believing insecticide usage had been the same and those believing there had been an increase.

9.2 Plans to maintain or change pesticide use in vines

Table 9.2i Plans to maintain or change pesticide use in vines

Region	Bordeaux (F)	Rioja (E)	Verona (I)
Number of farms	59	62	61
	Farms %		
Will change	14	11	10
Possibly change	10	26	15
Will not change	75	58	67
Don't know	2	5	8

A large majority of growers did not plan to change their pesticide use in the near future, although up to 35% of growers in Rioja will or may possibly change.

Those who answered that they will or may change were asked in which sector would the change be and for what reason.

Table 9.2ii Agrochemical sector and reasons identified for change

Reasons	Better control			Distribution /availability			Economics			Environment		
	% of growers who will or may change Base B - 14, R - 23, V - 15											
Sector	B	R	V	B	R	V	B	R	V	B	R	V
Herbicides	14	65	27	0	4	0	7	0	7	0	17	0
Fungicides	29	100	87	0	9	3	7	4	7	7	26	7
Insecticides /acaricides	14	100	60	0	0	0	0	4	0	14	17	14

Region abbreviations: B = Bordeaux, R = Rioja, V = Verona

Insecticides and fungicides were the main sectors where change might take place, and the main reason was ‘better control’. In Rioja, a significant minority included ‘environment’ as a reason for change in all chemical sectors. This was also the case for fungicides and insecticides/acaricides in Bordeaux and Verona. It may be that the high volume use of sulphur and of parathion and petroleum oil in Rioja has given rise to a feeling that there must be more effective/active chemicals which should therefore have less effect on the environment.

10.0 PESTICIDE/AGROCHEMICAL GENERALITIES

10.1 Sufficiency in choice of products

Table 10.1 Growers indicating satisfaction in the choice of products

Region	Bordeaux (F)	Rioja (E)	Verona (I)
Number of farms	59	62	61
Sector	Farms %		
Herbicides	93	92	79
Fungicides	95	97	92
Insecticides/acaricides	86	95	70

Most growers expressed satisfaction in the choice of products available to them. Least support was given to insecticides/acaricides in Verona.

10.2 Attitudes to developments in the agrochemicals market

Growers were asked to give their opinion on developments in the agrochemicals market with regard to availability of new products, improved efficacy, ease of application and lowered residue levels. They responded ‘good’ ‘satisfactory’ or ‘poor’. Table 10.2 shows the data for the ‘good’ and ‘satisfactory’ responses combined.

Table 10.2 Growers expressing satisfaction with agrochemicals developments

Region	Bordeaux (F)	Rioja (E)	Verona (I)
Number of farms	59	62	61
Attitude	Farms %		
Availability of new products	85	98	88
Improved efficacy	88	97	73
Ease of application	90	75	92
Lower residues	72	55	56

A generally favourable view was found in all regions. Concerning the low satisfaction about residue levels, there were 20%, 31% and 29%, respectively in Bordeaux, Rioja and Verona, answering ‘don’t know’, so it would seem that growers were generally unaware of the position. A significant minority in Verona questioned efficacy.

10.3 Attitudes to handling restrictions on the label

Growers were asked how important to their choice and use of products were the handling restrictions on the label. They were offered three responses - very important, important and not important. Table 10.3 presents those answering very important and important.

Table 10.3 Attitudes to handling restrictions on the label

Region	Bordeaux (F)		Rioja (E)		Verona (I)	
Number of farms	59		62		61	
Attitude	Farms %					
Importance	very imp	imp	very imp	imp	very imp	imp
On **choice** of products	37	58	52	47	72	23
On **use** of products	49	47	51	48	67	28

All growers in all regions believed handling restrictions were important to both their choice and use of product. Those in Verona were most emphatic about this.

10.4 Attitudes to environmental restrictions on the label

The same procedure of questioning was adopted as for 10.3.

Table 10.4 Attitudes to environmental restrictions on the label

Region	Bordeaux (F)		Rioja (E)		Verona (I)	
Number of farms	59		62		61	
Attitude	Farms %					
Importance	very imp	imp	very imp	imp	very imp	imp
On **choice** of products	34	56	42	55	54	43
On **use** of products	44	51	42	56	57	39

Environmental restrictions were important to all growers in all regions, but they were slightly less important in Bordeaux and more important in Verona.

