PESTICIDE USAGE IN SCOTLAND

PROTECTED CROPS 2003

J P Snowden

Scottish Agricultural Science Agency

East Craigs, Edinburgh EH12 8NJ

E-mail: jeremy.snowden@sasa.gsi.gov.uk
Web: http:/www.sasa.gov.uk

Scottish Agricultural Science Agency

Scottish Agricultural Science Agency

East Craigs
Edinburgh EH12 8NJ
Telephone: 0131 244 8862

An Agency of The Scottish Executive Environment and Rural Affairs Department

ISBN 0-9543886-5-8

CONTENTS

Page

Protected crops

Page

Mushrooms

SUMMARY

This report presents information from a survey of pesticide usage on protected crops in Scotland during the 2002/2003 growing season. The data have been raised to give estimates of national pesticide usage.

The combined areas of glasshouses and plastic structures in 2003 was 780,240 m^2, a 29% increase compared with the previous survey which covered the 1999 growing season. The total estimated area of edible crops more than doubled, and in 2003, the main crop was strawberries. On the other hand, estimated areas of non-edible crops declined by 32%.

The areas of edible crops treated with pesticides have shown huge increases due to the extensive usage on strawberries. Despite the fall in area of non-edible crops, there have been increases in the usage of all pesticide groups except molluscicides.

Usage of insecticides or acaricides on edible crops, when measured by area of active ingredients, was just under 2,000,000 m^2. Tebufenpyrad, recorded exclusively on strawberries, was the most commonly used active. Usage of biological control agents declined compared with 1999, and in 2003, were applied to 228,618 m^2. The principal agent used was *Bacillus thuringiensis*, also only on the strawberry crop. Just under 800,000 m^2 of non-edible crops were treated with insecticides or acaricides. Deltamethrin was the main insecticide recorded. *Hypoaspis miles* was the only biological control agent encountered, applied to an estimated 124,000 m^2.

The total area of edible crops treated with fungicides was over 7,000,000 m^2. Iprodione, applied only to strawberries, was the most commonly used fungicide. Usage on non-edible crops was just under 1,400,000 m^2, with chlorothalonil being the principal fungicide.

Almost 2,200,000 m^2 of edible crops were treated with herbicide active ingredients. Bromacil, applied exclusively to non-crop areas associated with strawberries, was the principal herbicide.

Around 373,500 m^2 of non-edible crops were treated, with paraquat being the most widely used active. Usage of growth regulators was restricted to non-edible crops. Over 400,000 m^2 were treated and daminozide was the most commonly used.

INTRODUCTION

This is the seventh survey of pesticide usage on protected crops in Scotland. Previous surveys of this type were conducted in 1976[1], 1981[2], 1987[3], 1991[4], 1995[5] and 1999[6], although the survey in 1987 did not include non-edible crops.

In line with recent publications, tables containing reasons for the use of pesticides are no longer recorded in the tables, as only a proportion of reasons were specified by users. Where appropriate, reasons for use are provided in the text.

DEFINITIONS AND NOTES

The term 'pesticide' includes commercial formulations containing active substances of insecticides, acaricides, molluscicides, biological control agents, fungicides, herbicides, soil sterilants, and growth regulators.

In this report the term 'formulation' refers to one or more active ingredients included in a product or group of products.

Active ingredient (ai) refers to an individual chemical which is active against a pest, disease or weed etc.

Basic area is the planted area of crop which was treated with a given pesticide or pesticide group, irrespective of the number of times it was applied to that area. Basic areas are not presented anywhere in the report, but their values are used to calculate the percentage of crop treated with a given pesticide or pesticide group.

Area treated (or hectares treated) is the basic area of a crop treated with a given pesticide multiplied by the number of treatments that area received. These terms are synonymous with 'spray area' and 'spray hectare' which have appeared in previous reports. The new terms are believed to more appropriate where pelleted or granular treatments are applied.

The reasons for the uses of pesticides reported in the text are those given by growers and may sometimes be inappropriate.

The areas of crops grown include successional sowings so that the total areas of crops grown can be larger than the total area of glasshouses and polytunnels.

It should be borne in mind that some of the herbicides may not have been applied directly to the crop itself but as land preparation treatments prior to planting the crop, to the ground beneath crops grown in pots and trays or on table tops, or the pathways between crops.

Insecticides include those treatments where the compost had been incorporated with insecticide at the manufacturers prior to delivery to growers.

Usage of disinfectants have not been recorded in this report as neither of the commodity substances, formaldehyde or sodium hypochlorite, were encountered in 2003.

Due to rounding, there may be slight differences in totals both within and between tables.

Data from the 1999 survey are provided for comparison purposes in some of the tables, although it should be borne in mind that there may be minor differences in the range of crops surveyed, together with changes in areas of each of the crops grown.

METHOD

Using the June 2003 Agricultural Census[7] a sample was drawn from growers of protected crops, these being any crops or plants grown within a glasshouse or polytunnel. For the purpose of sampling, the country was divided into 11 land-use regions as shown in figure 1[8]. The sample was stratified by region and size group, and sampling within size groups was based on area rather than numbers of holdings, so that smaller size groups would not dominate the sample. Slight adjustments were made to the numbers of holdings sampled in each of the size groups to improve the precision of the component of estimates from the smaller size groups. Corresponding reductions were made in the number of holdings sampled from the largest size group, which would otherwise have been totally exhausted.

The period of the survey covered pesticide applications to crops during the 12-month period 1 October 2002 to 30 September 2003. With the exception of a few growers who had to be interviewed by telephone, data were collected by personal interviews during visits to the holdings. In total, information was collected from 30 holdings (Table 2).

The data for the protected crops were raised to give national estimates of both the areas of some of the crops grown and the use of pesticide by using raising factors (Table 30) based on the areas of holdings growing protected crops in the June 2003 Agricultural Census[7] within regions and size groups. Some land-use regions were amalgamated: Highland & Islands, Caithness & Orkney, Moray Firth and Aberdeen (Northern Scotland); Angus with East Fife; Lothian, Tweed Valley, Southern Uplands and Solway (Southern Scotland) due to small populations of growers in certain regions. An adjustment (Table 31) was made for tomatoes and other fruit within each region by applying the raising factors to the sampled area and comparing this with the area from the Agricultural Census. Second adjustments were also made for crops which were not sampled within one or more regions.

EDIBLE CROPS

TOMATOES

The area of tomatoes grown in Scotland has shown a further decline, and in 2003 was only 47,394 m^2, a 41% fall compared with 1999.

Insecticides/acaricides, biological agents and molluscicides (Tables 4,10)

The proportion of the crop area treated with insecticides or acaricides was 59%, similar to that recorded in the previous survey. As in the previous two surveys, the main reason for their use was for the control of spider mite. The only insecticide or acaricide encountered in 2003 was fenbutatin oxide. In 1999, the most popular insecticide or acaricide had been abamectin.

The only biological control agent recorded in 2003 was *Macrolophus caliginosus*, applied to 59% of the crop area, for the control of spider mite and whitefly. In 1999, *Phytoseiulus persimilis*, used on 42% of the crop area had been the most commonly used biological control agent.

Thirty-four percent of the crop area was treated with molluscicides, compared with only 20% in 1999. Metaldehyde was the only molluscicide recorded in 2003. In the previous survey, methiocarb had been the principal molluscicide.

Fungicides (Tables 5,11)

There was a large decline in usage of fungicides, with only 18% of the crop area being treated, compared with 71% in the previous survey.

As in the previous two surveys, the main reason recorded for the use of fungicide was against *Botrytis*.

Azoxystrobin and pyrimethanil were the main fungicides recorded in 2003, and were each applied to 13,332 m^2, 14% of the crop area. In 1999, pyrimethanil had been by far the most commonly used fungicide, applied to half of the crop area.

Herbicides Tables 6,12)

A small proportion, 8%, of the crop area was treated with the herbicide, paraquat. No herbicides had been associated with this crop in either of the previous two surveys.

OTHER FRUIT

This category of protected crops has been recorded separately in the Agricultural Census for the first time, and in 2003, was almost 250,000 m^2, by far the largest category of edible protected crops. The only crop encountered was strawberry. In previous surveys, only small areas of other fruit had been grown and these were recorded under 'other edible crops'. Comparisons of pesticide usage with the previous survey are therefore not possible.

Insecticides/acaricides, biological agents and molluscicides (Table 4,10)

Almost all, 95%, of the crop area was treated with insecticides or acaricides, whilst biological control agents were applied to 52%.

The most commonly used insecticides or acaricides were tebufenpyrad and pirimicarb, each applied to 95% of the crop area, and to almost 600,000 m^2 for the control of spider mites, and to just under 500,000 m^2 for aphid control, respectively. In all, a total of around 1,848,000 m^2 were treated with insecticides or acaricides, which demonstrates their intensive usage.

