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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 POTATOES IN FOUR REGIONS IN EUROPE

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

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POTATOES - CROSS REGIONAL REVIEW

SUMMARY

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

General

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

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

Crop types and crop protection requirements

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

Chemical load

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

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

* Excluding sulphuric acid use as a desiccant.

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

Seed treatment

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

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

Weeds and herbicides

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

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

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

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

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

Diseases and fungicides

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

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

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

Insects, nematodes and their control

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

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

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

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

Miscellaneous pests and pesticides

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

Other agrochemicals

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

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

Trends in pesticide use and agrochemical generalities

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

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

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

Information sources

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

Profitability

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

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

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

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

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

Alternative crop protection systems

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

Environmental issues

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

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

Conclusion

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

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

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

1.0 THE REGIONS, METHODOLOGY AND SAMPLES

1.1 The regions

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

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

1.2 Methodology

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

1.3 The survey samples

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

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

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

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

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

Table 1.3 The sample

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

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

2.0 GENERAL RESEARCH FINDINGS

2.1 Farming demographics

2.1.1 Land tenure

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

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

2.1.2 Occupational status

Full-time farmers predominated in all regions.

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

2.1.3 Farm enterprises

Table 2.1.3 Farm enterprises

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

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

2.2 Crop agronomy

2.2.1 Crop types and varieties

Table 2.2.1i Crop types by farm

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

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

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

Table 2.2.1ii Crop types by area

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

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

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

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

Crop types

Increased need for agrochemicals

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

Decreased need for agrochemicals

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

Varieties

Sector affected

Increased need for agrochemicals

- Most popular varieties particularly Bintje and, to a lesser extent, Maris Piper are susceptible to *Phytophthora* + F
- The most susceptible variety on a farm can often determine the spray regime for all varieties + F
- Foliage varies modifying desiccant needs ± D

Decreasing need for agrochemicals

- Some varieties have in-bred resistance to nematodes and partial resistance to *Phytophthora* - I, F

2.2.2 Soil types

Table 2.2.2 Soil types

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

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

Soil types have implications on pesticide usage.

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

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

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

2.2.3 Rotations

Table 2.2.3 Rotations

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

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

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

2.2.4 Fertiliser use

Table 2.2.4 Fertiliser use

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

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

2.3 Commercial issues

2.3.1 Destination of produce

Table 2.3.1 Destination of produce

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

2.3.2 Advance contracts and pesticide restrictions

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

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

Table 2.3.2 Pesticide restrictions in contracts

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

3.0 PESTICIDE USE

3.1 Summary of chemical use

3.1.1 General

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

3.1.2 Seed treatment

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

3.1.3 Herbicides

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

3.1.4 Fungicides

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

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

3.1.5 Insecticides

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

3.1.6 Miscellaneous pesticides

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

3.1.7 Other agrochemicals

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

Table 3.1 Summary of chemical use

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

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

Seed treatment data was poor and under estimates actual use:

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

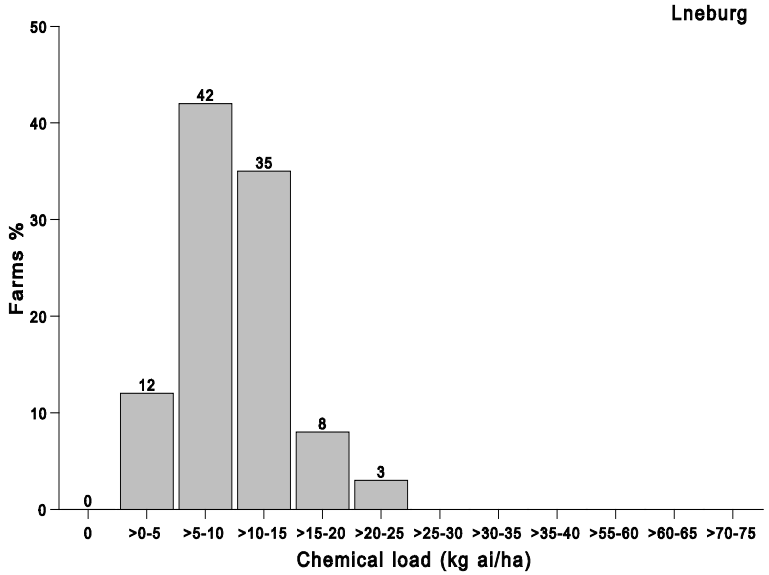
3.2 Variation in chemical load between farms and regions

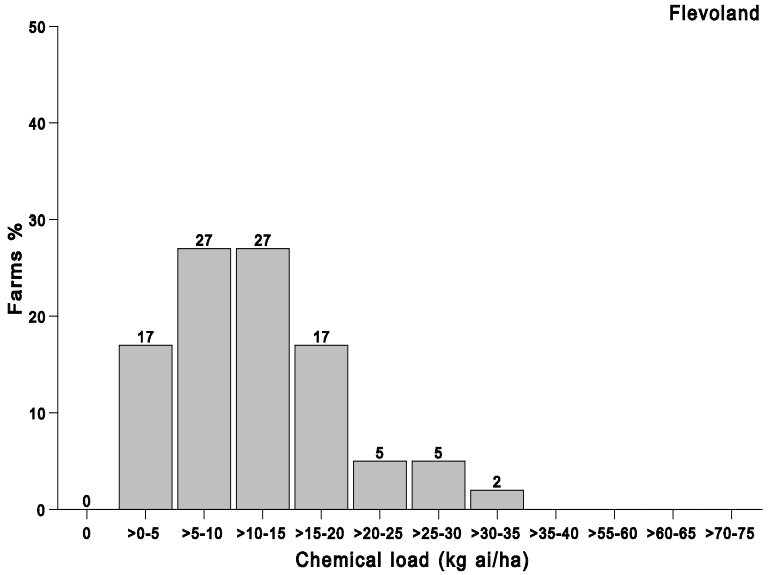
Table 3.2 Variation in chemical load between farms and regions

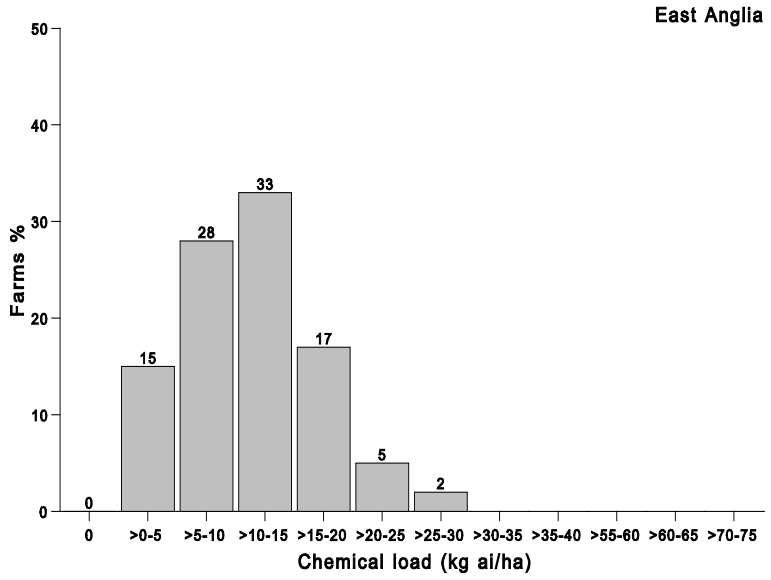
Region	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Number of farms	60	60	60	62
Chemical load kg ai/ha	Farms %			
0	0	0	0	0
>0 - 5	12	17	15	0
>5 - 10	42	27	28	2
>10 - 15	35	27	33	2
>15 - 20	8	17	17	19
>20 - 25	3	5	5	19
>25 - 30		5	2	23
>30 - 35		2		10
>35 - 40				19
>55 - 60				2
>60 - 65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

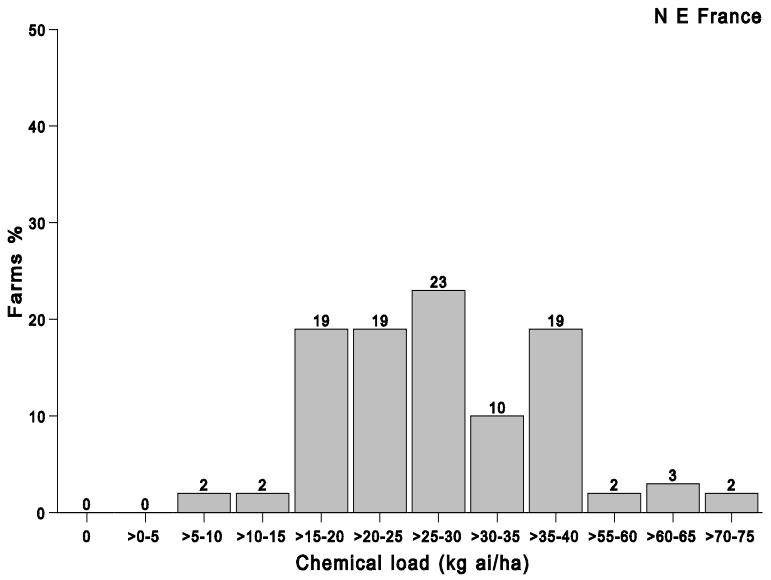
\+ Sulphuric acid was used on 33% of farms at c. 115 kg ai/ha.

