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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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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 Ritmo 14 Astron 12 Toronto 10 Pepital 10 Zentos 8	Riband 36 Hunter 12 Brigadier 12 Soisson 9 Hereware 8 Hussar 3	Soisson 35 Thesee 11 Sideral 10 Scipion 8 Rossini 6 Recital 4	Centauro 33 Golia 7 Eureka 6 Marius 6 Tommaso 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		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		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.

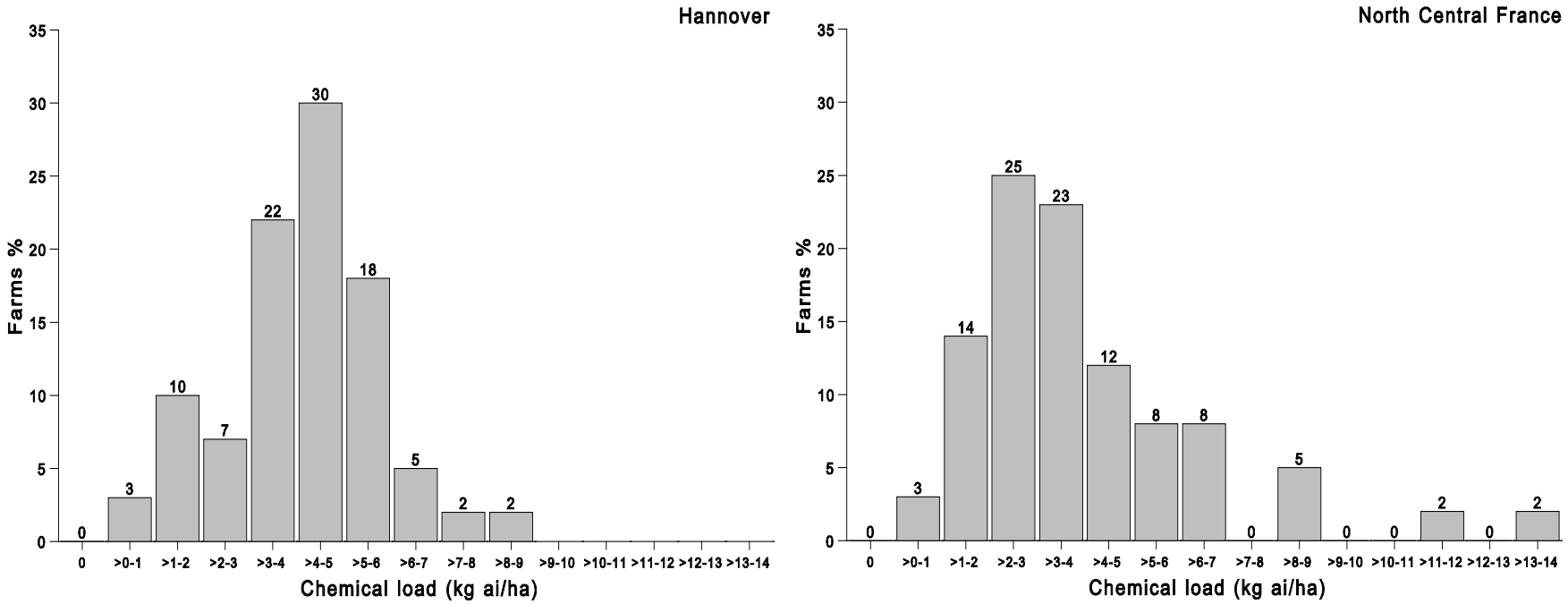
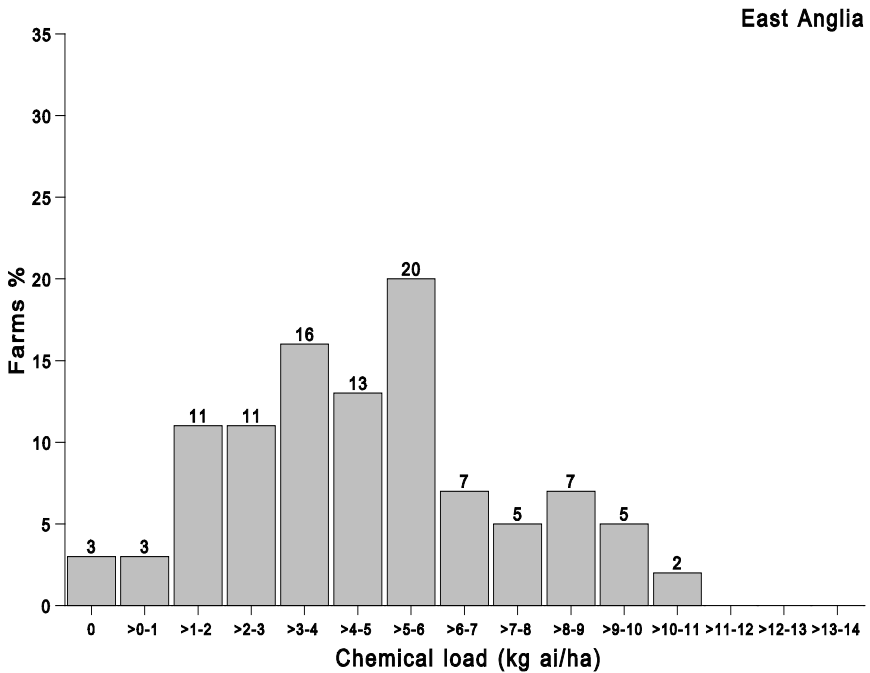
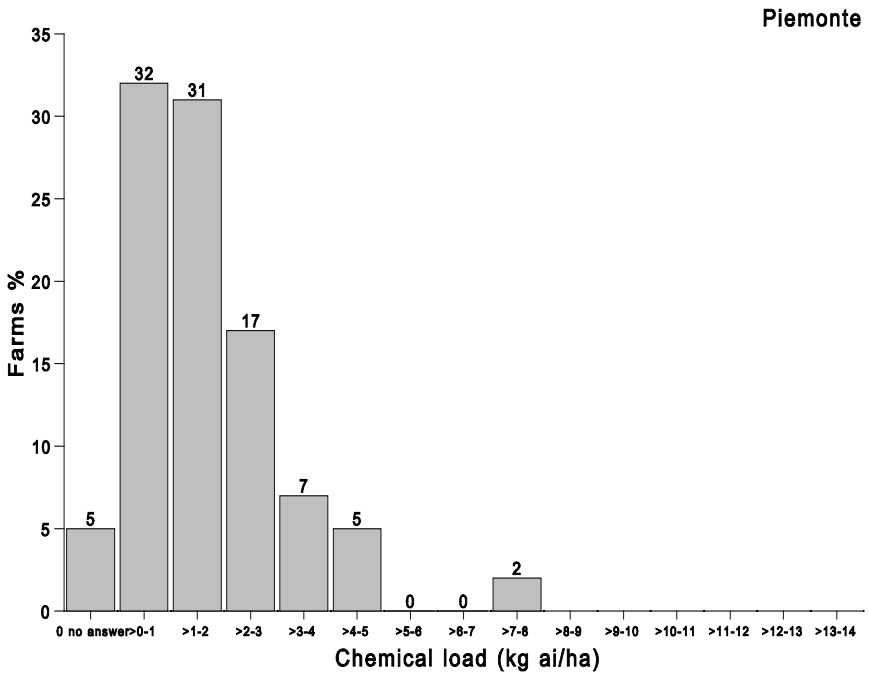