Bacillus thuringiensis was the main biological agent recorded, and was applied to almost 146,000 m^2, 51% of the crop area, for the control of caterpillars.

No molluscicides were recorded.

Fungicides (Tables 5,11)

The proportion of the crop area treated with fungicides was 96%, for the control of *Botrytis* and mildew.

Iprodione and bupirimate, each applied to over 1,200,000 m^2, were the principal fungicides recorded. Myclobutanil, pyrimethanil and fenhexamid were also extensively used. In all, almost 7,000,000 m^2 were treated with fungicides which represents an average of 28 formulations applied to the area of the crop throughout the survey period.

Herbicides (Tables 6,12)

Nearly all, 98%, of the crop area was treated with herbicides. Paraquat and bromacil, each applied to over 745,000 m^2, 73% and 44% of the crop area respectively, were the most commonly used herbicides, both applied exclusively either as land preparation treatments or to the ground beneath table tops. In all, over 2,000,000 m^2 were treated with herbicide active ingredients.

OTHER EDIBLE CROPS

This category is not listed in the Agricultural Census, but for the purposes of this publication, contains all edible protected crops except tomatoes and other fruit which have been reported on separately. An estimated 64,322 m^2 of 'other edible crops' were grown in Scotland in 2003. Crops encountered included minor vegetables, micropropagated potatoes and vegetable seedlings, but pesticide usage data cannot be compared with those from the previous survey because vegetable seedlings were recorded separately in 1999.

Insecticides, biological agents and molluscicides (Tables 4,10)

The proportion of crops treated with insecticides was only 13%. Pymetrozine, applied to 16,594 m^2 and lambda-cyhalothrin, to 8,297 m^2, both for aphid control on micropropagated potatoes were the only insecticides recorded.

No biological control agents were encountered.

Metaldehyde was the only molluscicide recorded and was applied to 29% of the total area of these crops.

Fungicides and soil sterilants (Tables 5,11)

All fungicides encountered were applied to micropropagated potatoes for blight control. Cyazofamid and cymoxanil, each applied to 33,188 m^2, were the principal fungicides used.

The soil sterilant, dazomet, was applied to 1,560 m^2, or 2% of the area of other edible crops.

Herbicides (Tables 6,12))

The proportion of the area of the crops treated with herbicides was only 22%. Glyphosate was the most commonly used herbicide.

NON-EDIBLE CROPS

BEDDING AND POT PLANTS

In addition to bedding and pot plants, this category includes propagated hardy nursery stock. The estimated area grown in 2003, which includes extensive multiple cropping, was 652,117 m^2, a 28% decline compared with estimates reported in 1999. As in the previous surveys, the proportion of crop area treated with individual pesticides or pesticide groups is not reported, as the continuous throughput of plants does not allow accurate recording of the appropriate data.

Insecticides, biological agents and molluscicides (Tables 7,13)

The total area treated with insecticide active ingredients was 742,446 m^2, a significant increase compared with 426,000 m^2 in 1999. As in the previous survey, the main specified reason for the use of insecticides was aphid control.

Deltamethrin, applied to over 262,000 m^2 was by far the most commonly recorded insecticide. In 1999, cypermethrin had been the principal insecticide used, whilst deltamethrin had been applied to only 3,145 m^2.

Over 124,000 m^2 were treated with the biological control agent, *Hypoaspis miles*, for the control of sciarid flies. In 1999, only small areas had been treated using *Heterorhabditis* sp, and *Encarsia formosa*.

In the present survey, over 145,000 m^2 were treated with molluscicides: methiocarb to over 94,000 m^2 and metaldehyde to over 51,000 m^2. In the previous survey, metaldehyde had been the most commonly used molluscicide, applied to almost 248,000 m^2.

Fungicides (Tables 8,14)

The total area of bedding and pot plants treated with fungicide active ingredients in 2003 was over 1,343,000 m^2, a significant increase compared with less than 876,000 m^2 in 1999. Mildew control was the most commonly specified reason for use of fungicides.

Chlorothalonil and iprodione, applied to around 327,000 m^2 and 258,000 m^2 respectively, were the most commonly applied fungicides. Zineb, which was no longer available in 2003 had been the principal fungicide recorded in the previous survey, whilst iprodione, applied to 130,000 m^2, had also been popular.

Herbicides and growth regulators (Tables 9,15))

The total area treated with herbicide active ingredients in 2003 was over 366,000 m^2, a 3-fold increase compared with the previous survey.

The main herbicides used were paraquat, applied to over 114,500 m^2 and isoxaben to almost 84,000 m^2. Glyphosate, which had been the most commonly used herbicide in 1999, was used on less than 30,000 m^2 in the present survey.

Usage of growth regulators increased almost 10-fold compared with the previous survey, with over 400,000 m^2 treated. Daminozide, applied to 157,760 m^2, was the principal growth regulator. Paclobutrazol had been the most commonly used active in 1999.

FLOWERS FOR CUTTING

The estimated area of this category grown in 2003 was just over 14,000 m^2, roughly one third of that recorded in 1999.

Insecticides and molluscicides (Tables 7,13)

The proportion of the crop area treated with insecticide active ingredients was 68%, double the 34% recorded in the previous survey. The main reason for use of insecticide was for the control of aphids.

Bifenthrin, in a mixed formulation with the fungicide myclobutanil, was the most widely used insecticide, and was applied to more than 50,000 m^2, or 60% of the crop area. In 1999, deltamethrin had been the principal insecticide.

Only 8% of the crop area was treated with molluscicides compared with 20% in 1999. Metaldehyde was the main molluscicide used on this crop.

Fungicides and soil sterilants (Tables 8,14)

Sixty-eight percent of the crop area was treated with fungicide, compared with 93% in 1999. Mildew control was the main reason given by growers for the use of fungicides.

Myclobutanil, applied to 60% of the crop area, and propiconazole, to 8%, were the only fungicides encountered on this crop. Chlorothalonil, had been the most popular fungicide in the previous survey.

No soil sterilants were recorded in 2003. Dazomet had been used on over 3,000 m^2 in 1999.

Herbicides (Tables 9,15)

The proportion of the crop area treated with herbicides in 2003 was 40%, and the main herbicide recorded was glyphosate, applied to almost 3,500 m^2, or 25% of the crop area. In the previous survey, glyphosate had been the only herbicide recorded, on only 11% of the crop area.

Edible crops (Table 26)

The total estimated area of protected edible crops grown in Scotland in 2003 was 359,755 m^2, more than double that recorded in the previous survey. Although the areas of tomatoes fell by 41%, there has been a huge increase in 'other fruit' (strawberries), which had not been previously listed in the Agricultural Census, and in 2003 was almost 250,000 m^2. Overall, there have been huge increases in pesticide usage of the three main pesticide types: insecticides, fungicides and herbicides, all significantly influenced by the extensive treatments applied to strawberries.

The total area treated with insecticide active ingredients was just under 2,000,000 m^2, compared with only 357,563 m^2 in 1999, a 5-fold increase. On the other hand, the weight applied fell to less than one third of that recorded in 1999, when chlorpyrifos had been recorded on vegetable seedlings and applied at relatively high dose rates. When measured by area of active ingredients, the subgroup comprising 'other insecticides' recorded the largest usage, dominated by tebufenpyrad and spinosad. There were significant increases in use of carbamates and pyrethroids, but no organochlorines or organophosphates were encountered in 2003. Tebufenpyrad was recorded only on strawberries and was the most popular insecticide in 2003, compared with abamectin in the previous survey.

Usage of biological agents has continued to decline, and in the present survey they were applied to 228,618 m^2, compared with 260,175 m^2 in 1999, despite the large increase in area grown. *Bacillus thuringiensis*, recorded solely on strawberries, was the main biological control agent recorded. In 1999, *Phytoseiulus persimilis* had been by far the most extensively used treatment.

Molluscicide usage also fell, from 48,565 m^2 treated to less than 35,000 m^2. Metaldehyde, which was the only molluscicide recorded in 2003, remained the most commonly used.

Fungicide usage, as measured by area treated, increased 10-fold compared with 1999, but weight applied increased only 3-fold. This discrepancy was due to the fact that in the previous survey, propamocarb hydrochloride and to a lesser extent, tolclofos-methyl and fosetyl-aluminium, had been applied at relatively high dosage rates to large areas of vegetable seedlings, but this crop was not encountered to the same degree in 2003. The principal fungicide in 2003, iprodione, applied exclusively to strawberries, replaced dichlofluanid which had been applied only to vegetable seedlings in the previous survey.

When measured by the area of active ingredients, herbicide usage increased more than 100-fold compared with 1999. The total weight of active ingredients applied, however, increased to a lesser degree, which was due to several herbicides recorded in 2003 being applied at lower dosage rates than glyphosate which dominated the usage data in 1999. Bromacil, used exclusively on strawberries, replaced glyphosate as the main herbicide on edible crops.