Chart 3.2 Variation in chemical load between farms and regions






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


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

4.0 SEED AND SEED TREATMENT

4.1 Seed sources

Table 4.1 Seed sources

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

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

4.2 Background to seed treatment

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

4.2.1 Target diseases

Table 4.2.1 Target diseases

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

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

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

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

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

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

4.2.2 Seed treatment application

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

Table 4.2.2i Proportion of seed treated

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

Farmers claimed the the majority of seed received a treatment.

Table 4.2.2ii Who treated the seed

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

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

Specialists views obtained were:

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

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

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

4.3 Seed treatment by active ingredient

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

4.3.1 Lüneburg

Table 4.3.1 Seed treatment by active ingredient - Lüneburg

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

* Dose attributed.

4.3.2 Flevoland

Table 4.3.2 Seed treatment by active ingredient - Flevoland

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

* in mixture with TBZ

4.3.3 East Anglia

Table 4.3.3 Seed treatment by active ingredient - East Anglia

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

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

4.3.4 N E France

Table 4.3.4 Seed treatment by active ingredient - N E France

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

4.3.5 Seed rates

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

Table 4.3.5 Seed rates

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

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

4.4 Opportunities to reduce seed treatment load

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

5.0 WEEDS AND HERBICIDES

5.1 Target weeds

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

Table 5.1 Target weeds

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

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

5.2 Resistant species claimed

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

5.3 Levels of weed control sought

Table 5.3 Levels of weed control sought

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

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

5.4 Herbicide active ingredients used

5.4.1 Lüneburg

Table 5.4.1 Herbicide use by active ingredient - Lüneburg

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

Key to abbreviations:

p = pre-emergence
po = post-emergence
b = broad-leaved weeds
g = grasses
c = cross spectrum (b+g)

5.4.2 Flevoland

Table 5.4.2 Herbicide use by active ingredient - Flevoland

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

Key to abbreviations:

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

5.4.3 East Anglia

Table 5.4.3 Herbicide use by active ingredient - East Anglia

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

Key to abbreviations:

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

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

5.4.4 N E France

Table 5.4.4 Herbicide use by active ingredient - N E France

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

Key to abbreviations:

p = pre-emergence
po = post-emergence
des = desiccants
b = broad leaf weeds
g = grasses
c = cross spectrum (b+g)

5.4.5 General commentary

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

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

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

5.5 Herbicide use parameters

5.5.1 Herbicide applications

Table 5.5.1 Herbicide applications

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

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

5.5.2 Mechanical weed control

Table 5.5.2i The practice of mechanical weed control

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

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

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

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

Table 5.5.2ii Mechanical weed control and herbicide use

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

* based only on those farms using herbicide

5.6 Herbicide load by farm

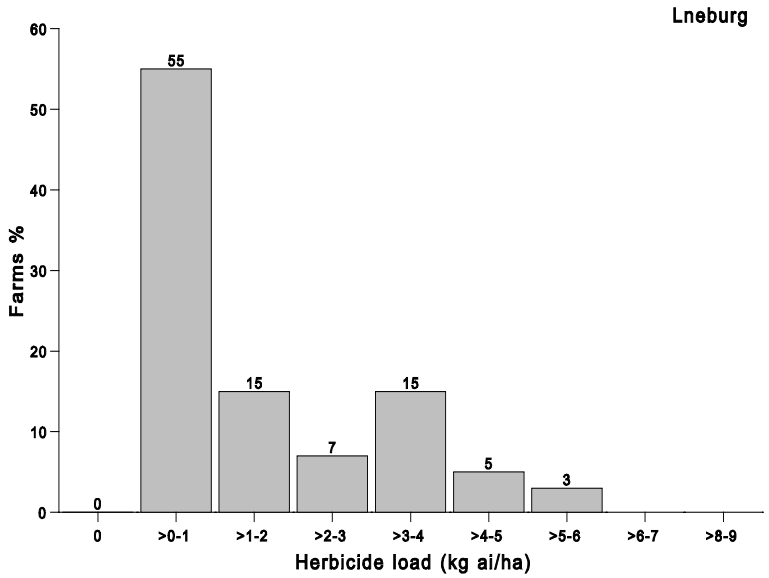
Table 5.6 Herbicide load by farm

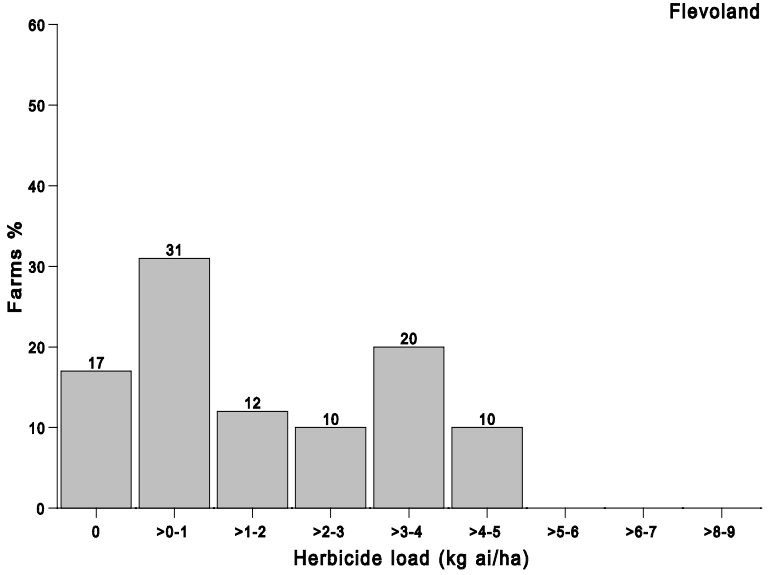
Region		Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Number of farms		60	60	60	62
Herbicide load kg ai/ha		Farms %			
0		0	17	22*	5
>0 - 1		55	31	22	34
>1 - 2		15	12	23	10
>2 - 3		7	10	27	8
>3 - 4		15	20	3	26
>4 - 5		5	10	2	8
>5 - 6		3		0	8
>6 - 7				2	0
>8 - 9					2
Load kg ai/ha grown	Average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

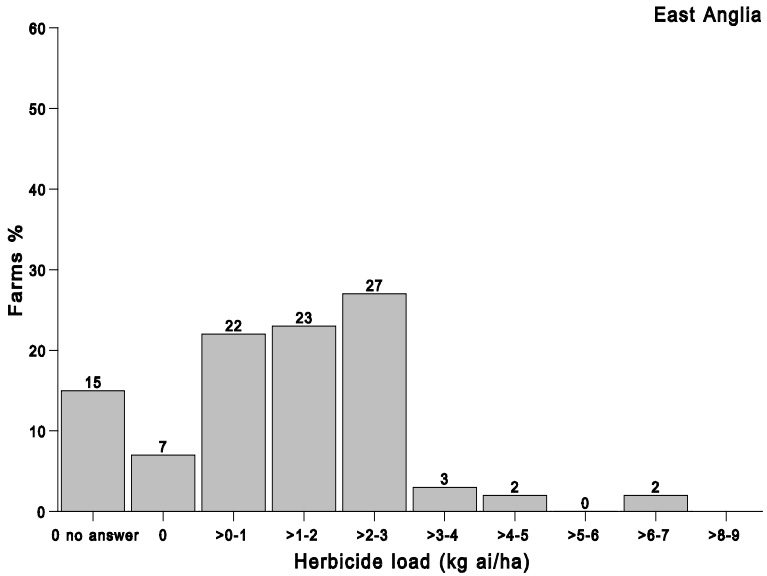
* includes 15% who did not answer

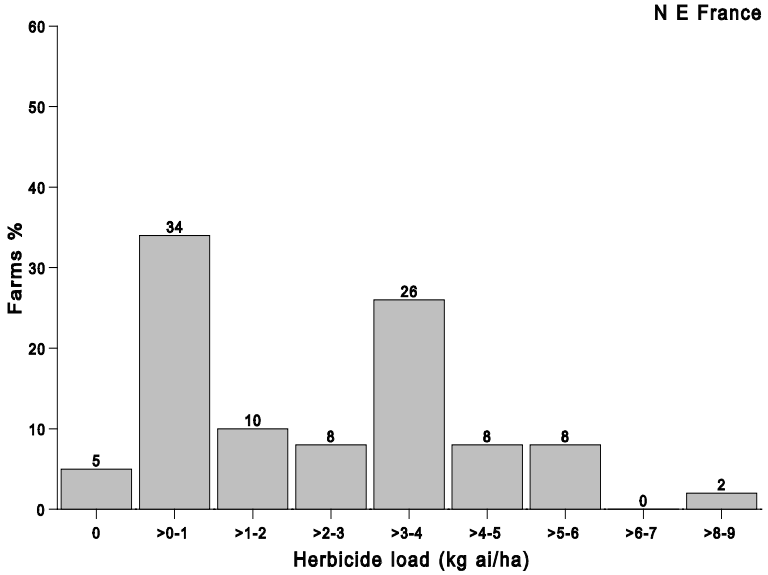
There was no common reason across regions for heavy or lighter use. Heavier users did tend, however, to use higher dose active ingredients and apply more products and make more applications. Lighter users tended to use lower dose active ingredients and to make more targeted or partial applications, and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