Chart 3.2 Variation in chemical load between farms and regions


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-methyl	4	68	24	68			2	76
triadimenol							2	31
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-methyl	pob	4	1	1.0	7	7	7
amidosulfuron	pob	3	1	1.0	15	22	17
bentazone	saf	3	1	1.0	520	520	520
fenchlorazole-e	pog	2	1	1.0	22	30	27
fenoxaprop-e	pc	2	1	1.0	90	120	110
pendimethalin	pob	2	1	1.0	400	800	755
bromoxynil	syn	<1	1	1.0	470	470	470
flurenol		<1	1	1.0	120	120	120

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 (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
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	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
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 (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
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

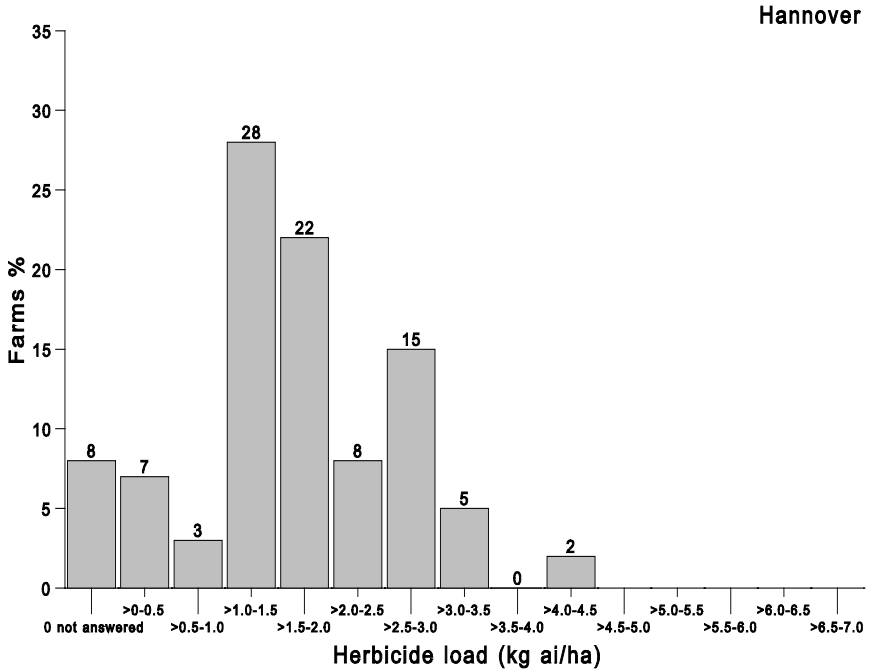
The proportion of farmers spraying parts of their crop for any given treatment was very similar in the three northerly regions and demonstrates a targeted approach to weed control. The smaller proportion in Piemonte reflects the farm sizes as well as the less developed approach.

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)