Non-edible crops (Table 27)

The total estimated areas of non-edible crops grown in 2003 were 666,212 m^2, a decline of 32%, compared with the previous survey. Areas of both bedding & pot plants and flowers for cutting fell. Despite this, there were increases in the usage of all the pesticide groups except molluscicides.

The total area treated with insecticides increased by 60% and their weights by 48% compared with 1999. The area treated with pyrethroids increased 3-fold and remained the main insecticide type. Deltamethrin replaced cypermethrin as the principal insecticide.

Use of biological control agents increased 11-fold. *Hypoaspis miles* replaced *Heterorhabditis* sp as the most commonly used biological control. Use of molluscicides fell by half compared with the previous survey. Methiocarb replaced metaldehyde as the main molluscicide.

Fungicide usage increased by 38% when measured by the area of active ingredients, but more than doubled when measured by the total weight applied. This was due mainly to the use of etridiazole in 2003 which is applied at relatively high dosage rates, and which was not recorded at all in 1999. Chlorothalonil replaced iprodione as the principal fungicide on non-edible crops.

The area treated with herbicide active ingredients more than doubled compared with 1999. Paraquat replaced glyphosate as the most commonly used herbicide.

Usage of growth regulators increased almost 10-fold. Daminozide replaced paclobutrazol as the most widely used growth regulator.

REFERENCES

1. Umpleby, R.A., Sly J.M. A. and Cutler, J.R. Pesticide usage survey report 13, Glasshouse Crops 1976; MAFF, DAFS 1980.

2. Brodie, J. and Wood, J. Pesticide usage survey report 42, Glasshouse Crops 1981; DAFS, Edinburgh 1984.

3. Shave, P.R. and Dickson, J.M. Pesticide usage survey report 75, Edible Protected Crops 1987; SOAFD, Edinburgh, 1992.

4. Snowden, J.P. and Thomas, L.A. Pesticide usage survey reports 96 and 97, Protected Crops (edible and non-edible) 1991 and Mushrooms 1991; SOAFD, Edinburgh, 1992.

5. Thomas, L.A. Pesticide usage survey report, Protected Crops 1995; SOAEFD, Edinburgh 1997.

6. Snowden, J.P. Pesticide usage survey report, Protected Crops 1999; SEERAD, Edinburgh 2001.

7. Agricultural Statistics, Scotland 2003. HMSO, Edinburgh 2003.

8. Wood, H.J. An Agricultural Atlas of Scotland. George Gill and Sons, London, 1931.

ACKNOWLEDGEMENTS

The author wishes to thank all the growers who provided the information for this report. Thanks are also given to Dr C J Griffiths for providing editorial assistance. In addition, the author is particularly grateful for support from Mr D Garthwaite and colleagues at Central Science Laboratory, York, Information Technology Section, SASA, and to Mr A Roberts of Biomathematics & Statistics Scotland.

Figure 1 Land-Use Regions of Scotland

Figure 2 Percentages of estimated protected crop areas

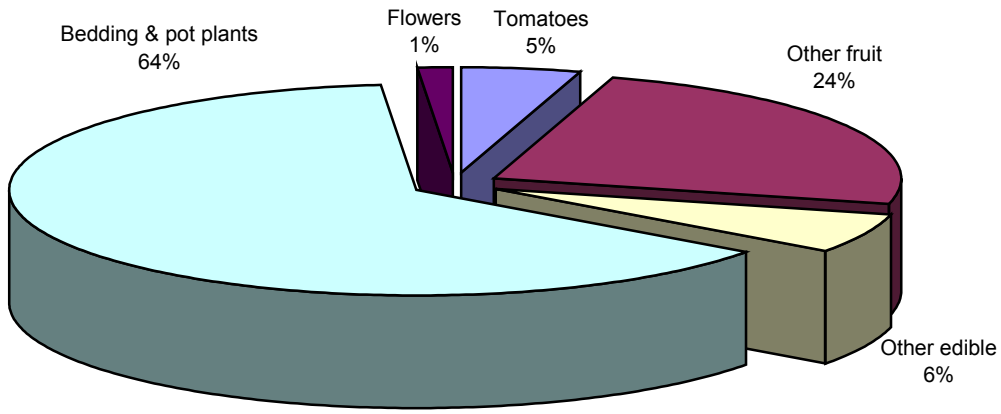

Figure 3 Percentages of crops treated with pesticides

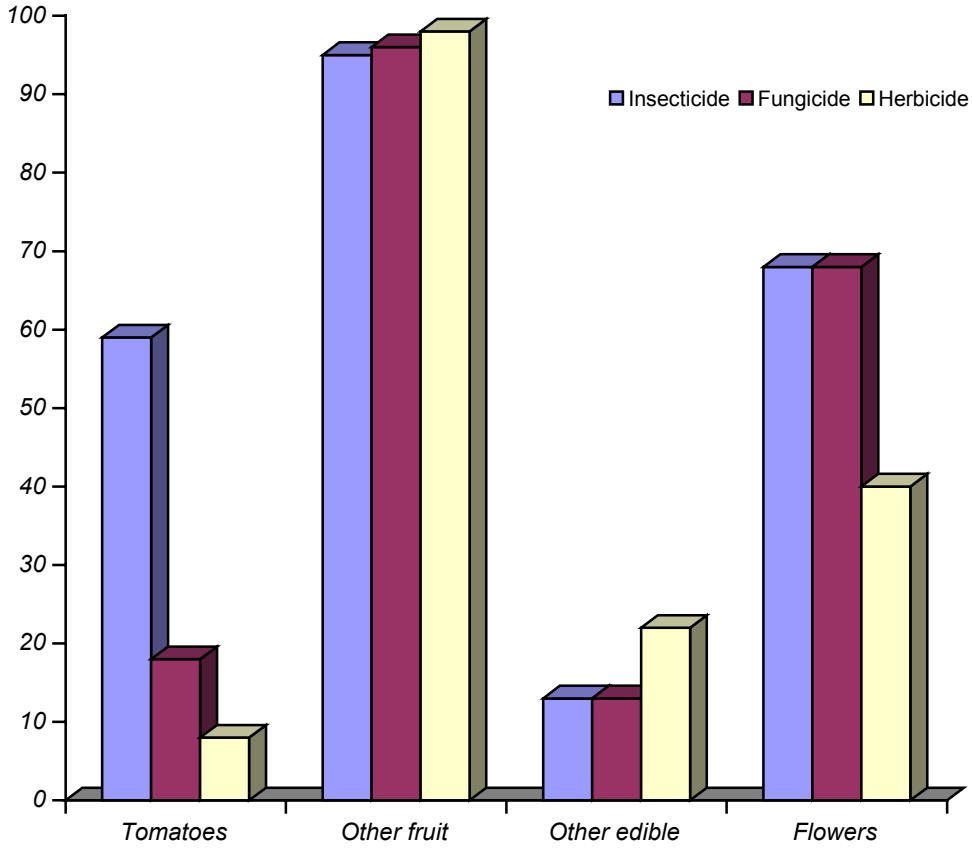

TABLE 1 Crop areas

Estimated area, m^2, of protected crops grown in Scotland

Crop	*2003*	*1999*	*% change*
Tomatoes	***47,394**	80,042	-41
Other fruit	***248,039**	60,978	412
Other edible crops	**64,322**		
Bedding & pot plants***	**652,117**	906,967	-28
Flowers for cutting	**14,095**	41,254	-66
All crops	**1,025,967**	**1,121,050	-8
Glasshouses & plastic structures	**780,240**	606,595	29

'*' Census areas; '**' includes 31,809 m^2 trees '***' includes hardy nursery stock

TABLE 2 Distribution of sample

Number of holdings sampled in each region

Highlands & Islands	*Caithness & Orkney*	*Moray Firth*	*Aberdeen*	*Angus*	*East Fife*	*Lothian*	*Central Lowlands*	*Tweed Valley*	*Southern Uplands*	*Solway*	*Scotland*
4		3	4	2	1	3	9	2		2	**30**

Size groups have not been published in order to prevent disclosure of fewer than 5 holdings

TABLE 3 Proportion (%) of each crop treated with pesticides

	Tomatoes	*Other fruit*	*Other edible*	*Flowers for cutting*
Insecticides & acaricides	59	95	13	68
Biological agents	59	52		
Molluscicides	34		29	8
Fungicides	18	96	13	68
Herbicides	8	98	22	40
Soil sterilants			2	
Any pesticide	**96**	**100**	**49**	**100**

TABLE 4 Edible crops insecticide/acaricide, biological and molluscicide formulations