Chart 5.6 Herbicide load by farm






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


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

5.6.1 Herbicide load relative to yield

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

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

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

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

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

5.8 Opportunities to reduce herbicide load

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

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

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

6.0 DISEASES AND FUNGICIDES

6.1 Target diseases

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

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

6.2 Resistance of diseases to fungicides

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

6.3 Levels of disease control sought

Table 6.3 Levels of disease control sought

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

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

6.4 Fungicide active ingredients used

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

6.4.1 Lüneburg

Table 6.4.1 Fungicide use by active ingredient - Lüneburg

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

Key to abbreviations:

c = contact
s = systemic

Phy = *Phytophthora* spp

6.4.2 Flevoland

Table 6.4.2 Fungicide use by active ingredient - Flevoland

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

Key to abbreviations:

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

* Inclusive of seed treatments

6.4.3 East Anglia

Table 6.4.3 Fungicide use by active ingredient - East Anglia

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

Key to abbreviations:

c = contact
s = systemic

Phy = *Phytophthora infestans*

6.4.4 N E France

Table 6.4.4 Fungicide use by active ingredient - N E France

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

Key to abbreviations:

c = contact
s = systemic

Phy = *Phytophthora*

6.4.5 General commentary

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

6.5 Fungicide use parameters

6.5.1 Fungicide applications

Table 6.5.1i Fungicide applications

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

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

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

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

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

( ) = < 10% of farms

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

6.6 Fungicide load by farm

Table 6.6 Fungicide load by farm

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

* Products not identified.

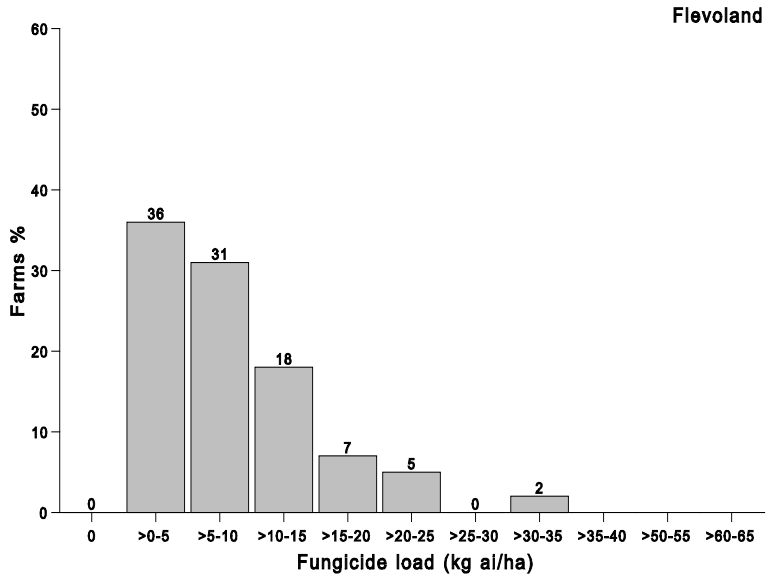
N E France stands out for its much heavier load of fungicides. This region and Flevoland had the highest proportion of ware potato production area in the sample, 71% and 78% respectively.

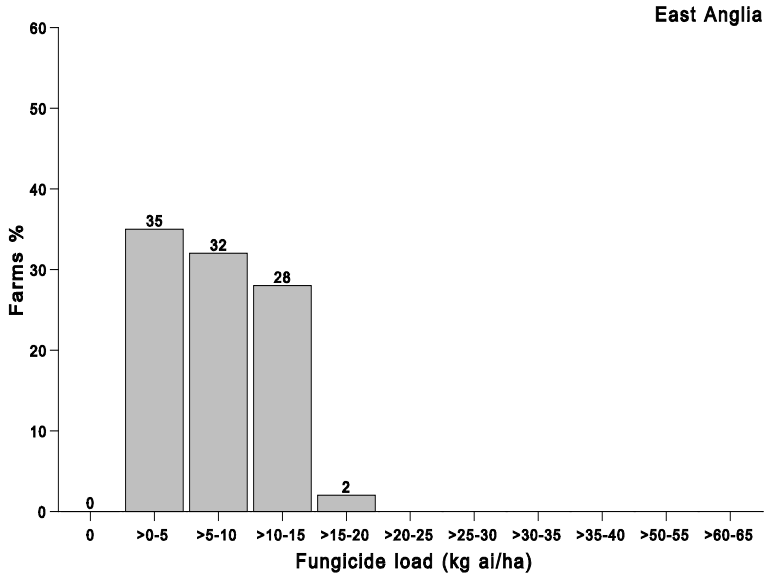
Both Flevoland and N E France made a very high number of product applications per hectare. In the former case at least this was due to the exceptionally long season. However, the load in N E France was three times as high.

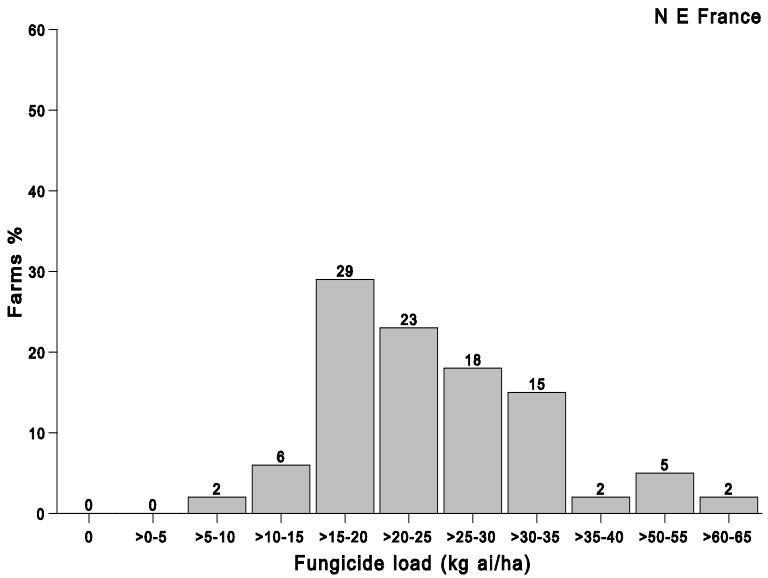
The average number of spray applications of the most used protectant fungicide, mancozeb was 12.8 in N E France, whilst in Flevoland it was only 4.2 on half the area. However, in Flevoland the difference had been taken up by the use of fluazinam which had an average of 10.2 applications/ha treated.

The reason for the high fungicide load in N E France relative to Flevoland was thus due almost entirely to the use of the high dose rate active ingredient mancozeb compared with the low dose fluazinam.

Chart 6.6 Fungicide load by farm




East Anglia
Farms %
60
50
40
30
20
10
0
0
35
32
28
2
0
>0-5
>5-10
>10-15
>15-20
>20-25
>25-30
>30-35
>35-40
>50-55
>60-65
Fungicide load (kg ai/ha)


N E France
Farms %
60
50
40
30
20
10
0
0
0
2
6
29
23
18
15
2
5
2
0
>0-5
>5-10
>10-15
>15-20
>20-25
>25-30
>30-35
>35-40
>50-55
>60-65
Fungicide load (kg ai/ha)

6.6.1 Fungicide load relative to yield

Fungicide load was plotted against yield for the different regions (presented in the individual country reports).

In a crop protection programme which is extremely sensitive to the day-to-day incidence of disease attack and where yield is optimised through other aspects, there should be no relationship between agrochemical load and yield.

In potatoes, the main disease control programme is a protectant one and similarly, if yield is optimised via other aspects there should be no relationship between agrochemical load and yield.

In both cases it would be expected to find, statistically, a clumping of yield data around the crop's potential yield.

In Lüneburg, Flevoland, E Anglia and in seed and starch crops in N E France there was no relationship demonstrated between yield and fungicide load. For ware potatoes in N E France, however, there was an increase in yield between 10 and 35 kg fungicide ai/ha. This suggests that disease control was, firstly, important in preserving yields and, secondly, that control was technically sub-optimal at the lower fungicide loads used. Two aspects present themselves. Either that the chemicals used (or the way they were used) was not optimal, or that the lower loads/lower yields were not necessarily less cost-effective.

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

Table 6.7 Fungicide use in the study year (1994) compared with an average year

Region	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Crop area - ha	1,076	897	2,060	862
	Area %			
Greater use	16	45	3	34
The same	61	30	84	56
Lesser use	17	19	7	10
No answer	6	6	6	0

In Lüneburg it tended to be larger farmers who believed they used less or more than average. Again in Flevoland it was larger farmers who thought they had used more than average in 1994. In the continental European regions there was greater variability within each region than in E Anglia where the great majority used the same quantity.