Specialists in Bordeaux and Rioja said that growers were being polite to the interviewer and that in reality the 'environment' meant nothing to growers in terms of choice or use of product!

Comparing the results in Table 10.3 and Table 10.4, there was slightly greater emphasis on handling restrictions than environmental ones.

10.5 Sources of information

Growers were asked to indicate their sources of information on pesticides/agrochemicals and to attribute a score on a scale of 1 - 5, where 5 was most important.

Table 10.5 Information sources

Region	Bordeaux (F)		Rioja (E)		Verona (I)	
Number of farms	59		62		61	
Information source	Farms %	Score	Farms %	Score	Farms %	Score
Cooperative rep	66	3.9	74	3.8	72	4.4
Farming press	32	3.5	29	1.8	21	2.8
Manufacturer's rep	20	3.9	6	2.3	15	3.0
Merchant	22	3.6	69	3.6	43	4.3
Neighbour/colleague	27	3.7	27	3.5	15	3.0
Plant protection advisor	29	4.0	55	4.0	15	4.6
Private consultant	8	4.0	44	4.3	16	3.7
Other	15	2.6	2	5.0	0	0

In all three regions the most important source of information was the co-operative representative, particularly so in Bordeaux and Verona. In Rioja there was a wider spread of sources used, including agrochemical merchants, official plant protection advisors and private consultants - the latter two having high scores for the quality of the information they gave. In Verona larger farmers used merchants more than smaller because they tended not to be members of the local Cantine Sociali (cooperative), and it is of great significance that although the official plant protection advisors achieved high scores, they were not used by many growers - a situation which was also found in the wheat study in Piemonte, Italy (though not in the apple study in Trentino, Italy). It is understood that the coop rep is the channel for dissemination of advice from the plant protection advisors in these regions in Italy.

11.0 PROFITABILITY AND PESTICIDES

11.1 Profitability of the vine crop

Table 11.1 Profitability of the vine crop

Region	Bordeaux (F)				Rioja (E)				Verona (I)			
No. of farms	59				62				61			
	Farms %											
Profitability of vines	Study year (1994)	Σ	5 years ago	Σ	Study year (1994)	Σ	5 years ago	Σ	Study year (1994)	Σ	5 years ago	Σ
Very good	9		24		8		5		10		7	
Good	30	69	33	89	56	90	23	50	36	77	51	83
Satisfactory	30		32		26		26		31		25	
Poor	23		6		10		16		16		11	
Very poor	8		2		0		3		3		3	
No answer	-		3		0		27		3		3	

The majority of growers in all regions felt that the profitability of their crop was satisfactory or above. In Rioja more growers were satisfied in 1994 than five years before. In Verona there was little change. In Bordeaux, a majority of those replying indicated satisfaction with profits in 1994. These were substantially fewer, however, than for five years previously.

The same question was also put to growers about the profitability of their farm as a whole, and the results were the same as their views on vines. Specialists in Bordeaux said that vines were the main source of income of growers in the region followed by the EC subsidised crops, cereals and oil-seeds.

11.2 Returns and costs of production

Models of returns and costs are presented in the individual region reports. The detail, terms and make up of the models vary considerably and do not bear comparison.

Table 11.2 Comparison of agrochemical costs

Agrochemical costs	Bordeaux (F)	Rioja (E)	Verona (I)
as % of variable costs	44	n/a	15
as % of gross income	8	9	4.5

These data tend to confirm the major differences in use of agrochemicals detailed in this report, particularly the low usage in Verona.

11.3 Influence of anticipated profit on pesticide use and choice

Farmers were asked the effect that anticipated profitability might have on aspects of their choice and use of products.