Area treated (m^2) and percentage of crop treated

Insecticides & acaricides	***Tomatoes***		***Other fruit***		***Other edible crops***		***All edible crops***	***1999***
	(m^2)	%	(m^2)	%	(m^2)	%	**(m^2)**	(m^2)
Abamectin			18,189	7			**18,189**	97,905
Bifenthrin			287,520	65			**287,520**	
Fenbutatin oxide	55,681	59					**55,681**	40,097
Lambda-cyhalothrin					8,297	13	**8,297**	
Pirimicarb			490,778	95			**490,778**	42,020
Pymetrozine					16,594	13	**16,594**	
Spinosad			363,785	29			**363,785**	
Tebufenpyrad			597,127	95			**597,127**	
Tetradifon			90,946	37			**90,946**	
All insecticides	**55,681**	**59**	**1,848,346**	**95**	**24,891**	**13**	**1,928,919**	**307,775**
Biological agents								
Bacillus thuringiensis			145,904	51			**145,904**	3,288
Heterorhabditis megidis			18,189	7			**18,189**	869
Macrolophus caliginosus	27,841	59					**27,841**	
Phytoseiulus persimilis			306	+			**306**	256,019
Steinernema kraussei			36,379	7			**36,379**	
All biological agents	**27,841**	**59**	**200,777**	52			**228,618**	**260,175**
Molluscicides								
Metaldehyde	15,966	34			18,934	29	**34,900**	34,865
All molluscicides	**15,966**	**34**			**18,934**	**29**	**34,900**	**48,565**
Area grown	**47,394**		**248,039**		**64,322**		**359,755**	

TABLE 5 Edible crops fungicide and soil sterilant formulations

Area treated (m^2) and percentage of crop treated

Fungicides	***Tomatoes***		***Other fruit***		***Other edible crops***		***All edible crops***	***1999***
	(m^2)	%	(m^2)	%	(m^2)	%	**(m^2)**	(m^2)
Azoxystrobin	13,332	14	838	+			**14,170**	
Bupirimate			1,200,586	96			**1,200,586**	
Chlorothalonil			376,128	51			**376,128**	789
Cyazofamid					33,188	13	**33,188**	
Cymoxanil					33,188	13	**33,188**	
Dichlofluanid	8,938	4					**8,938**	190,456
Dimethomorph/mancozeb					16,594	13	**16,594**	
Etridiazole	89	+					**89**	459
Fenarimol			34,430	14			**34,430**	
Fenhexamid			936,876	95			**936,876**	
Fluazinam					8,297	13	**8,297**	
Fluazinam/metalaxyl-M					16,594	13	**16,594**	
Fosetyl-aluminium			91,784	37			**91,784**	76,183
Iprodione			1,205,872	95			**1,205,872**	1,589
Kresoxim-methyl			216,322	51			**216,322**	
Myclobutanil			957,176	95			**957,176**	
Pyrimethanil	13,332	14	956,683	95			**970,015**	141,128
Thiram			359,887	58			**359,887**	
Tolylfluanid			535,933	51			**535,933**	
All fungicides	**35,691**	**18**	**6,872,516**	**96**	**107,862**	**13**	**7,016,068**	**584,923**
Soil sterilants								
Dazomet					1,560	2	**1,560**	
All soil sterilants					**1,560**	**2**	**1,560**	
Area grown	**47,394**		**248,039**		**64,322**		**359,755**	

'+' = <0.5%

TABLE 6 Edible crops herbicide formulations

Area treated (m^2) and percentage of crop treated

Herbicides	***Tomatoes***		***Other fruit***		***Other edible crops***		***All edible crops***	***1999***
	(m^2)	%	(m^2)	%	(m^2)	%	**(m^2)**	(m^2)
Bromacil			745,759	44			**745,759**	
Diquat/paraquat			236,460	44			**236,460**	
Glyphosate			280,612	69	13,895	22	**294,506**	19,046
Isoxaben			36,379	7			**36,379**	
Paraquat	3,991	8	509,299	73	412	1	**513,702**	
Simazine			53,009	21			**53,009**	
Trifluralin			72,757	29			**72,757**	
All herbicides	**3,991**	**8**	**1,934,274**	**98**	**14,306**	**22**	**1,952,572**	**21,386**
Area grown	**47,394**		**248,039**		**64,322**		**359,755**	

TABLE 7 Non-edible crops insecticide/acaricide, mixed, biological and molluscicide formulations

Area treated (m^2) and percentage of crop treated

Insecticides & acaricides	*Bedding & pot plants**		*Flowers for cutting*		*All non-edible crops*	*1999*
	(m^2)		(m^2)	%	**(m^2)**	(m^2)
Abamectin	53,651				**53,651**	
Bifenthrin	20,445				**20,445**	12,162
Buprofezin	19,747				**19,747**	30,100
Carbosulfan	1,823				**1,823**	
Chlorpyrifos	73,595				**73,595**	35,272
Cypermethrin	61,839				**61,839**	126,437
Deltamethrin	262,524		1,175	8	**263,700**	25,640
Dimethoate	10,544				**10,544**	
Fipronil	11,820				**11,820**	
Imidacloprid	46,110				**46,110**	10,047
Permethrin	38,285				**38,285**	
Pirimicarb	75,708		1,175	8	**76,884**	81,229
Pyrethrins	40,620				**40,620**	
Teflubenzuron	5,834				**5,834**	3,860
Thiacloprid	3,412				**3,412**	
All insecticides	**725,959**		**2,351**	**8**	**728,310**	**494,234**

'*' includes hardy nursery stock

Cont…

TABLE 7 Non-edible crops insecticide/acaricide, mixed, biological and molluscicide formulations continued

Area treated (m^2) and percentage of crop treated

Mixed insecticides and fungicides	***Bedding & pot plants****		***Flowers for cutting***		***All non-edible crops***	***1999***
	(m^2)	%	(m^2)	%	**(m^2)**	(m^2)
Bifenthrin/myclobutanil	16,487		50,691	60	**67,178**	
All mixed formulations	**16,487**		**50,691**	**60**	**67,178**	
Biological agents						
Hypoaspis miles	124,086				**124,086**	
All biological agents	**124,086**				**124,086**	**11,088**
Molluscicides						
Metaldehyde	51,037		1,175	8	**52,213**	299,432
Methiocarb	94,041				**94,041**	42,740
All molluscicides	**145,078**		**1,175**	**8**	**146,253**	**342,172**
Area grown	652,117		14,095		**666,212**	

'*' includes hardy nursery stock

TABLE 8 Non-edible crops fungicide formulations

Area treated (m^2) and percentage of crop treated

Fungicides	***Bedding & pot plants****		***Flowers for cutting***		***All non-edible crops***	***1999***
	(m^2)		(m^2)	%	**(m^2)**	(m^2)
Azoxystrobin	45,535				**45,535**	41,480
Benodanil	536				**536**	
Bupirimate	1,988				**1,988**	
Bupirimate/triforine	51,520				**51,520**	40,693
Chlorothalonil	203,330				**203,330**	89,933
Chlorothalonil/metalaxyl	124,086				**124,086**	3,293
Cupric ammonium carbonate	994				**994**	
Etridiazole	102,934				**102,934**	
Fenarimol	1,988				**1,988**	
Fenpropimorph	1,988				**1,988**	
Fosetyl-aluminium	124,583				**124,583**	9,240
Furalaxyl	398				**398**	11,060
Iprodione	257,621				**257,621**	152,512
Metalaxyl/thiram	301				**301**	944
Myclobutanil	16,913				**16,913**	12,724
Oxycarboxin	15,115				**15,115**	1,872
Prochloraz	3,170				**3,170**	38,338
Propamocarb hydrochloride	130,154				**130,154**	48,186
Propiconazole	53,354		4,702	8	**58,056**	33,112
Quinoxyfen	10,523				**10,523**	
Tolclofos-methyl	3,828				**3,828**	57,974
All fungicides	**1,150,858**		**4,702**	**8**	**1,155,560**	**932,555**
Area grown	652,117		14,095		**666,212**	

'*' includes hardy nursery stock

TABLE 9 Non-edible crops herbicide and growth regulator formulations

Area treated (m^2) and percentage of crop treated

Herbicides	***Bedding & pot plants****		***Flowers for cutting***		***All non-edible crops***	***1999***
	(m^2)		(m^2)	%	**(m^2)**	(m^2)
Chlorpropham			1,175	8	**1,175**	
Diquat/paraquat			1,014	7	**1,014**	45
Glufosinate-ammonium	2,245				**2,245**	
Glyphosate	29,845		3,457	25	**33,302**	74,089
Isoxaben	83,920				**83,920**	
Metazachlor	31,280				**31,280**	
Oxadiazon	50,640				**50,640**	2,222
Paraquat	114,579				**114,579**	71,986
Propaquizafop	99				**99**	
Propyzamide	25,523				**25,523**	
Simazine	28,742				**28,742**	6,892
All herbicides	**366,874**		**5,646**	**40**	**372,520**	**163,712**
Growth regulators						
Chlormequat	122,660				**122,660**	9,559
2-chloroethylphosphonic acid	8,751				**8,751**	
Daminozide	157,760				**157,760**	6,644
4-indol-3-ylbutyric acid	62,080				**62,080**	
1-naphthylacetic acid/ 4-indol-3-ylbutyric acid	156				**156**	687
Paclobutrazol	49,028				**49,028**	21,379
All growth regulators	**400,435**				**49,184**	**40,650**
Area grown	652,117		14,095		**666,212**	