6.8 Factors determining the start of fungicide application

Table 6.8 Factors determining the start of fungicide application

Region	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Number of farms	60	60	60	62
	Farms %			
Calendar date	38	3	27	23
Disease stage	25	10	21	16
Plant stage	60	83	48	34
Warning system	55	27	22	27
Weather	77	70	34	71

In all regions 'plant stage' along with 'weather' were the most important factors in determining the start of spraying. Warning systems operate in all regions but farmers will only use these if the warning occurs before 'plant stage' or 'weather'. The systems were not relied upon as a means of delaying application, such is the level of risk aversion among potato growers.

6.9 Opportunities to reduce fungicide load

Spray decision support systems are being developed in all regions, utilising computer technology to harness the huge variability inherent in 'weather'. Farmers naturally use 'weather' and if these warning systems can build on this and combine it with other factors, there is a chance of delaying the start and perhaps stretching the interval between sprays.

All specialists believed that prophylactic strategies were fundamental with present chemicals. Systemic, partially curative, active ingredients used alone are likely to result in resistance.

In Flevoland, specialists pointed out the crucial importance of farmer attitude in introducing change, and that variability in attitudes was a real consideration which would need to be addressed.

Varietal resistance or reduced susceptibility may increase in the longer term. However, the top priority for breeding is determined by market demand. Future technologies may be able to link these two attributes more closely.

7.0 INSECTS AND INSECTICIDES

7.1 Target insects and nematodes

Farmers responses indicated the following:

Table 7.1 Target insects and nematodes

Region	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Crop area - ha	1,076	897	2,060	862
Pest	Area %			
Insects				
Agrotis spp (cutworm)	0	0	40	0
Leptinotarsa spp (Colorado potato beetle)	58	4	0	12
Myzus persicae (peach/potato aphid)	77	94	92	99
Nematodes				
Globodera spp (potato cyst nematode)	25	15	68	2

Specialists felt *Leptinotarsa* was overstated in Lüneburg. They indicated that aphids were the most important pest. *Globodera* only required significant control measures in E Anglia but there was a fear by specialists that the nematode problem in Lüneburg and Flevoland was not adequately recognised by the farmers.

7.2 Insects exhibiting resistance

Some farmers in each region claimed to have cases of aphids resistant to several insecticides. Only in E Anglia did specialists accept these cases as genuine. These involved three common organophosphates, demeton-s-methyl, dimethoate and oxydemeton-methyl, and the carbamate pirimicarb.

7.3 Levels of insect control sought

Table 7.3 Levels of insect control sought

Region	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Number of farms	60	60	60	62
	Farms %			
< 70%	3	2	0	0
71 - 80%	7	12	2	0
81 - 90%	28	23	2	3
91 - 100%	52	53	92	95
Don't know	10	10	5	2

The preparedness in Lüneburg to accept lower levels of pest control was considered to be due to the high proportion of starch potato growers. In Flevoland, farmers accept populations up to 50 aphids/leaf before spraying ware crops (78% of the area of the study). Such a system is recommended for ware crops in E Anglia.

7.4 Insecticide active ingredient use

Insecticides were used on 87 - 98% of farms several times throughout the season mainly to control aphids.

7.4.1 Lüneburg

Table 7.4.1 Insecticide use by active ingredient - Lüneburg

Active ingredient	Activity	% of crop treated (Base: 1,076 ha)	No. of applications		Cumulative dose g ai/ha of crop receiving that ai		
			Range per farm	Ave per ha treated	min	max	ave
methamidophos	s/b	38	1 - 9	3.5	479	4,800	1,843
pirimicarb	s/aph	28	1 - 4	1.6	149	800	307
deltamethrin	c/b	25	1 - 3	1.7	3	30	9
cypermethrin	c/b	9	1 - 3	2.2	59	180	110
oxydemeton-m	s/b	7	1 - 2	1.5	120	386	224
alphacypermethrin	c/b	3	1 - 4	1.2	4	10	9
parathion-e	c/b	2	2	2.0	104	209	129
ethoprophos	c/nem	1	1	1.0	7,000	7,000	7,000
lambda-cyhalothrin	c/b	<1	2	2.0	9	9	9
fenvalerate	c/b	<1	1	1.0	30	30	30

Key to abbreviations:

c = contact
s = systemic
aph = aphicide
b = broad spectrum
nem = nematicide

7.4.2 Flevoland

Table 7.4.2 Insecticide use by active ingredient - Flevoland

Active ingredient	Activity	% of crop treated (Base: 897ha)	No. of applications		Cumulative dose g ai/ha of crop receiving that ai		
			Range per farm	Ave per ha treated	min	max	ave
pirimicarb	s/aph	44	1-7	2.3	125	2,000	490
deltamethrin	c/b	36	1-10	4.1	4	100	32
esfenvalerate	c/b	35	1-10	3.1	4	100	16
dimethoate	s/b	33	1-5	1.6	200	2,000	539
parathion-e	c/b	10	1-2	1.3	250	1,250	420
oxydemeton-m	s/b	8	1-3	1.7	187	750	459
aldicarb	c/nem	8	1	1.0	200	1,500	751
phosphamidon	s/b	3.3	1-2	1.3	375	500	412
thiometon	s/b	2.6	1	1.0	250	250	250
propoxur	c/b	2.2	1	1.0	100	100	100
chlorpyrifos	cf/b	0.8	1	1.0	1,919	1,919	1,919
demeton-s-	c/b	0.7	2	2.0	1,000	1,000	1,000
methyl	c/nem	0.4	1	1.0	3,000	4,000	3,750
ethoprofos	adj	1.4	5-8	5.9	19,759	55,327	30,703
petroleum oil							

Key to abbreviations:

c = contact
f = fumigant
s = systemic
adj = adjuvant
aph = aphids
b = broad spectrum
nem = nematodes

7.4.3 East Anglia

Table 7.4.3 Insecticide use by active ingredient - East Anglia

Active ingredient	Activity	% of crop treated (Base: 2,060 ha)	No. of applications		Cumulative dose g ai/ha of crop receiving that ai		
			Range per farm	Ave per ha treated	min	max	ave
pirimicarb	s/aph	72	1-7	2.3	127	980	364
aldicarb	cs/nem	26	1	1.0	700	6,719	3,057
oxamyl	cs/b	25	1	1.0	2,500	5,500	5,189
deltamethrin	c/b	13	1-3	1.8	7	22	13
dimethoate	s/b	13	1-2	1.2	339	680	410
heptenophos	s/aph	12	1-3	1.9	119	360	223
cypermethrin	c/b	9	1-3	1.5	24	75	39
chlorpyrifos-e	cf/b	6	1	1.0	219	219	219
demeton-s-methyl	c/b	3	1-8	1.5	170	1,949	328
alphacypermethrin	c/b	2	2	2.0	20	20	20
lambda-cyhalothrin	c/b	1	7	7.0	26	26	26
esfenvalerate	c/b	0.7	4	4.0	20	20	20

Key to abbreviations:

s = systemic
c = contact
f = fumigant
adj = adjuvant
aph = aphids
b = broad spectrum
nem = nematodes

7.4.4 N E France

Table 7.4.4 Insecticide use by active ingredient - N E France

Active ingredient	Activity	% of crop treated (Base: 862 ha)	No. of applications		Cumulative dose g ai/ha of crop receiving that ai		
			Range per farm	Ave per ha treated	min	max	ave
pirimicarb	s/aph	52	1 - 3	1.4	100	750	199
deltamethrin	c/b	37	1 - 3	1.3	5	25	11
tau-fluvalinate	c/b	38	1 - 3	1.5	21	288	72
thiometon	s/b	35	1 - 2	1.5	60	240	170
lambda-cyhalothrin	c/b	34	1 - 3	1.3	2	19	8
fenvalerate	c/b	9	1 - 2	1.5	10	100	44
heptenophos	s/aph	9	1 - 2	1.8	200	400	368
dimethoate	s/b	6	1 - 4	2.4	600	3,200	2,289
lindane	c/b	4	1	1.0	750	1,350	907
esfenvalerate	c/b	2	2	2.0	25	25	25
chlorpyrifos-m	cf/b	1	2	2.0	499	499	499
cyfluthrin	c/b	1	1 - 2	1.5	150	250	200
oxydemeton-m	s/b	1	1	1.0	200	200	200
fenitrothion	c/b	0.2	2	2.0	50	50	50

Key to abbreviations:

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

7.4.5 General commentary

The lists of active ingredients all typify use where the overwhelmingly important pests are aphids. The specific aphicide, pirimicarb, was very widely used particularly in E Anglia and N E France, followed by the synthetic pyrethroid deltamethrin, other synthetic pyrethroids and one or two organophosphates. In E Anglia, the nematicides aldicarb and oxamyl were important, both of which in addition control early season aphids. These add substantially to the chemcial load.