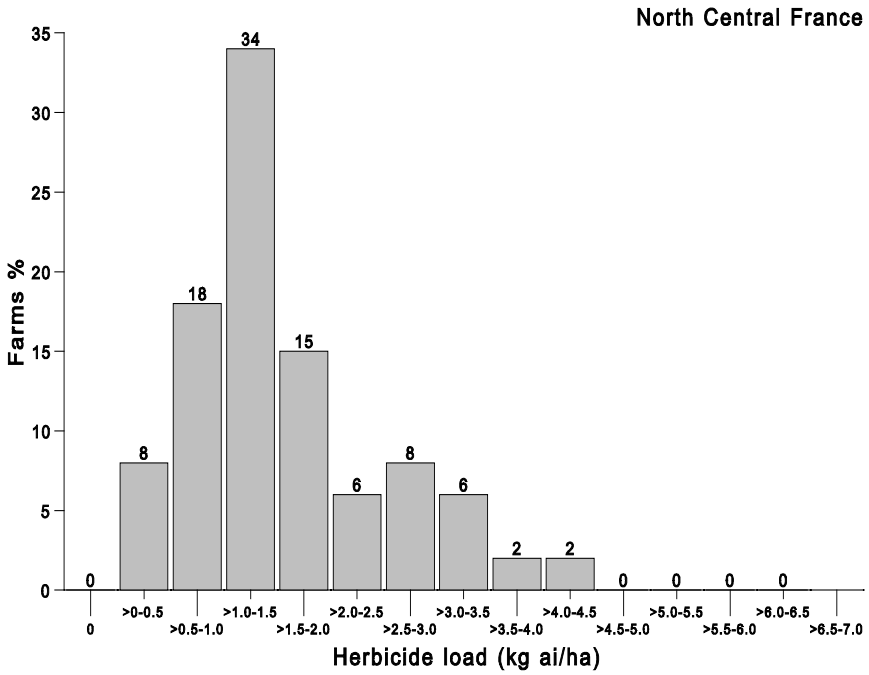
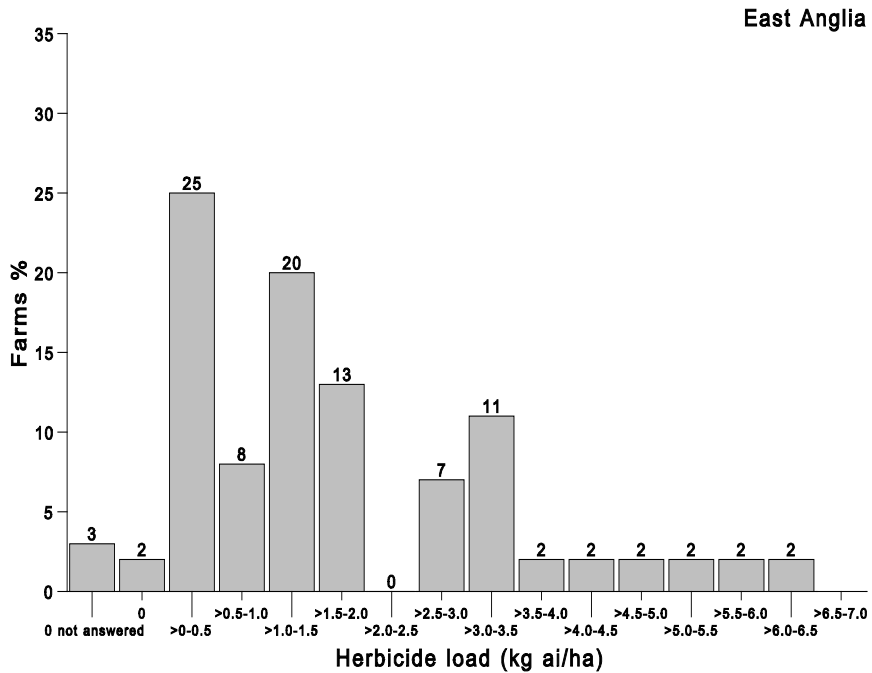
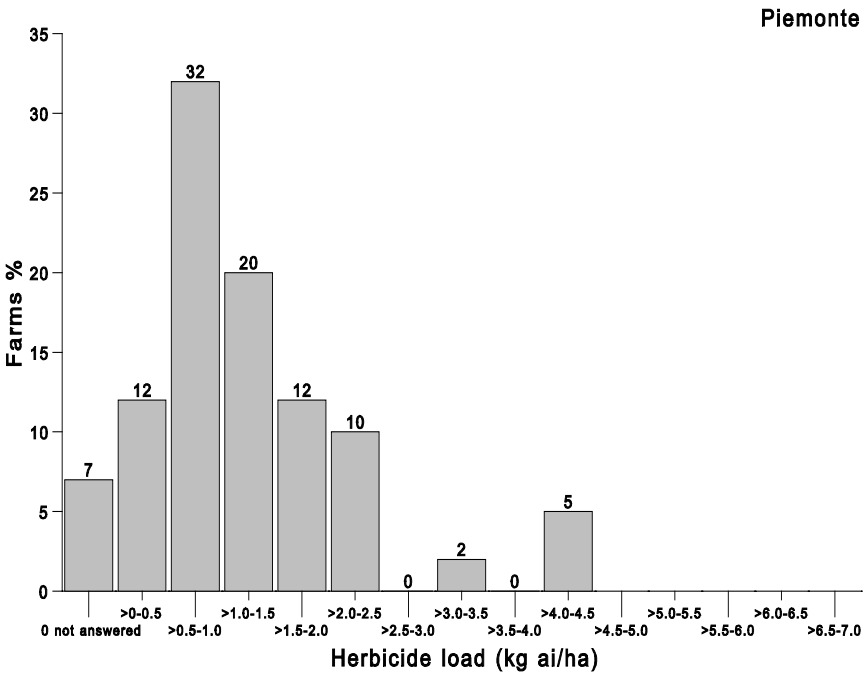


Chart 5.6 Herbicide load per farm


East Anglia
Farms %
35
30
25
20
15
10
5
0
3
2
25
8
20
13
0
7
11
2
2
2
2
2
2
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
Herbicide load (kg ai/ha)


Piemonte
Farms %
35
30
25
20
15
10
5
0
7
12
32
20
12
10
0
2
0
5
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
Herbicide load (kg ai/ha)

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
c = contact
p = protectant
a = additive
b = broad-spectrum