'*' includes hardy nursery stock

TABLE 10 Edible crops insecticide/acaricide, biological and molluscicide active ingredients

Area treated (m^2) and percentage of crop treated

Insecticides & acaricides	***Tomatoes***		***Other fruit***		***Other edible crops***		***All edible crops***	***1999***
	(m^2)	%	(m^2)	%	(m^2)	%	**(m^2)**	(m^2)
Pyrethroids								
Bifenthrin			287,520	65			**287,520**	
Lambda-cyhalothrin					8,297	13	**8,297**	
All pyrethroids			**287,520**		**8,297**		**295,817**	**38,687**
Carbamates								
Pirimicarb			490,778	95			**490,778**	42,020
All carbamates			**490,778**				**490,778**	**42,020**
Others								
Abamectin			18,189	7			**18,189**	97,905
Fenbutatin oxide	55,681	59					**55,681**	40,097
Pymetrozine					16,594	13	**16,594**	
Spinosad			363,785	29			**363,785**	
Tebufenpyrad			597,127	95			**597,127**	
Tetradifon			90,946	37			**90,946**	11,697
All others	**55,681**		**1,070,048**		**16,594**		**1,142,323**	**150,885**
All insecticides & acaricides	**55,681**	**59**	**1,848,346**	**95**	**24,891**	**13**	**1,928,919**	**357,563**

Cont…

TABLE 10 Edible crops insecticide/acaricide, biological and molluscicide active ingredients continued

Area treated (m^2) and percentage of crop treated

Biological agents	***Tomatoes***		***Other fruit***		***Other edible crops***		***All edible crops***	***1999***
	(m^2)	%	(m^2)	%	(m^2)	%	**(m^2)**	(m^2)
Bacillus thuringiensis			145,904	51			**145,904**	3,288
Heterorhabditis megidis			18,189	7			**18,189**	869
Macrolophus caliginosus	27,841	59					**27,841**	
Phytoseiulus persimilis			306	+			**306**	256,019
Steinernema kraussei			36,379	7			**36,379**	
All biological agents	**27,841**	**59**	**200,777**	**52**			**228,618**	**260,175**
Molluscicides								
Metaldehyde	15,966	34			18,934	29	**34,900**	34,865
All molluscicides	**15,966**	**34**			**18,934**	**29**	**34,900**	**48,565**
Area grown	47,394		248,039		64,322		**359,755**	

'+' = <0.5%

TABLE 11 Edible crops fungicide and soil sterilant active ingredients

Area treated (m^2) and percentage of crop treated

Fungicides	***Tomatoes***		***Other fruit***		***Other edible crops***		***All edible crops***	***1999***
	(m^2)	%	(m^2)	%	(m^2)	%	**(m^2)**	(m^2)
Azoxystrobin	13,332	14	838	+			**14,170**	
Bupirimate			1,200,586	96			**1,200,586**	10,024
Chlorothalonil			376,128	51			**376,128**	789
Cyazofamid					33,188	13	**33,188**	
Cymoxanil					33,188	13	**33,188**	
Dichlofluanid	8,938	4					**8,938**	190,456
Dimethomorph					16,594	13	**16,594**	
Etridiazole	89	+					**89**	459
Fenarimol			34,430	14			**34,430**	
Fenhexamid			936,876	95			**936,876**	
Fluazinam					24,891	13	**24,891**	
Fosetyl-aluminium			91,784	37			**91,784**	76,183
Iprodione			1,205,872	95			**1,205,872**	1,589
Kresoxim-methyl			216,322	51			**216,322**	
Mancozeb					16,594	13	**16,594**	76,183
Metalaxyl-M					16,594	13	**16,594**	
Myclobutanil			957,176	95			**957,176**	
Pyrimethanil	13,332	14	956,683	95			**970,015**	141,128
Thiram			359,887	58			**359,887**	
Tolylfluanid			535,933	51			**535,933**	
All fungicides	**35,691**	**18**	**6,872,516**	**96**	**141,050**	**13**	**7,049,257**	**671,130**
Soil sterilants								
Dazomet					1,560	2	**1,560**	
All soil sterilants					**1,560**	**2**	**1,560**	
Area grown	47,394		248,039		64,322		**359,755**	

TABLE 12 Edible crops herbicide active ingredients

Area treated (m^2) and percentage of crop treated

Herbicides	***Tomatoes***		***Other fruit***		***Other edible crops***		***All edible crops***	***1999***
	(m^2)	%	(m^2)	%	(m^2)	%	**(m^2)**	(m^2)
Bromacil			745,759	44			**745,759**	
Diquat			236,460	44			**236,460**	
Glyphosate			280,612	69	13,895	22	**294,506**	19,046
Isoxaben			36,379	7			**36,379**	
Paraquat	3,991	8	745,759	73	412	1	**750,162**	
Simazine			53,009	21			**53,009**	
Trifluralin			72,757	29			**72,757**	
All herbicides	**3,991**	**8**	**2,170,734**	**98**	**14,306**	**22**	**2,189,032**	**21,386**
Area grown	47,394		248,039		64,322		**359,755**	

TABLE 13 Non-edible crops insecticide/acaricide, biological and molluscicide active ingredients

Area treated (m^2) and percentage of crop treated

Insecticides & acaricides	***Bedding & pot plants****		***Flowers for cutting***		***All non-edible crops***	***1999***
	(m^2)		(m^2)	%	**(m^2)**	(m^2)
Pyrethroids						
Bifenthrin	36,932		50,691	60	**87,623**	12,162
Cypermethrin	61,839				**61,839**	126,437
Deltamethrin	262,524		1,175	8	**263,700**	25,640
Permethrin	38,285				**38,285**	1,198
Pyrethrins	40,620				**40,620**	1,573
All pyrethroids	**440,201**		**51,866**		**492,067**	168,582
Carbamates						
Carbosulfan	1,823				**1,823**	
Pirimicarb	75,708		1,175	8	**76,884**	81,229
All carbamates	**77,531**		**1,175**		**78,707**	81,229
Organophosphates						
Chlorpyrifos	73,595				**73,595**	35,272
Dimethoate	10,544				**10,544**	
All organophosphates	**84,139**				**84,139**	93,247
Others						
Abamectin	53,651				**53,651**	
Buprofezin	19,747				**19,747**	30,100
Fipronil	11,820				**11,820**	
Imidacloprid	46,110				**46,110**	10,047
Teflubenzuron	5,834				**5,834**	3,860
Thiacloprid	3,412				**3,412**	
All others	**140,575**				**140,575**	148,643
All insecticides	**742,446**		**53,042**	**68**	**795,488**	**497,413**

'*' includes hardy nursery stock

Cont…

TABLE 13 Non-edible crops insecticide/acaricide, biological and molluscicide active ingredients continued

Area treated (m^2) and percentage of crop treated

Biological agents	***Bedding & pot plants****		***Flowers for cutting***		***All non-edible crops***	***1999***
	(m^2)		(m^2)	%	**(m^2)**	(m^2)
Hypoaspis miles	124,086				**124,086**	
All biological agents	**124,086**				**124,086**	**11,088**
Molluscicides						
Metaldehyde	51,037		1,175	8	**52,213**	299,432
Methiocarb	94,041				**94,041**	42,740
All molluscicides	**145,078**		**1,175**	**8**	**146,253**	**342,172**
Area grown	652,117		14,095		**666,212**	