7.5 Insecticide use parameters

7.5.1 Insecticide applications

Table 7.5.1 Insecticide applications

On farms using insecticides	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
No. of active ingredients used per farm	1.9	2.1	2.4	2.5
No. of active ingredients used per hectare	1.1	1.9	1.8	2.3
Number of product applications per hectare	2.4	4.5	3.0	2.0
Proportion of farms spraying parts of their crop	46%	23%	20%	10.5%
Average load kg ai/ha crop treated	1.01	1.09	2.65	0.40

There was a wide range in the number of product applications per ha in all regions up to 1 - 14 spread in Flevoland and E Anglia. The range is partly due to type of crop (seed, ware or starch), but also partly due to natural variation in pest attack between farms.

7.6 Insecticide load by farm

Table 7.6 Insecticide load by farm

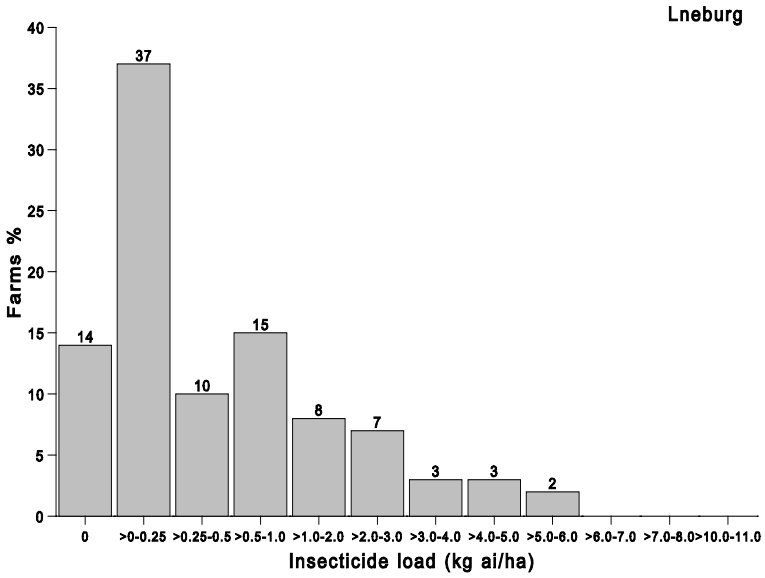
Region	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Number of farms	60	60	60	62
Insecticide load kg ai/ha	Farms %			
0	14	4	7	8
>0 - 0.25	37	30	10	39
>0.25 - 0.5	10	13	20	37
>0.5 - 1.0	15	28	17	10
>1.0 - 2.0	8	17	12	5
>2.0 - 3.0	7	2	5	2
>3.0 - 4.0	3		18	
>4.0 - 5.0	3		2	
>5.0 - 6.0	2		10	
>7.0 - 8.0		2*		
>10.0 - 11.0		2*		
Insecticide load kg ai/ha grown Average	0.94	1.07	2.47	0.38
Range	0.001-5.6	(0)0.004-10.5	(0)0.05-5.8	(0)0.006-2.6

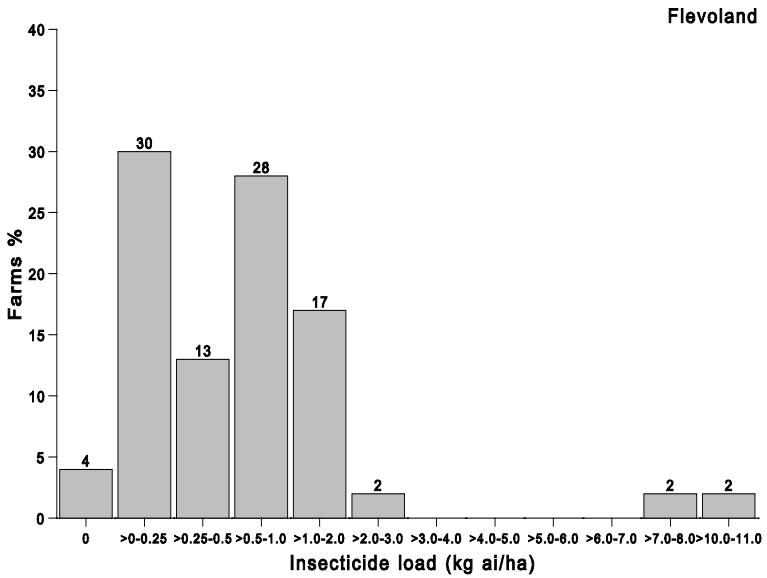
* includes the use of petroleum oil

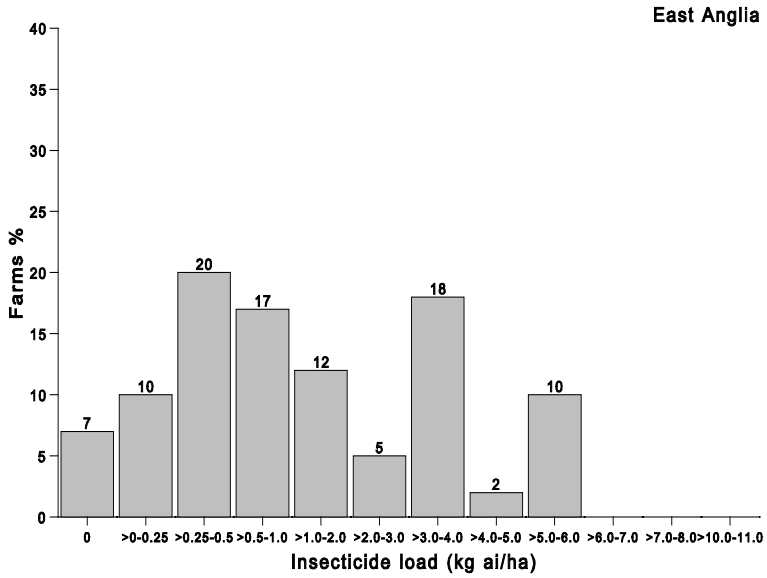
The higher loads in E Anglia were entirely due to the use of the nematicides, aldicarb and oxamyl, both of which were applied at several kilogrammes per hectare. The two high loads in Flevoland were the result of petroleum oil being used on two farms.

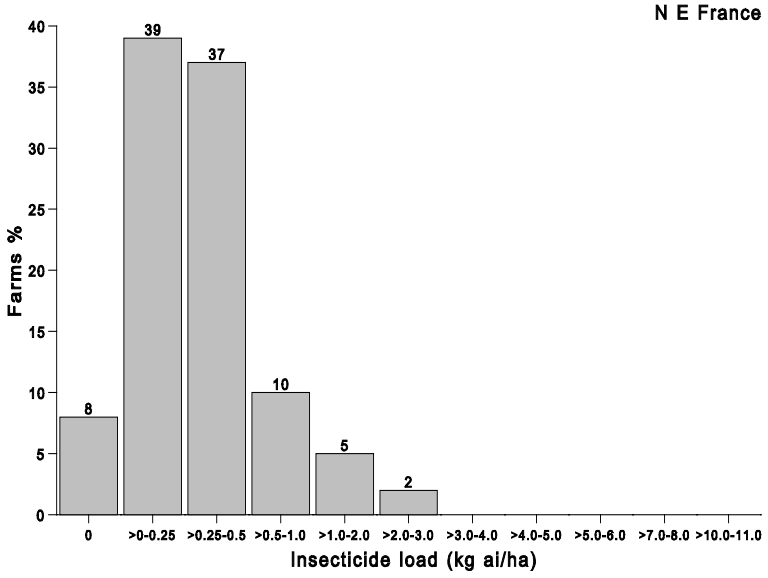
Generally speaking high loads were the result of using organophosphates or pirimicarb, compared with light loads where synthetic pyrethroids were used. Lighter loads were also a consequence of fewer applications used on ware and starch crops.

Chart 7.6 Insecticide load by farm






East Anglia
Farms %
40
35
30
25
20
15
10
5
0
7
10
20
17
12
5
18
2
10
0
>0-0.25
>0.25-0.5
>0.5-1.0
>1.0-2.0
>2.0-3.0
>3.0-4.0
>4.0-5.0
>5.0-6.0
>6.0-7.0
>7.0-8.0
>10.0-11.0
Insecticide load (kg ai/ha)


N E France
Farms %
40
35
30
25
20
15
10
5
0
8
39
37
10
5
2
0
>0-0.25
>0.25-0.5
>0.5-1.0
>1.0-2.0
>2.0-3.0
>3.0-4.0
>4.0-5.0
>5.0-6.0
>7.0-8.0
>10.0-11.0
Insecticide load (kg ai/ha)

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

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

Region	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Crop area - ha	1,076	897	2,060	862
	Area %			
Greater use	18	20	8	13
The same	72	40	81	81
Less use	4	34	0	0
No answer	6	4	10	3

Usage across all regions in 1994 was the same as usual.

7.8 Factors determining the start of insecticide application

Table 7.8 Factors determining the start of insecticide application

Region	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Number of farms	60	60	60	62
	Farms %			
Date	15	27	5	8
Plant stage	23	35	14	9
Pest stage	18	15	33	4
Pest pressure	43	62	52	56
Warning system	42	28	13	18
Don’t know	0	0	0	5

Aphid pressure was the main factor determining when to start to spray for *Myzus* control. In addition in Lüneburg a warning system was used to a greater extent than elsewhere.