Ery = *Erysiphe* (Mildew)
Puc = *Puccinia* (Rusts)
Psc = *Pseudocercosporella* (Eye spot)
Sept = *Septoria*
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	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
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
c = contact
p = protectant
a = additive

b = broad-spectrum
Ery = *Erysiphe* (Mildew)
Puc = *Puccinia* (Rusts)
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

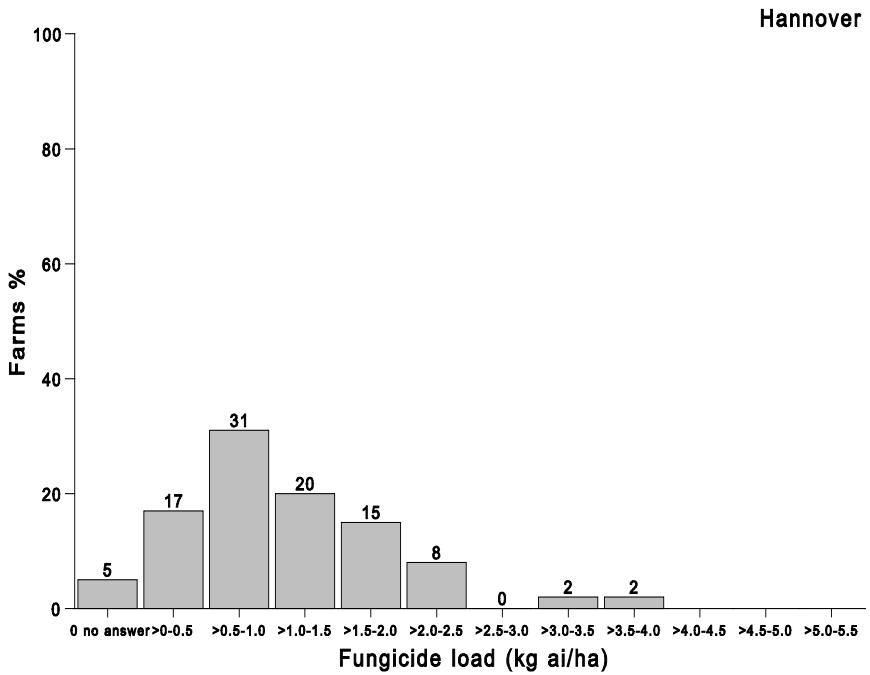
The greatest number of active ingredients per hectare were used by farmers in Hannover. Targeted spraying of parts of the crop was most developed in Hannover.

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.