Table 11.3 Influence of anticipated profit on pesticide use and choice

Region	Bordeaux (F)		Rioja (E)		Verona (I)	
Number of farms	59		62		61	
	Farms %					
Anticipated profit	good	poor	good	poor	good	poor
Influence on use						
Price of product						
Use more expensive product	3	2	21	2	3	5
Use less expensive product	6	9	0	31	2	10
No influence	88	86	79	68	87	66
No answer	3	3	0	0	8	19
Dose rate						
Use higher dose	0	3	8	2	7	10
Use lower dose	14	11	0	16	8	7
No influence	85	85	92	82	77	66
No answer	2	2	0	0	8	18
Age of product						
Use newer product	2	2	2	0	26	26
Use older product	0	6	0	0	3	3
No influence	97	91	98	100	62	54
No answer	2	2	0	0	8	16

In all regions the great majority indicated that there would be no influence.

11.4 The effect of agrochemicals on profitability

Growers were asked which agrochemical sector had the greatest and least effect on profitability.

Table 11.4i Effect of agrochemicals on profitability

Region	Bordeaux (F)		Rioja (E)		Verona (I)	
Number of farms	59		62		61	
	Farms %					
Effect	greatest	least	greatest	least	greatest	least
Sector						
Herbicides	3	59	10	42	5	35
Fungicides	92	0	43	5	77	0
Insecticides	2	12	21	10	8	22
Plant growth regulators	0	9	0	2	2	13
Don’t know	2	20	25	42	8	30

Most growers thought that fungicides had the greatest effect on profitability and herbicides the least.

Growers were then asked whether agrochemical inputs could be reduced while maintaining profitability and if so in which sector.

Table 11.4ii Possibility to reduce agrochemicals inputs without affecting profitability

Region	Bordeaux (F)	Rioja (E)	Verona (I)
Number of farms	59	62	61
Opinion	Farms %		
Yes	20	21	11
Possibly	18	8	15
No	55	58	53
No answer	8	13	21

Growers who answered either ‘yes’ or ‘possibly’ were asked to say in which sector reductions might be made.

Table 11.4iii Sector where reductions may be made without affecting profitability

Region	Bordeaux (F)	Rioja (E)	Verona (I)
Number of farms	22	18	16
Sector	Farms %		
Herbicides	32	48	19
Fungicides	64	100	56
Insecticides	32	57	6

Though sample numbers were small fungicides were the sector where most growers thought there could be reductions made. In Rioja this was the view of nearly a third of the total study sample.

12.0 ALTERNATIVE CROP PROTECTION SYSTEMS

12.1 Awareness of alternative systems

Growers were asked if they were aware of any alternative systems of crop protection which might be equally profitable to conventional methods. No prompts were given. Those not mentioning a system were then asked if they were aware of Integrated Crop Management (ICM), Integrated Pest Management (IPM), or Organic Production (OP).

Table 12.1 Awareness of alternative systems that might be equally profitable

Region	Bordeaux (F)	Rioja (E)	Verona (I)
Number of farms	59	62	61
Unprompted	Farms %		
IPM	12	37	34
ICM	44	19	18
OP	3	37	38
No answer	-	-	54
After prompting	Farms % Base - all growers		
IPM	35	8	12
ICM	34	4	8
OP	74	16	13

Growers in Bordeaux were proportionately most aware of ICM, and after prompting, of OP. It is understood that in France to some growers, ICM can mean just adhering to co-operative or SRPV programmes, and they were thought not to fully appreciate the terminology used in the questionnaire, even though the meanings were described. (Definitions in Appendix I.)

Awareness in the other two regions was less than in Bordeaux. The PPS in Rioja confirmed that there was little interest. In Verona there was a very low response level though amongst those reponding, awareness of IPM and OP was high. Local specialists confirmed that IPM/ICM techniques had been practised in the area for many years.

12.2 Interest in developing alternative systems

Farmers were asked for the level of interest in developing an alternative system on their farm.

Table 12.2 Interest in developing alternative systems

Region	Bordeaux (F)	Rioja (E)	Verona (I)
Number of farms	59	62	61
	Farm giving a positive response %		
IPM	23	16	15
ICM	57	10	10
OP	12	23	8

It is difficult to analyse these data because of the possible lack of awareness of the terminology, given that specialists say that many farmers were already practising ICM and IPM techniques. Nevertheless, the data show that there appears to be a significant proportion of growers in Bordeaux interested in ICM methods as they understood them. All the positive responses concerning IPM and ICM in Rioja were from larger growers, so that although only 16% of growers were interested in developing IPM they represented 47% of the crop area. The greatest interest in OP was in Rioja and this group of growers were of all crop sizes.