7.9 Opportunities to reduce insecticide/nematicide load

Specialists felt there was little opportunity to reduce insecticide use for aphid control. However, better use of the warning systems might lead to improved timing and reduced use.

Nematicide use has declined dramatically in Lüneburg and Flevoland over the past few years according to specialists but there was concern that there might be an increase required in the medium-term.

8.0 MISCELLANEOUS PESTS AND PESICIDES

8.1 Target pests

The only pests mentioned were slugs which were only reported to be a significant problem by farmers in E Anglia. In the area of the study in Lüneburg, the soils are too sandy although on the more organic soils slugs do occur. There was only one farmer in each of Flevoland and N E France who mentioned slugs though no molluscicides were applied. Specialists in N E France said there had been an increase in the slug *Limax horticae* but it was localised. In E Anglia the situation was as follows:

Table 8.1 Miscellaneous pests in East Anglia (UK)

Pest	Farms (Base: 60)	
	No.	%
Slugs (*Limax budapestensis*)	24	40
Snails (*Helix* spp)	3	5

8.2 Molluscicide use by active ingredient in East Anglia (UK)

20 farmers applied molluscicides to 469 ha (23%). Table 8.2 summarises use by active ingredient.

Table 8.2 Molluscicide use by active ingredient in East Anglia (UK)

Active ingredient	% of crop treated (Base: 2,060 ha)	No. of applications		Cumulative dose g ai/ha of crop receiving that ai		
		Range per farm	Ave per ha treated	min	max	ave
methiocarb	14	1-6	2.9	219	879	389
metaldehyde	8	1-7	3.5	300	2,625	1,317
thiodicarb	0.5	1	1.0	*	*	*

* One respondent - no dose given.

Slugs are a serious problem on certain soils and fields. Certain varieties, including the most widely grown variety in East Anglia, Maris Piper, are prone to damage. Treatments were well targeted and little opportunity is seen for reduction.

9.0 OTHER AGROCHEMICALS

9.1 Background

Chemicals were applied to desiccate potato haulms and suppress regrowth. In 1994 this was practiced on over three quarters of the farms.

9.2 Other agrochemicals active ingredients used

9.2.1 Lüneburg

Table 9.2.1 Other agrochemicals active ingredients used - Lüneburg

	% of crop treated (Base: 1,076 ha)	No. of applications		Cumulative dose g ai/ha of crop receiving that ai		
		Range per farm	Ave per ha treated	min	max	ave
Desiccants:						
diquat	59	1 - 4	1.3	200	2,000	568
Others:						
thiabendazole	<1	4	4.0	4,012	4,012	4,012
bitter salts	<1	1	1.0	-	-	-

9.2.2 Flevoland

Table 9.2.2 Other agrochemicals active ingredients used - Flevoland

Active ingredients	% of crop treated (Base: 897 ha)	No. of applications		Cumulative dose g ai/ha of crop receiving that ai		
		Range per farm	Ave per ha treated	min	max	ave
Desiccants:						
diquat	76	1-3	1.1	300	1,800	643
metoxuron	23	1	1.0	400	1,600	1,078
DNOC	9	1-3	1.2	2,000	6,000	5,193
glufosinate	6	1	1.0	225	450	405
Growth regulator:						
MCPA	0.9	1	1.0	75	75	75

9.2.3 East Anglia

Table 9.2.3 Other agrochemicals active ingredients used - East Anglia

Chemical	% of crop treated (Base: 2,060 ha)	No. of applications		Cumulative dose g ai/ha per ha of farm crop receiving that ai		
		Range per farm	Ave per ha treated	min	max	ave
Sprout suppression:						
maleic hydrazide	1.4	1	1.0	4,000	4,000	4,000
Haulm destruction:						
sulphuric acid	47	1	1.0	*	*	*
glufosinate	16	1-2	1.2	450	900	642
diquat	11	1	1.0	100	3,000	858
paraquat	1	1	1.0	400	400	400
others unidentified	2			-	-	-

* Applied by contractors at an average of 150 l/ha (770g/l) = 115.5 kg ai/ha

9.2.4 N E France

Table 9.2.4 Other agrochemicals active ingredients used - N E France

Active ingredients	% of crop treated (Base: 862 ha)	No. of applications		Cumulative dose g ai/ha of crop receiving that ai		
		Range per farm	Ave per ha treated	min	max	ave
diquat	68	1 - 5	1.8	200	3,000	999
glufosinate	18	1 - 2	1.4	74	750	455

9.2.5 General commentary

Desiccants for haulm destruction were applied to facilitate harvesting and also to minimise the spread of *Phytophthora* from the foliage to the tubers.

Growth regulators were applied in Flevoland and E Anglia to prevent secondary growth and berry formation occurring in what was a very long season.

9.3 Other agrochemical use parameters

9.3.1 Other agrochemical applications

Table 9.3.1 Other agrochemical applications

On farms using other agrochemicals	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
No. of active ingredients used per farm	1	1.4	1.1	1.1
No. of active ingredients used per hectare	1	1.2	1.0	1.4
Number of product applications per hectare	1.2	1.3	1.1	1.3
Proportion of farms spraying parts of their crop	54%	27%	23%	22%
Average load kg ai/ha crop treated	0.57	1.32	0.35*	1.11

* excludes sulphuric acid treatments (Table 9.2.3) made at an average of 150l/ha, 115.5kg ai/ha.

9.4 Other agrochemicals load per farm

Table 9.4 Other agrochemicals load per farm

Region	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Number of farms	60	60	60	62
Load kg ai/ha	Farms %			
0	22	5	20	27
>0 - 0.5	63	22	23	19
>0.5 - 1.0	13	38	25	34
>1.0 - 2.0	2	24	0	18
>2.0 - 3.0		3	0	2
>3.0 - 4.0		5	2	
>4.0 - 5.0		2	2	
Sulphuric acid @ 115 kg ai/ha			33	
Load kg ai/ha grown Average	0.34	1.29	0.27*	0.76
Range	0.05 - 2.0	(0)0.1 - 4.0	(0)0.1 - 4.4	(0)0.07 - 3.0

* excludes sulphuric acid

Variations in dose rate were wide, due to the different requirements of particular farms, fields and varieties as a consequence of varying soil moisture and amounts of vegetation.

The unique use of sulphuric acid, mainly applied by contractors in E Anglia, is of interest. It provides the most rapid destruction of haulms and poses no risk of translocation to tubers.

9.5 Opportunities to reduce 'other agrochemicals' loads

Desiccation is important and specialists say that there is generally little room for reduction in chemical use. Other non-chemical techniques have been tried but result either in damage to the crop (tubers) or too severe an environmental impact (burning).

Cultural techniques, including varietal choice, can minimise the amount of foliage present in late summer but as a priority the avoidance of desiccant use is not high.

10.0 TRENDS IN PESTICIDE USE

10.1 Variation in pesticide use in potatoes over the last five years

Table 10.1 Variation in pesticide use over the last five years

Region	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Crop area - ha	1,076	897	2,060	862
	Area %			
Seed treatment				
Increased use	8	11	32 ↑	20 ↑
The same	70 ↓	49 ↓	51	54
Less use	17	31	10	0
Don't know/no answer	5	9	7	23
Herbicides				
Increased use	12	5	26 ↑	23 ↑
The same	70 ↓	38 ↓	57	74
Less use	18	56	8	2
Don't know/no answer	0	1	8	0
Fungicides				
Increased use	23 ↑	54 ↑	33 ↑	37 ↑
The same	72	22	53	60
Less use	5	21	8	0
Don't know/no answer	0	3	6	3
Soil insecticides				
Increased use	7	1	15 ↑	19 ↑
The same	35 ↓	11 ↓	70	38
Less use	15	52	8	0
Don't know/no answer	43	36	6	41
Foliar insecticides				
Increased use	25 ↑	16	21 ↑	20 ↑
The same	53	54 ↓	65	74
Less use	3	23	8	0
Don't know/no answer	18	7	6	4
Desiccants				
Increased use	5	12 ↑	0	15 ↑
The same	52 ↓	20	77 ↓	74
Less use	28	5	10	2
Don't know/no answer	15	63	13	9

↑↓ arrows show graphically main direction of trend.

In Lüneburg, pesticide use had largely remained the same except for a significant minority of farmers who believed fungicide and foliar insecticide use had increased and desiccants decreased.

Flevoland farmers felt there had been an increase in fungicide use (agreed by specialists) and a reduction in herbicide and soil insecticides and for a minority also in seed treatment use.

The majority of farms in E Anglia felt usage had remained the same but a significant minority felt fungicides, seed treatment, herbicides and foliar insecticides had increased.

N E France farmers held similar views to those in E Anglia, 'the same', but some had experienced an increase in fungicides, seed treatment, herbicides and foliar insecticides.

The conclusion across all regions is therefore that a significant minority of farmers (the majority in Flevoland) had experienced an increase in fungicide use. Greatest unanimity within a region concerning changes occurred in Flevoland.