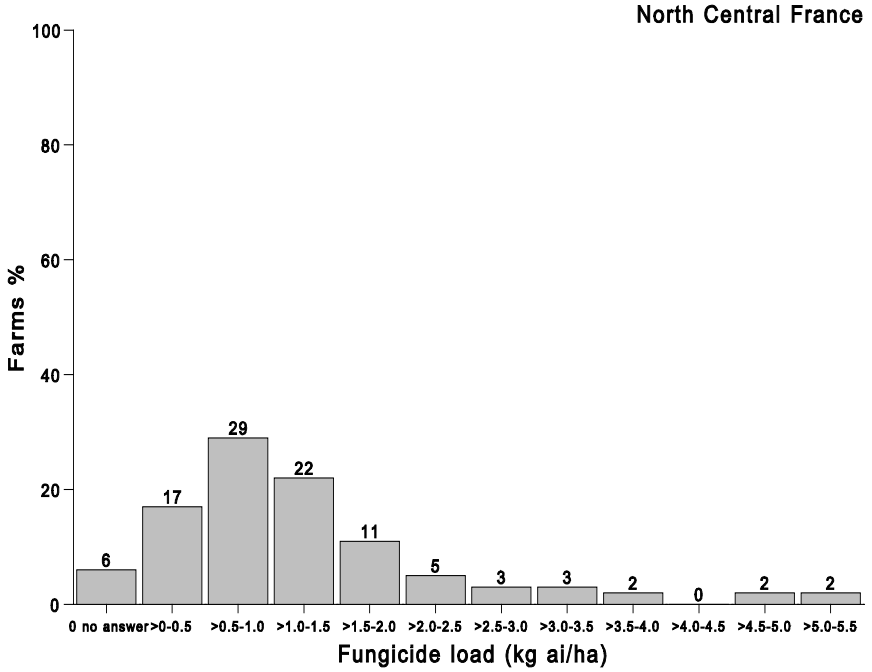
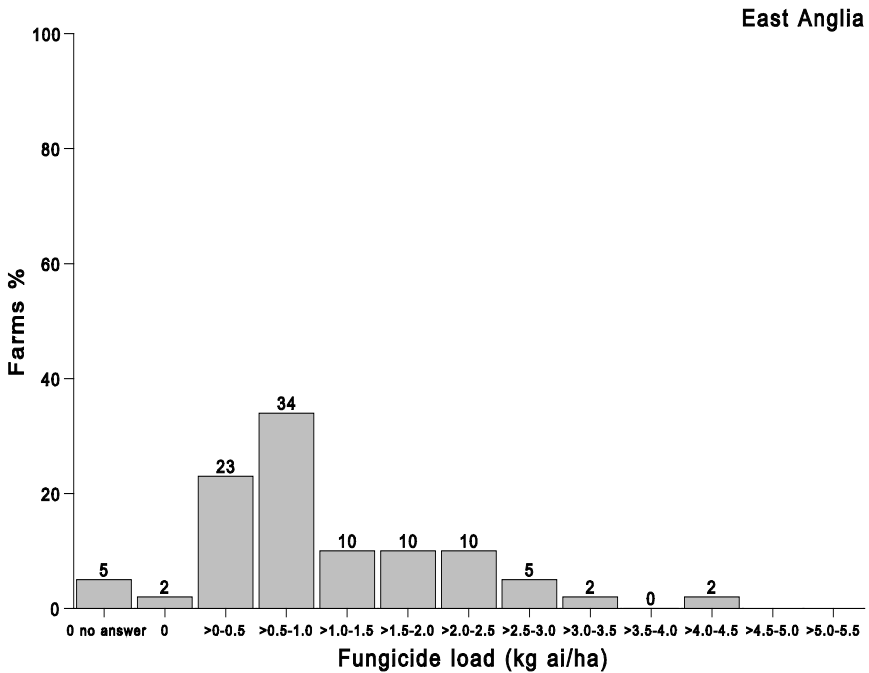
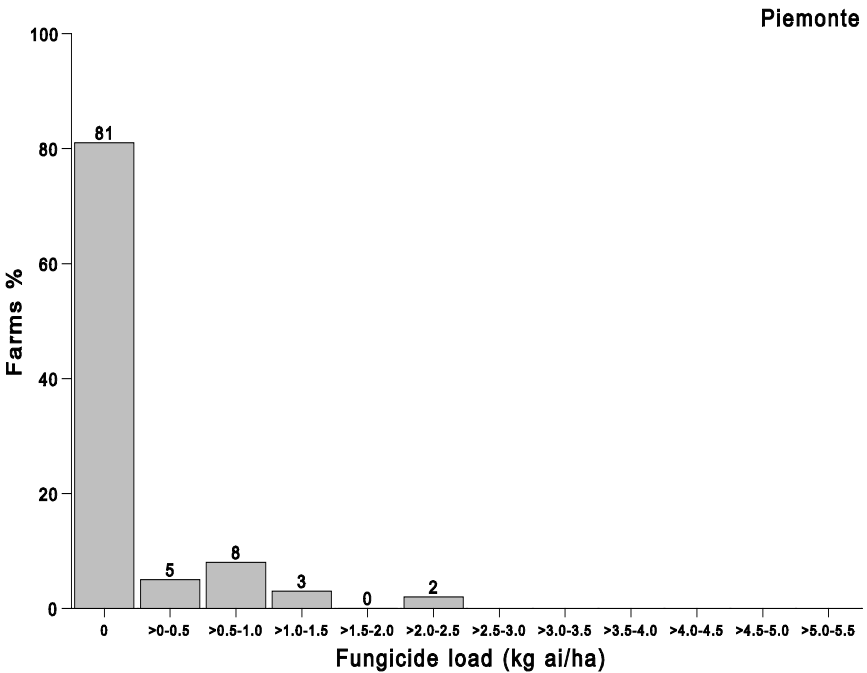


Chart 6.6 Fungicide load per farm


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 (11,13)	5.8	5	124	49
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
s = systemic
f = fumigant

aph = aphids
b = broad-spectrum

♣ = 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 (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
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
s = systemic
f = fumigant

aph = aphids
b = broad spectrum

♣ = 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
s = systemic
f = fumigant

aph = aphids
b = broad-spectrum

♣ = 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).