13.0 ENVIRONMENTAL ISSUES

13.1 Vineyards in restricted areas

Few farms were in areas with environmental restrictions. There was one in Bordeaux none in Rioja, but four in Verona. Three of the four in Verona mentioned that there were restrictions on the use of agrochemicals which made ‘choice’ difficult.

13.2 Considerations influencing the choice of chemicals

Growers were shown a list of suggested environmental considerations and asked which they took into account when choosing their agrochemicals.

Table 13.2 Environmental considerations influencing choice of chemicals

Region	Bordeaux (F)	Rioja (E)	Verona (I)
Number of farms	59	62	61
	Farms %		
Surface water	15	5	7
Ground water	17	6	15
Soil protection	21	8	42
Flora	21	8	12
Fauna	24	10	10
Produce quality	36	18	27
None of these	54	13	27
Don’t know	1	40	20

Over half the growers in Bordeaux and Rioja and just under half in Verona said they were not influenced by any of the environmental considerations listed or could not answer this question. ‘Produce quality’ followed by absence of residues in the grapes, were the only two aspects which specialists in Bordeaux said growers were interested in. Growers in Verona may have been influenced by the publicity surrounding the ground water problems in the Po Valley in suggesting ‘soil protection’.

APPENDIX I

DEFINITIONS AND CAVEAT

BACKGROUND

1 Ideally this study should have been conducted on an individual field basis. Economics and practical considerations, however, precluded this. Farmers were therefore asked about their treatments for the entire crop over their whole farm.

2 Typically fields were treated several times for any one pesticide sector (fungicides, insecticides, particularly). Occasionally on certain farms some fields were treated more times than others - though review of the data shows this to be limited.

3 Applications were made with agrochemical products containing one or more active ingredients. While data was collected from the farms at product level the results were required at active ingredient level for calculation of chemical load and to facilitate cross-country comparisons.

4 Presentation of the data as kg ai/ha has been used for simplification. This of course hides the great variation in inherent activity of different chemicals. Attempts are made to cover for this in the text.

DEFINITIONS

Regional level:

Base area treated (for a chemical sector)

That part of the crop which receives any treatment at all for the chemical sector in question. This is represented by Crop Area - Untreated Area = Base Area Treated.

Farm level:

Proportion of crop treated

This is defined as "That portion of crop receiving the active ingredient at least once". Where a series of treatments, of differing areas, had been made on a farm then the assumption has been made that the treatments were made sequentially on the largest area receiving that active ingredient. In practice the largest area was nearly always the complete area of crop on that farm so this is usually correct.

Average number of applications

For a given active ingredient this was calculated as the average number of times an active ingredient was applied on a given farm. Where an active ingredient is applied on different areas then the average number of applications/ha is calculated for the whole farm. This can occasionally underestimate the number of applications on a given field.

Cumulative dose

This is the total volume of an active ingredient used on a farm divided by the area of study crop grown on that farm. In situations where a chemical was not always used on the whole farm this has the effect of underestimating the dose - however, as already indicated these situations were limited.

Product applications

Products may be applied alone or in tank mixes. The latter were not catered for in the questionnaire. The term product applications has therefore been introduced meaning products x applications. As a consequence this can exaggerate the number of applications made on a farm where considerable use was made of tank mixes (possibly mixes of two products at low dose).

ALTERNATIVE CROP PROTECTION

Integrated Pest Management (IPM)

The objective here is control of pests (weeds, disease, insects etc) using a mix of the less aggressive chemicals available and the stimulation of the crop or beneficial organisms to control the pest. Such methods may involve choice of resistant varieties, modifying rotations, use of biological pesticides etc.

Integrated Crop Management (ICM)

The objective here is to manage the growing of crops in such a way as to reduce any negative effects on the environment, typically ground water. As such, the same methods may be used as with IPM, but taken further to include fertilisers and any other ‘contaminating’ inputs and cultural methods.

Organic Production (OP)

The objective here is to produce crops in which chemical pest control or fertilisers have played no part.

APPENDIX II

CONTACTS AND COLLABORATORS

FRANCE

Field survey:

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