10.2 Plans to maintain or change pesticide use in potatoes

Table 10.2i Plans to maintain or change pesticide use in potatoes

Region	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Number of farms	60	60	60	62
	Farms %			
Will change	7	3	5	18
Possibly change	25	52	23	6
Will not change	62	42	67	76
Don't know	7	3	8	0

Except in Flevoland the majority would maintain their previous use. Farmers who said they will or may change were then asked in which agrochemical sector and for what reason change would be made.

Table 10.2ii Agrochemical sector and reason identified for change

Reasons	Better control				Availability				Economics				Environment			
	% of farmers who will or may change. Base: L 19, F 33, E 17, N 15															
Region	L	F	E	N	L	F	E	N	L	F	E	N	L	F	E	N
Seed treatment	11	18	53	7	-	6	47	-	21	24	35	-	5	3	29	-
Herbicides	32	33	59	33	5	12	35	-	26	51	29	7	21	27	35	-
Fungicides	37	64	76	20	11	9	35	-	26	27	29	7	5	27	41	-
Soil insecticides	5	3	41	-	5	0	41	-	21	3	29	-	11	0	41	-
Foliar insecticides	26	33	35	-	11	6	41	-	26	33	29	-	5	15	41	-
Growth suppressants	5	6	29	-	-	3	29	-	11	6	24	-	-	3	29	7
Desiccants	5	18	29	-	-	9	35	-	11	27	24	-	-	12	35	-
Molluscicides	-	-	24	-	-	-	29	-	-	-	24	-	-	-	29	-

L = Lüneburg, F = Flevoland, E = E Anglia, N = N E France

Fungicides was the predominant sector for change for reasons of better control. The herbicides sector was the second most important sector for change for reasons of 'better control' in E Anglia and 'economics' in Flevoland. The cost-efficacy of seed treatment ranked highly for the farmers in E Anglia.

Growers in E Anglia also expressed a high level of concern for all sectors regarding 'environment' and availability (distribution).

10.3 Change across all crops in the last five years

Table 10.3 Change across all crops in the last five years

Region	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Number of farms	60	60	60	62
	Farms %			
Increased use	28	28	35	23
The same	33	23	43	37
Less use	38	43	12	6
Don't know/no answer	0	5	10	34

This question reflected usage across all crops on the farm.

Lüneburg and Flevoland demonstrated similar results with most farms having changed in use one way or the other. E Anglia and the N E France showed a greater proportion remaining the same but those that had changed tended to have increased.

In Lüneburg, reduced use in cereals outweighed the increase in potatoes. The majority in Flevoland felt there had been a decrease - a view particularly strongly held by those who applied the lowest loads (less than 5 kg ai/ha). This related to both soil nematicides in potatoes and general usage in sugar beet.

11.0 PESTICIDE/AGROCHEMICAL GENERALITIES

11.1 Sufficiency of product choice

Table 11.1 Farmers indicating satisfaction in the choice of products

Region	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Number of farms	60	60	60	62
	Farms %			
Herbicides	80	87	70	71
Fungicides	85	75	88	92
Insecticides	85	87	87	98
Nematicides	43	35	72	32

Interestingly there was significant dissatisfaction regarding herbicide choice particularly in E Anglia and N E France. Low responses for nematicides were because many farmers were not involved in this sector.

11.2 Attitudes to developments in the pesticide market

Farmers were asked to comment on development in the agrochemicals market with respect to availability of new products, improved efficacy, ease of application and lowered residue levels. They responded good, satisfactory or poor. Table 11.2 shows the results for 'good' and 'satisfactory' combined.

Table 11.2 Farmers expressing satisfaction with agrochemicals developments

Region	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Number of farms	60	60	60	62
	Farms %			
Availability of new products	95	81*	80*	67*
Increasing efficacy	96	90	90	70*
East of application	100	90	88*	63*
Lower residues	73	83	81	53*

In all regions the figures for 'lower residues' were affected by many farmers who 'did not know'. However, those figures asterisked are where the remainder, who did not express satisfaction, actually expressed dissatisfaction.
There appears to be some dissatisfaction with herbicides in terms of avilability of new

product.

Potato growers in N E France appear to show least satisfaction with developments in the market.

11.3 Attitudes to handling restrictions on the label

Table 11.3 Attitudes to handling restrictions on the label

Region	Lüneburg (D)		Flevoland (NL)		E Anglia (UK)		N E France (F)	
Number of farms	60		60		60		62	
	Farms %							
Importance	v imp	imp	v imp	imp	v imp	imp	v imp	imp
On **choice** of products	58	37	37	52	65	28	40	32
On **use** of products	63	33	28	57	65	28	47	37

The least importance accorded to handling restrictions occurred in N E France, followed by farmers in Flevoland.

11.4 Attitudes to environmental restrictions on the label

Table 11.4 Attitudes to environmental restrictions on the label

Region	Lüneburg (D)		Flevoland (NL)		E Anglia (UK)		N E France (F)	
Number of farms	60		60		60		62	
	Farms %							
Importance	v imp	imp	v imp	imp	v imp	imp	v imp	imp
On **choice** of products	60	35	20	50	57	37	40	35
On **use** of products	62	37	12	60	57	37	43	39

Farmers with least interest in environmental restrictions were found in Flevoland. About a quarter said such restrictions were not important in influencing their choice of products. Farmers in N E France were close behind with about a fifth expressing that view. Less than 5% shared these views in Lüneburg and E Anglia. These figures demonstrate a considerable difference in attitude between the regions.

11.5 Sources of information

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

Table 11.5 Information sources

Region	Lüneburg (D)		Flevoland (NL)		E Anglia (UK)		N E France (F)	
Number of farms	60		60		60		62	
	Farms %							
Information source	% farms	score	% farms	score	% farms	score	% farms	score
Cooperative rep	48	3.6	27	4.4	5	4.5	58	3.7
Farming press	73	3.2	62	3.0	20	2.9	44	3.2
Manufacturers rep	12	2.6	3	3.5	12	3.8	15	3.3
Merchant	47	3.2	82	4.2	60	4.5	37	4.0
Neighbour	40	3.1	33	3.1	8	2.3	15	3.7
Plant protect.	61	3.6	37	3.2	30	3.9	39	3.8
advisor	18	3.2	15	4.7	18	4.2	6	2.8
Private consultant	-	-	17	2.2	-	-	52	2.4
Other								

The data are interesting and show large regional differences. While all farmers used several sources, those in E Anglia appear to have used fewest, although scores for quality/reliability were generally high. In Lüneburg, most sources were used but the average scores were generally low.

12.0 PROFITABILITY AND PESTICIDES

12.1 Profitability of potatoes

Table 12.1 Profitability of potatoes

Region	Lüneburg (D)		Flevoland (NL)		E Anglia (UK)		N E France (F)	
Number of farms	60		60		60		62	
	Farms %							
	Study year 1994	5 years ago	Study year 1994	5 years ago	Study year 1994	5 years ago	Study year 1994	5 years ago
Very good	30	5	47	-	60	2	13	5
Good	28	32	40	25	27	25	32	19
Satisfactory	33	42	7	35	7	38	21	39
Poor	8	13	3	23	-	23	31	13
Very poor	0	-	2	15	-	5	3	-
Don't know/no answer	-	8	2	2	7	7	-	24

In all regions profitability over the five years prior to the study year had improved markedly.

The same question was asked with regard to the farm as a whole and for all regions except N E France a similar although less marked trend was apparent. In N E France 1994 had slighly more farmers expressing a positive view for the farm as a whole than for potatoes, although it was still a better year than five years before.

12.2 Returns and costs of production

Models of returns and costs of production are presented in the individual region reports. The details and terms used vary considerably and are not directly comparable.

Table 12.2 Comparison of agrochemical costs - ware

Region	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Agrochemical costs				
- as % of variable costs	18 9.4	34* 11	24 8.4	33* 19

- as % of gross income				

* includes some fixed costs.

The figures as a proportion of variable costs can not really be compared as regions differed so markedly in the costs build up. The best comparison is agrochemical costs as a proportion of gross income where most regions were similar except in N E France where their proportion was about twice the other regions.

12.3 Influence of profitability on pesticide usage

Farmers were asked to predict their reaction in terms of three aspects of pesticide usage where good or poor potato profitability was anticipated.

Table 12.3 Influence of profitability on pesticide usage

Region	Lüneburg (D)		Flevoland (NL)		E Anglia (UK)		N E France (F)	
Number of farms	60		60		60		62	
	Farms %							
Anticipated profit	good	poor	good	poor	good	poor	good	poor
Price of product								
Use more expensive product	12	2	13	2	5	5	10	5
Use less expensive product	7	15	5	12	3	15	3	11
No influence	78	75	78	82	80	68	84	79
Don't know/no answer	3	8	3	3	12	12	3	5
Dose rate								
Reduce dose	12	13	5	10	3	5	2	2
Increase dose	3	2	3	0	2	7	0	6
No influence	83	77	88	87	85	77	94	87
Don't know/no answer	2	8	3	3	10	13	5	5
Age of product								
Use older product	3	7	0	3	2	5	5	10
Use newer product	28	12	10	3	17	12	13	10
No influence	65	70	87	92	72	70	79	76
Don't know/no answer	3	12	3	3	10	13	3	5

The great majority of farmers would not be influenced by anticipated profit.