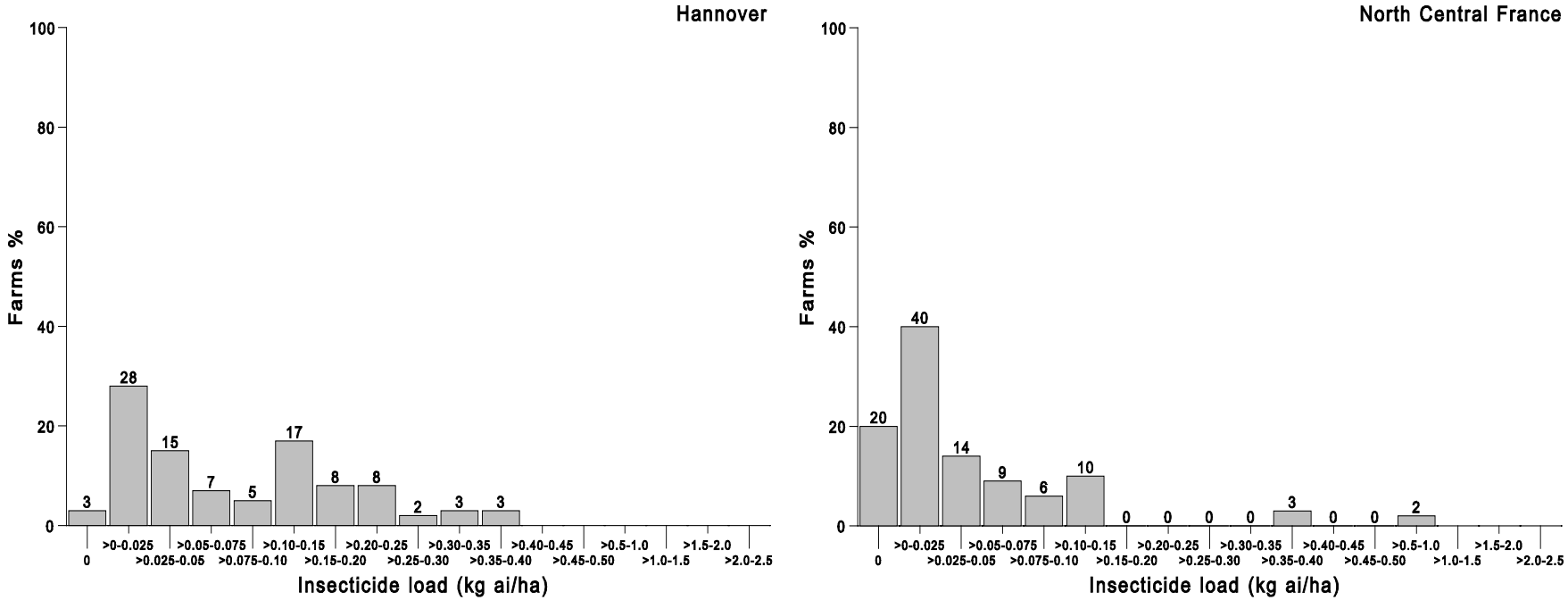
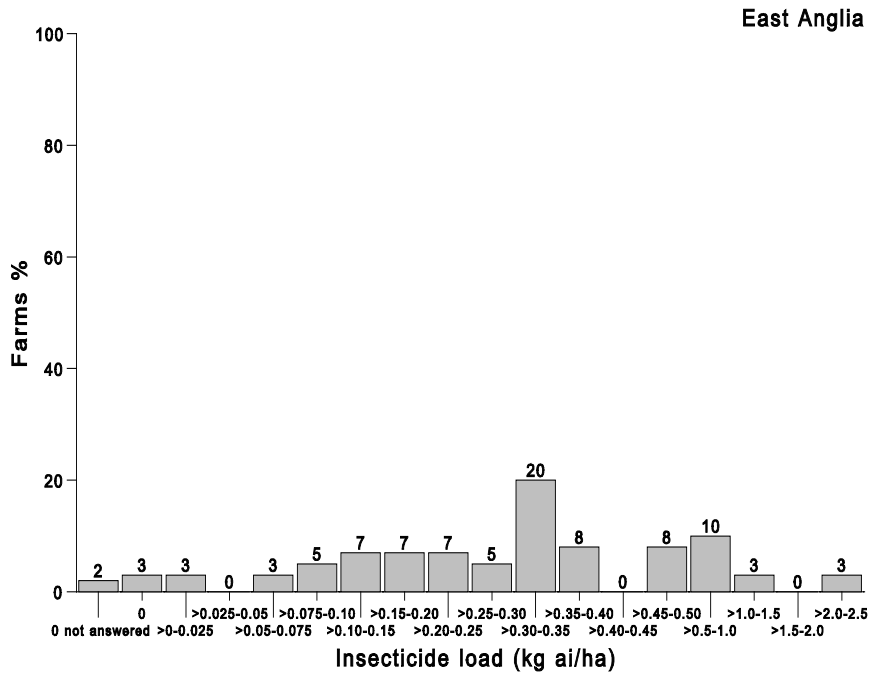
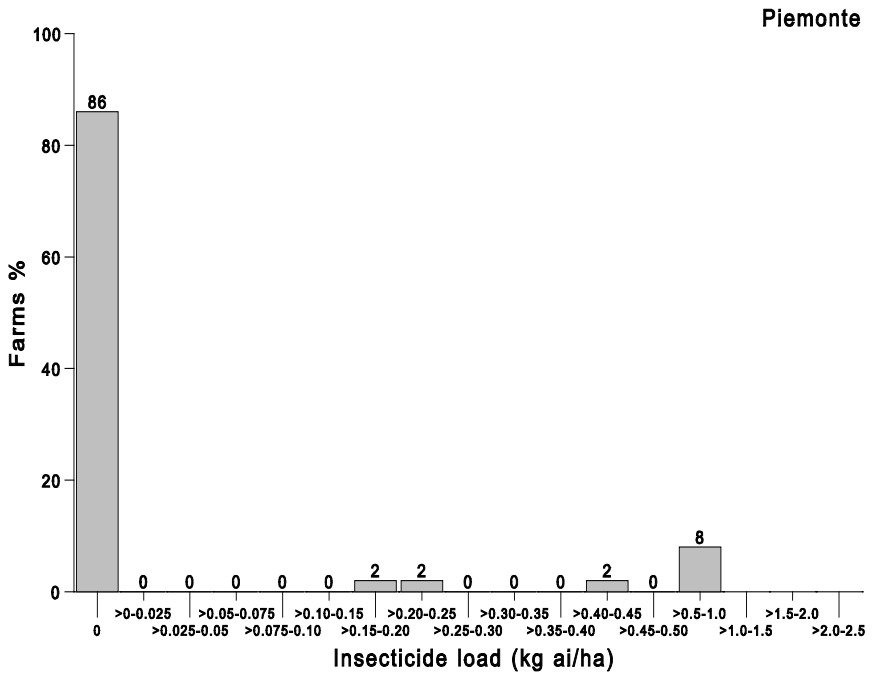


Chart 7.6 Insecticide load per farm


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 %
100
80
60
40
20
0
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:

Product und Markt
Otto-Lilienthal-Straße 15
49134 Wallenhorst
Germany

Local specialists:

Landwirtschaftskammer Hannover - Betriebswirtschaft
Herr Meister
Johannssenstraße 10
30159 Hannover

Beratungsring Südhannover
Dr G Golisch ü Beratungsringleiter
Parkstraße 19
30952 Ronnenberg

Raiffeisen Hauptgenossenschaft
Abt. Pflanzenschutz
Herr Dr H Thiel
Krausenstraße 46-50
30171 Hannover

EAST ANGLIA

Mr W Clark
ADAS, Cambridge
Brooklands Avenue
Cambridge CB2 2BL

National Cereals Pathologist

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.

Mr G Davidson
Ms C Asby
Mr M Murphy
Agricultural Economics Unit
Department of Land Economy
University of Cambridge
19 Silver Street
Cambridge CB3 9EP

NORTH CENTRAL FRANCE

Farm survey: Brule Ville Associés
191 avenue du Général Leclerc
B P 59
78220 Viroflay

Local specialists: M. Henri Magendie
Responsable du Service Agronomie
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