'*' includes hardy nursery stock

TABLE 14 Non-edible crops fungicide active ingredients

Area treated (m^2) and percentage of crop treated

Fungicides	***Bedding & pot plants****		***Flowers for cutting***		***All non-edible crops***	***1999***
	(m^2)		(m^2)	%	**(m^2)**	(m^2)
Azoxystrobin	45,535				**45,535**	41,480
Benodanil	536				**536**	
Bupirimate	53,509				**53,509**	40,693
Chlorothalonil	327,415				**327,415**	93,226
Cupric ammonium carbonate	994				**994**	
Etridiazole	102,934				**102,934**	
Fenarimol	1,988				**1,988**	
Fenpropimorph	1,988				**1,988**	
Fosetyl-aluminium	124,583				**124,583**	9,240
Furalaxyl	398				**398**	11,060
Iprodione	257,621				**257,621**	152,512
Metalaxyl	124,386				**124,386**	42,575
Myclobutanil	33,400		50,691	60	**84,090**	12,724
Oxycarboxin	15,115				**15,115**	1,872
Prochloraz	3,170				**3,170**	38,338
Propamocarb hydrochloride	130,154				**130,154**	48,186
Propiconazole	53,354		4,702	8	**58,056**	33,112
Quinoxyfen	10,523				**10,523**	
Thiram	301				**301**	944
Tolclofos-methyl	3,828				**3,828**	57,974
Triforine	51,520				**51,520**	40,693
All fungicides	**1,343,252**		**55,393**	**68**	**1,398,644**	**1,016,509**
Area grown	652,117		14,095		**666,212**	

'*' includes hardy nursery stock

TABLE 15 Non-edible crops herbicide and growth regulator active ingredients

Area treated (m^2) and percentage of crop treated

Herbicides	***Bedding & pot plants****		***Flowers for cutting***		***All non-edible crops***	***1999***
	(m^2)		(m^2)	%	**(m^2)**	(m^2)
Chlorpropham			1,175	8	**1,175**	
Diquat			1,014	7	**1,014**	45
Glufosinate-ammonium	2,245				**2,245**	
Glyphosate	29,845		3,457	25	**33,302**	74,089
Isoxaben	83,920				**83,920**	1,586
Metazachlor	31,280				**31,280**	
Oxadiazon	50,640				**50,640**	2,222
Paraquat	114,579		1,014	7	**115,593**	72,031
Propaquizafop	99				**99**	
Propyzamide	25,523				**25,523**	
Simazine	28,742				**28,742**	6,892
All herbicides	**366,874**		**6,660**	**40**	**373,534**	**165,874**
Growth regulators						
Chlormequat	122,660				**122,660**	9,559
2-chloroethylphosphonic acid	8,751				**8,751**	
Daminozide	157,760				**157,760**	6,644
4-indol-3-ylbutyric acid	62,236				**62,236**	687
1-naphthylacetic acid	156				**156**	3,067
Paclobutrazol	49,028				**49,028**	21,379
All growth regulators	**400,590**				**400,590**	**41,337**

'*' includes hardy nursery stock

TABLE 16 Edible crops

Quantities (kg) of insecticides/acaricides and molluscicides

Insecticides and acaricides	***Tomatoes***	***Other fruit***	***Other edible***	***Total weight***	***1999***
Pyrethroids					
Bifenthrin		1.6		**1.6**	
Lambda-cyhalothrin			+	+	
All pyrethroids		**1.6**	+	**1.6**	**0.5**
Carbamates					
Pirimicarb		17.4		**17.4**	0.8
All carbamates		**17.4**		**17.4**	**0.8**
Others					
Abamectin		+		+	+
Fenbutatin oxide	1.4			**1.4**	1.3
Pymetrozine			0.2	**0.2**	
Spinosad		1.9		**1.9**	
Tebufenpyrad		15.9		**15.9**	
Tetradifon		1.2		**1.2**	0.5
All others	**1.4**	**19.0**	**0.2**	**20.7**	**2.5**
All insecticides and acaracides	**1.4**	**38.0**	**0.2**	**39.7**	**129.1**
Molluscicides					
Metaldehyde	1.0		1.1	**2.1**	2.5
All molluscicides	**1.0**		**1.1**	**2.1**	**2.6**

'+' = <0.05 kg

TABLE 17 Edible crops

Quantities (kg) of fungicides and soil sterilants

Fungicides	***Tomatoes***	***Other fruit***	***Other edible***	***Total weight***	***1999***
Azoxystrobin	0.4	+		**0.4**	
Bupirimate		52.6		**52.6**	0.3
Chlorothalonil		46.4		**46.4**	0.1
Cyazofamid			0.3	**0.3**	
Cymoxanil			0.4	**0.4**	
Dichlofluanid	0.7			**0.7**	7.3
Dimethomorph			0.2	**0.2**	
Etridiazole	+			+	0.5
Fenarimol		0.2		**0.2**	
Fenhexamid		91.2		**91.2**	
Fluazinam			0.4	**0.4**	
Fosetyl-aluminium		25.7		**25.7**	13.9
Iprodione		80.9		**80.9**	0.2
Kresoxim-methyl		4.3		**4.3**	
Mancozeb			2.2	**2.2**	7.4
Metalaxyl-M			0.1	**0.1**	
Myclobutanil		8.4		**8.4**	
Pyrimethanil	0.6	96.3		**96.9**	9.6
Thiram		44.7		**44.7**	
Tolylfluanid		86.2		**86.2**	
All fungicides	**1.7**	**536.9**	**3.6**	**542.2**	**169.3**
Soil sterilants					
Dazomet			84.1	**84.1**	
All soil sterilants			**84.1**	**84.1**	

'+' = <0.05 kg

TABLE 18 Edible crops

Quantities (kg) of herbicides

Herbicides	*Tomatoes*	*Other fruit*	*Other edible*	*Total weight*	*1999*
Bromacil		34.4		**34.4**	
Diquat		1.9		**1.9**	
Glyphosate		14.6	0.9	**15.5**	2.7
Isoxaben		0.2		**0.2**	
Paraquat	0.2	17.5	+	**17.7**	
Simazine		5.3		**5.3**	
Trifluralin		7.7		**7.7**	
All herbicides	**0.2**	**81.6**	**0.9**	**82.6**	**2.9**

'+' = <0.05 kg

TABLE 19 Non-edible crops

Quantities (kg) of insecticides/acaricides and molluscicides

Insecticides & acaricides	***Bedding & pot plants****	***Flowers for cutting***	***Total weight***	***1999***
Pyrethroids				
Bifenthrin	+	+	**+**	+
Cypermethrin	2.0		**2.0**	0.3
Deltamethrin	0.2	+	**0.2**	0.1
Permethrin	1.6		**1.6**	+
Pyrethrins	+		**+**	+
All pyrethroids	**3.8**	+	**3.9**	**0.6**
Carbamates				
Carbosulfan	5.3		**5.3**	
Pirimicarb	0.7	0.1	**0.9**	1.5
All carbamates	**6.0**	**0.1**	**6.1**	**1.5**
Organophosphates				
Chlorpyrifos	144.5		**144.5**	67.7
Dimethoate	0.2		**0.2**	
All organophosphates	**144.7**		**144.7**	**75.4**
Others				
Abamectin	0.1		**0.1**	
Buprofezin	0.1		**0.1**	0.2
Fipronil	0.2		**0.2**	
Imidacloprid	9.5		**9.5**	0.9
Teflubenzuron	+		**+**	+
Thiacloprid	+		**+**	
All others	**9.9**		**9.9**	**32.3**
All insecticides	**164.5**	**0.1**	**164.6**	**111.0**
Molluscicides				
Metaldehyde	7.7	0.1	**7.8**	21.2
Methiocarb	5.8		**5.8**	2.7
All molluscicides	**13.5**	**0.1**	**13.6**	**24.0**

'+' = <0.05 kg '*' includes hardy nursery stock

TABLE 20 Non-edible crops

Quantities (kg) of fungicides

Fungicides	***Bedding & pot plants****	***Flowers for cutting***	***Total weight***	***1999***
Azoxystrobin	2.2		**2.2**	1.0
Benodanil	0.1		**0.1**	
Bupirimate	0.8		**0.8**	0.4
Chlorothalonil	34.5		**34.5**	12.4
Cupric ammonium carbonate	+		+	
Etridiazole	633.5		**633.5**	
Fenarimol	+		+	
Fenpropimorph	+		+	
Fosetyl-aluminium	4.5		**4.5**	3.3
Furalaxyl	2.0		+	3.5
Iprodione	14.7		**14.7**	13.7
Metalaxyl	1.9		**1.9**	1.3
Myclobutanil	0.1	0.1	**0.2**	0.1
Oxycarboxin	0.5		**0.5**	0.1
Prochloraz	+		+	3.5
Propamocarb hydrochloride	259.9		**259.9**	298.3
Propiconazole	1.1	+	**1.2**	0.7
Quinoxyfen	0.6		**0.6**	
Thiram	0.2		**0.2**	0.2
Tolclofos-methyl	0.8		**0.8**	44.5
Triforine	0.8		**0.8**	0.4
All fungicides	**958.2**	**0.1**	**956.33**	**454.9**