12.4 Effect of pesticides on profitability

Farmers were asked to identify the agrochemical sectors which they thought had the greatest and least effect on the profitability of the crop.

Table 12.4 Effect of pesticides on profitability

Region	Lüneburg (D)		Flevoland (NL)		E Anglia (UK)		N E France (F)	
Number of farms	60		60		60		62	
	Farms %							
Effect on profit	great	least	great	least	great	least	great	least
Sector								
Nematicides	2	35	2	5	18	5	-	16
Herbicides	5	2	2	45	2	14	13	10
Fungicides	65	-	72	3	42	-	84	-
Insecticides	18	7	8	22	13	5	2	18
PGRs	2	20	2	-	5	23	-	5
Desiccants	3	3	-	3	2	17	-	29
Seed treatment	5	30	-	5	5	14	-	8
Don’t know	-	3	-	8	13	22	2	11

Fungicides were felt by a majority of farmers to have the greatest effect on profit in all regions. A minority of farmers in each region separately felt that one or other of the sectors had least or most effect. In Flevoland a substantial proportion of farmers identified herbicides as providing the least effect on profit.

12.5 Possibility to reduce pesticide use without reducing profitability

Table 12.5 Possibility to reduce pesticide use without reducing profitability

Region	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Number of farms	60	60	60	62
	Farms %			
Yes	13	18	2	5
Perhaps	12	17	7	8
No	72	62	85	87
Don't know	3	3	7	-

Farmers were asked if they felt it was possible to reduce pesticide use without reducing profitability. The great majority (particularly of those answering) felt that this was not possible. However, there were small numbers in Lüneburg and Flevoland who felt it was or perhaps was possible.

Those answering 'yes' or 'perhaps' were asked in which sector this reduction might be possible.

In Flevoland, the sectors fungicides and herbicides were most commonly put forward. In Lüneburg, farmers suggested herbicides and seed treatments.

Specialists generally were unsure whether farmers would in practice risk reducing pesticide inputs.

13.0 ALTERNATIVE CROP PROTECTION SYSTEMS

13.1 Awareness of alternative systems

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

Definitions were given to farmers for the different regimes (Appendix I). However, local terms and understandings played a role in these answers and the results need to be viewed with care.

Table 13.1 Awareness of alternative systems that might be equally profitable

Region	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Number of farms	60	60	60	62
Unprompted	Farms %			
ICM	32	27	47	66
IPM	27	2	47	10
OP	20	22	52	2
None	57	53	25	15
Don't know/no answer	2	0	10	0
Prompted	Awareness amongst farmers who had not mentioned the system - % of total sample			
ICM	30	67	17	15
IPM	24	5	12	33
OP	26	71	30	65

Unprompted awareness was generally highest for ICM although OP was well recognised in E Anglia. (It was questionable whether farmers were thinking in profitability terms here.)

The highest unprompted responses came from N E France for ICM. The term used was 'agriculture raisonée' which has a very broad interpretation in France.

Following prompting, Flevoland farmers appeared to have the best awareness but specifically of ICM and OP, and many in E Anglia and N E France mentioned OP.

IPM was the least supported of the alternative systems.

13.2 Interest in developing alternative systems

Farmers were asked for their level of interest in developing the various alternative systems mentioned:

Table 13.2 Interest in developing alternative systems

Region	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Number of farms	60	60	60	62
	Farms %			
IPM	43	15	22	23
ICM	40	55	25	76
OP	20	13	13	8

Considerable interest was shown in developing ICM in all regions except E Anglia. The support ICM received in N E France should be set against the remark made in Section 13.1 concerning definition.

Specialists in all regions stressed that potato production was a high risk enterprise and farmers were very risk-averse.

14.0 ENVIRONMENTAL ISSUES

14.1 Farms in restricted areas

The Lüneburg region had the most farms in restricted areas. Nineteen farms (27%) claimed to be in restricted water catchment areas and one (2%) in an environmentally sensitive area. Ten farmers (17%) indicated their restriction posed difficulties in selecting pesticides.

Among the other regions only one farmer each in Flevoland and N E France were in restricted areas but neither indicated difficulty with choice of pesticides.

14.2 Considerations influencing choice of pesticides

Farmers were asked to choose from a list of suggested environmental considerations, those they took into account when choosing pesticides.

Table 14.2 Environmental considerations influencing choice of pesticides

Region	Lüneburg (D)	Flevoland (NL)	E Anglia (UK)	N E France (F)
Number of farms	60	60	60	62
	Farms %			
Ground water	73	13	28	8
Surface water	63	17	28	8
Soil protection	70	13	37	8
Flora	58	15	37	18
Fauna	70	27	40	29
Produce quality	70	12	80	11
None of these	10	67	17	60
Don’t know	8	0	2	5

Farmers in Lüneburg appeared to have the strongest environmental concerns when choosing pesticides, particularly about ground water. The other three regions had far lower levels of interest, E Anglia being the highest of the three. Specialists in these three regions were not surprised by the responses. They felt that the farmers’ main priority was to produce a top quality product free of residues and that governmental departments would vet the products that came on the market and make suitable environmental judgements.

APPENDIX I

DEFINITIONS AND CAVEAT

BACKGROUND

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

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

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

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

DEFINITIONS

Regional level:

Base area treated (for a chemical sector)

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

Farm level:

Proportion of crop treated

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

Average number of applications

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

Cumulative dose

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

Product applications

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

ALTERNATIVE CROP PROTECTION

Integrated Pest Management (IPM)

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

Integrated Crop Management (ICM)

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

Organic Production (OP)

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

APPENDIX II

COLLABORATORS AND CONTACTS

GERMANY

Field survey:

Product und Markt
Otto-Lilienthal-Straße 15
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Germany

Local specialists:

Dr Maykus (Head of station)
Herr Jurgen Pickny (Potato advisor)
Pflanzenschutzamt
Uelzen

Dr Peters (Potato expert)
Kuratorium für Technik und Bauwesen in die Landwirtschaft
Versuchstation in der Kartoffel
Dethlingen
Munster

Herr Wolfgang Hauschild (Potato suppliers)
Stade Saatzucht
Stade

Frau Dr Schöber-Butin (Potato expert)
BBA
Institut für Pflanzenschutz
Ackerbau
Braunschweig

NETHERLANDS

The group discussions and field survey were carried out by Landell Mills.

CONTACTS

Dr C D van Loon — Proefstation AGV (Research Station for Arable Farming and Field Production of Vegetables)
Edelhertweg, P O Box 430
8200 Lelystad

Co-ordinator of potato research in the Netherlands, Chief Research Officer at Lelystad, main specialities agronomy and diseases

Mr H Campmans — IKC AGV (Information and Knowledge Centre for Arable Farming and Field Production of Vegetables)
Edelhertweg 1, P O Box 369
8200 Lelystad

Officer responsible for advising on technical implementation of government policy with regard to Integrated Crop Management and MJPG (policy for reduction of fertiliser and crop protection inputs)

Mr B L Versluis — DLV (Agricultural Advisory Service)
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8251 GH Dronten

Officer in the Arable Team, Central West Area

Mr S R M Janssens — DLO-NL, LEI-DLO (Research Department of the Agricultural Economics Research Institute)
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Economist, Farm management research

Mr B Varder	Meijer Ltd Industriesweg 1 Swifterband Head of Quality and Production for major potato processor/wholesaler. Participant in MJPG.
Dr G A A Wossink	Wageningen Agricultural University Department of Farm Management Hollandseweg 1 6706 KN Wageningen Lecturer in farm economics and key economist in arable farming economic research
Dr L J Turkensteen	DLO-NL of IPO-DLO (Agricultural Research Department of the Research Institute for Plant Protection) Binnenhaven 12, P O Box 9060 6700 GW Wageningen Plant pathologist, senior pathologist in *Phytophthora* research in the Netherlands
Dr A Mulder	H L Hilbrands P O Box 323 9400 AH Assen Research nematologist, and Director of Laboratory for Soil Borne Pests and Diseases (private)

UNITED KINGDOM

The group discussions and field survey were carried out by Landell Mills.

CONTACTS

Dr M Foley	ADAS, Cambridge Brooklands Avenue Cambridge CB2 2BL National potato 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 J Ward	Scott Abbot Arable Crops Station Sacrewell Lodge Thornhaugh Peterborough PE8 6HJ Chief Agronomist, ex ADAS senior advisory officer. Consultant.
Mr R Ward	Golden Grove Nursery Wigtoft Boston Lincolnshire PE20 2PU Consultant. Ex ADAS advisor. Farmer. Nursery-man.

FRANCE

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Chef du Service Regional de la Protection des Vegetaux (SRPV)
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Pas-de-Calais (62)

M Michel Martin
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M Brussé
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