'+' = <0.05 kg '*' includes hardy nursery stock

TABLE 21 Non-edible crops

Quantities (kg) of herbicides

Herbicides	***Bedding & pot plants****	***Flowers for cutting***	***Total weight***	***1999***
Chlorpropham		0.1	**0.1**	
Diquat		0.5	**0.5**	+
Glufosinate-ammonium	0.1		**0.1**	
Glyphosate	3.1	0.2	**3.3**	16.8
Isoxaben	1.7		**1.7**	0.1
Metazachlor	2.3		**2.3**	
Oxadiazon	18.3		**18.3**	0.6
Paraquat	4.0	0.5	**4.6**	5.5
Propaquizafop	+		+	
Propyzamide	2.5		**2.5**	
Simazine	1.1		**1.1**	0.5
All herbicides	**33.1**	**1.4**	**34.5**	**24.6**
Growth regulators				
Chlormequat	22.2		**22.2**	2.8
2-chloroethylphosphonic acid	0.2		**0.2**	
Daminozide	3.8		**3.8**	3.1
4-indol-3-ylbutyric acid	0.1		**0.1**	+
1-naphthylacetic acid	+		+	+
Paclobutrazol	+		+	+
All growth regulators	**26.2**		**26.2**	**5.8**

'+' = <0.05 kg '*' includes hardy nursery stock

TABLE 22 Edible crops

Area (total pesticide treated area, m^2 x 1,000) treated with the 15 most used active ingredients on all crops

	Active ingredient	*Type*	*2003*	*1999*
1	Iprodione	F	**1,206**	2
2	Bupirimate	F	**1,201**	10
3	Pyrimethanil	F	**970**	141
4	Myclobutanil	F	**957**	
5	Fenhexamid	F	**937**	
6	Paraquat	H	**750**	
7	Bromacil	H	**746**	
8	Tebufenpyrad	I	**597**	
9	Tolylfluanid	F	**536**	
10	Pirimicarb	I	**491**	42
11	Chlorothalonil	F	**376**	1
12	Spinosad	I	**364**	
13	Thiram	F	**360**	
14	Glyphosate	H	**295**	19
15	Bifenthrin	I	**288**	

TABLE 23 Edible crops

Quantity (kg) of the 15 most used active ingredients on all crops

	Active ingredient	*Type*	*2003*	*1999*
1	Pyrimethanil	F	**97**	10
2	Fenhexamid	F	**91**	
3	Tolylfluanid	F	**86**	
4	Dazomet	SS	**84**	
5	Iprodione	F	**81**	+
6	Bupirimate	F	**53**	+
7	Chlorothalonil	F	**46**	+
8	Thiram	F	**45**	
9	Bromacil	H	**34**	
10	Fosetyl-aluminium	F	**26**	14
11	Paraquat	H	**18**	
12	Pirimicarb	I	**17**	1
13	Tebufenpyrad	I	**16**	
14	Glyphosate	H	**15**	3
15	Myclobutanil	F	**8**	

For tables 22 and 23 the pesticide type is shown (F: Fungicide, H: Herbicide, I: Insecticide, SS: Soil Sterilant)

TABLE 24 Non-edible crops

Area (total pesticide treated area, m^2 x 1,000) treated with the 15 most used active ingredients on all crops

	Active ingredient	*Type*	*2003*	*1999*
1	Chlorothalonil	F	**327**	93
2	Deltamethrin	I	**264**	26
3	Iprodione	F	**258**	153
4	Daminozide	G	**158**	7
5	Propamocarb hydrochloride	F	**130**	48
6	Fosetyl-aluminium	F	**125**	9
7	Metalaxyl	F	**124**	43
8	Hypoaspis miles	B	**124**	
9	Chlormequat	G	**123**	10
10	Paraquat	H	**116**	72
11	Etridiazole	F	**103**	
12	Methiocarb	M	**94**	43
13	Bifenthrin	I	**88**	12
14	Myclobutanil	F	**84**	13
15	Isoxaben	H	**84**	2

TABLE 25 Non-edible crops

Quantity (kg) of the 15 most used active ingredients on all crops

	Active ingredient	*Type*	*2003*	*1999*
1	Etridiazole	F	**633**	
2	Propamocarb hydrochloride	F	**260**	298
3	Chlorpyrifos	I	**145**	68
4	Chlorothalonil	F	**35**	12
5	Chlormequat	G	**22**	3
6	Oxadiazon	H	**18**	1
7	Iprodione	F	**15**	14
8	Imidacloprid	I	**9**	1
9	Metaldehyde	M	**8**	21
10	Methiocarb	M	**6**	3
11	Carbosulfan	I	**5**	
12	Paraquat	H	**5**	5
13	Fosetyl-aluminium	F	**4**	3
14	Daminozide	G	**4**	3
15	Glyphosate	H	**3**	17

For tables 24 and 25 the pesticide type is shown (F: Fungicide, H: Herbicide, I: Insecticide, G: Growth regulator, M: Molluscicide)

TABLE 26 Edible crops

Comparison of pesticide usage 1995 – 2003, total pesticide treated area (m^2) of active ingredients and quantities used (kg)

	1995		1999		2003	
	Treated area of ai's (m^2)	***Kg***	***Treated area of ai's (m^2)***	***Kg***	***Treated area of ai's (m^2)***	***Kg***
Insecticides						
Pyrethroids	32,465	0.1	38,687	0.5	295,817	1.6
Carbamates	23,902	0.2	42,020	0.8	490,778	17.4
Organophosphates	36,405	28.8	114,274	124.0		
Organochlorines	30,136	2.5	11,697	1.3		
Other	257,685	9.3	150,885	2.5	1,142,323	20.7
All insecticides	380,593	40.9	357,563	129.1	1,928,919	39.7
Biological agents	496,847		260,175		228,618	
Molluscicides	37,087	1.2	48,565	2.6	34,900	2.1
Fungicides	472,808	125.4	702,062	185.6	7,049,257	542.2
Herbicides	48,331	6.7	21,386	2.9	2,189,032	82.6
Soil sterilants	3,473	136.2			1,560	84.1
Area planted (m^2)	161,863		141,020		359,755	

TABLE 27 Non-edible crops

Comparison of pesticide usage 1995 – 2003, total pesticide treated area (m^2) of active ingredients and quantities used (kg)

	1995		1999		2003	
	Treated area of ai's (m^2)	***Kg***	***Treated area of ai's (m^2)***	***Kg***	***Treated area of ai's (m^2)***	***Kg***
Insecticides						
Pyrethroids	443,816	0.9	168,582	0.6	492,067	3.9
Organophosphates	329,935	49.4	93,247	75.4	84,139	144.7
Organochlorines	33,467	1.6	5,712	1.3		
Carbamates	204,715	5.0	81,229	1.5	78,707	6.1
Other	190,706	38.1	148,643	32.3	140,575	9.9
All insecticides	1,202,639	95.0	497,413	111.0	795,488	164.6
Biological agents	339,658		11,088		124,086	
Molluscicides	199,250	4.2	342,172	24.0	146,253	13.6
Fungicides	1,650,434	1,917.5	1,016,509	454.9	1,398,644	956.33
Herbicides	129,814	56.7	165,874	24.6	373,534	34.5
Growth regulators	147,323	14.9	41,337	5.8	400,590	26.2
Soil sterilants			11,751	652.3		
Area planted (m^2)	565,644		980,030		666,212	

TABLE 28 Sampled areas

Areas (m^2) of protected crop holdings in sample

Northern Scotland	*Angus & E Fife*	*Central Lowlands*	*Southern Scotland*	*Total*
23,659	**180,912**	**47,764**	**38,874**	**291,209**

Size groups have not been published in order to prevent disclosure of fewer than 5 holdings

TABLE 29 Census areas

Areas (m^2) of protected crop holdings in Census

Northern Scotland	*Angus & E Fife*	*Central Lowlands*	*Southern Scotland*	*Total*
128,977	**310,947**	**237,372**	**102,944**	**780,240**

Size groups have not been published in order to prevent disclosure of fewer than 5 holdings

TABLE 30 Raising factors

Size (m2)	Northern Scotland	Angus & E Fife	Central Lowlands	Southern Scotland
1-1,999	16.22	140.71	20.82	15.69
2000 - 3,999	2.82		3.16	
4000 - 9,999	3.64		5.02	1.00
10,000 - 19,999			1.85	1.65
20,000 +		1.35		

TABLE 31 First and second adjustment factors

	Northern Scotland	Angus & E Fife	Central Lowlands	Southern Scotland	Adj 2
Tomatoes	1.07		1.02	9.84	1.00
Other fruit	5.30	0.97	0.27	0.05	1.03

PESTICIDE USAGE IN SCOTLAND

MUSHROOMS 2003

J P Snowden

Scottish Agricultural Science Agency

East Craigs, Edinburgh EH12 8NJ

E-mail: jeremy.snowden@sasa.gsi.gov.uk
Web: http:/www.sasa.gov.uk

Scottish Agricultural Science Agency

Scottish Executive Environment & Rural Affairs Department, East Craigs, Edinburgh EH12 8NJ
Telephone : 0131 244 8862

INTRODUCTION

This is the sixth survey of pesticide usage on mushrooms in Scotland. Previous surveys were carried out in 1976[1], 1981[2], 1991[3], 1995[4] and 1999[5].

In line with recent publications, tables containing reasons for the use of pesticides are no longer published, as only a proportion of reasons were specified by users. Where appropriate, reasons for use are provided in the text.

DEFINITIONS AND NOTES

The term 'pesticide' includes commercial formulations containing active substances of insecticides, acaricides, molluscicides, fungicides, herbicides, soil sterilants, and growth regulators.

In this report the term 'formulation' refers to one or more active ingredients included in a product or group of products.

Active ingredient (ai) refers to an individual chemical which is active against a pest, disease or weed etc.

'Treated area' is the area of a crop treated with a given pesticide multiplied by the number of treatments the area received. For example 100 m^2 of mushrooms which have been treated with a given pesticide once, twice or three times, would have a total treated area of 100, 200, or 300 m^2 respectively. Where biological agents were employed, 'total pesticide treated area' includes the re-introduction of insect or mite predators.

'Basic area' is the area of a crop which was treated with a given pesticide, irrespective of the number of times it was applied to that area. In the example given in the definition 4 above, the basic area would be 100 m^2 in all 3 cases. The basic area is used to calculate the percentage of crop treated with an individual formulation or a group of pesticides.

The reason for use reported in the text is the grower's stated reason for use of that particular pesticide on that crop and may not always correspond to the approved use of the pesticide.

The areas of crops grown include successional sowings so that the total areas of crops grown can be larger than the total area of mushroom houses.

Data from the 1999 survey are provided for comparison purposes in some of the tables, although it should be borne in mind that there will be changes in the area of mushrooms grown.

METHOD

Mushrooms are not included in the Agricultural Census, and in consultation with the Horticulture and Marketing Unit of SEERAD, all the known commercial mushroom growers in Scotland were identified. In all, 11 mushroom growers were visited.

PESTICIDE USAGE

The total production area of mushrooms in 2003 declined by 33%, from 422,066 m^2 in 1999 to 281,166 m^2 in 2003.

Insecticides and biological agents (Table 32)

There has been a further decline in insecticide usage, and in 2003 insecticides were applied to only 20% of the crop area, compared with 33% in the previous survey. Fly control was the only reason given for insecticide use.

The most popular insecticide in 2003, bendiocarb, which was applied to 15% of the crop area, had not been encountered in the previous survey. In 1999, diflubenzuron had been the principal insecticide, but was applied to only 14,790 m^2, 5% of the crop area in 2003. Methoprene, which had been widely used in previous surveys, is no longer available.

The biological agent, *Steinernema feltiae*, was applied to 47% of the crop area, compared with only 19% in 1999.

Fungicides and disinfectants (Table 32)

Nearly all, 95% of the production area was treated with fungicides, compared with the entire crop in 1999. Prochloraz remained the most commonly used fungicide, and in 2003 was applied to 92% of the crop area.

Although not specifically listed in the tables, sodium chloride was used to prevent spread of diseases. In all, over 21 tonnes were used for this purpose.

As in the previous survey, the entire production area received a disinfectant. Formaldehyde remained the most popular disinfectant, although the proportion of the crop area treated fell from 85% in 1999 to only 31% in the present survey.

COMPARISONS WITH PREVIOUS SURVEYS

Although the number of growers has remained the same as in the previous survey, the total production area declined by 33% to 281,166 m^2.

Comparisons in the usage of pesticides in terms of treated area of active ingredients and their weight applied between the current and previous surveys are presented in Table 34.

When measured by the total area of insecticide active ingredients, insecticide usage declined from over 155,000 m^2 in 1999 to around 65,400 m^2 in 2003, but the weights applied fell to only 5% of those recorded in 1999. This discrepancy is due mainly to to the reduction in usage of diflubenzuron which is applied at relatively high dosage rates. In 2003, the carbamate bendiocarb replaced diflubenzuron as the main insecticide used by mushroom growers.

The total area of mushrooms treated with fungicide active ingredients fell by 30%, but when the drop in crop area is taken into account, usage was roughly similar in both surveys. Total weights applied declined by 15% compared with the previous survey. Prochloraz remained the most commonly used fungicide.

Disinfectants were again used widely, although the area treated with formaldehyde fell to less than one quarter of that recorded in the previous survey.

REFERENCES

1. Umpleby, R. A., Sly J. M. A. and Cutler, J. R. Pesticide usage survey report 13, Glasshouse Crops 1976; MAFF, DAFS 1980.

2. Brodie, J. and Wood, J. Pesticide usage survey report 42, Glasshouse Crops 1981; DAFS, Edinburgh 1984.

3. Snowden, J. P. and Thomas, L. A. Pesticide usage survey reports 96 and 97, Protected Crops (edible and non-edible) 1991 and Mushrooms 1991; SOAFD, Edinburgh, 1992.

4. Thomas, L. A. Pesticide usage survey report, Protected Crops 1995; SOAEFD, Edinburgh 1997.

5. Snowden, J. P. Pesticide usage survey report, Mushrooms 1999; SEERAD, Edinburgh 2001.

ACKNOWLEDGEMENTS

The author wishes to thank all the mushroom growers who provided the information for this report and the Horticulture and Marketing Unit of SEERAD for help with the current list of mushroom growers in Scotland. Thanks are also given to Mr LA Thomas who collected some of the data and to Dr C J Griffiths for providing editorial assistance. In addition, the author is particularly grateful for support from Mr D Garthwaite and colleagues at Central Science Laboratory, York, and to Information Technology Section, SASA.

TABLE 32 Mushroom pesticide formulations

Area treated (m^2) and percentage of crop treated

Insecticides	***(m^2)***	***%***	***1999***
Bendiocarb	42,214	15	
Diflubenzuron	14,790	5	72,096
Permethrin/tetramethrin	4,816	2	5,100
Pyrethrins/resmethrin	3,555	1	
All insecticides	**65,375**	**20**	**155,078**
Biological control agents			
Steinernema feltiae	133,355	47	81,694
All biological control agents	**133,355**	**47**	**81,694**
Fungicides			
Carbendazim	8,290	3	9,152
Prochloraz	512,487	92	732,074
All fungicides	**520,777**	**95**	**741,226**
Disinfectants			
Formaldehyde	86,025	31	365,584
Sodium hypochlorite	69,050	25	138,892
Unspecified disinfectants	649,504	100	720,122
All disinfectants	**804,579**	**100**	**1,224,598**
Area of crop	281,166		

TABLE 33 Mushroom pesticide active ingredients

Area treated (m^2) and percentage of crop treated

Insecticides	***(m^2)***	***%***	***Kg***	***Kg 1999***
Pyrethroids				
Permethrin	4,816	2	0.1	6.8
Pyrethrins	3,555	1	+	
Resmethrin	3,555	1	0.1	
Tetramethrin	4,816	2	+	+
All pyrethroids	**16,742**		**0.3**	
Carbamates				
Bendiocarb	42,214	15	2.2	
All carbamates	**42,214**	**15**	**2.2**	
Others				
Diflubenzuron	14,790	5	2.4	63.8
All others	**14,790**	**5**	**2.4**	
All insecticides	**73,746**	**20**	**4.8**	**90.9**
Biological control agents				
Steinernema feltiae	133,355	47		
All biological control agents	**133,355**	**47**		
Fungicides				
Carbendazim	8,290	3	4.5	5.2
Prochloraz	512,487	92	280.2	330.2
All fungicides	**520,777**	**95**	**284.7**	**335.4**
Disinfectants				
Formaldehyde	86,025	31	364.5	935.1
Sodium hypochlorite	69,050	25		
Unspecified disinfectants	649,504	100		
All disinfectants	**804,579**	**100**		
Area of crop	281,166			

'+' = <0.05 kg

TABLE 34 Mushrooms

Comparison of pesticide usage 1995 – 2003, total pesticide treated area (m^2) of active ingredients and quantities used (kg)

	1995		1999		2003	
	Treated area of ai's (m^2)	***Kg***	***Treated area of ai's (m^2)***	***Kg***	***Treated area of ai's (m^2)***	***Kg***
Insecticides						
Pyrethroids	122,240	4.2	17,060	6.8	16,742	0.3
Carbamates					42,214	2.2
Organophosphates	61,328	56.1	980	0.6		
Organochlorines	3,300	1.1	4,576	0.4		
Other	129,834	67.4	137,562	83.1	14,790	2.4
All insecticides	316,702	128.8	160,178	90.9	73,746	4.8
Biological agents			81,694		133,355	
Fungicides	418,792	227.5	741,226	335.4	520,777	284.7
Disinfectants	308,170	327.8	1,729,074	34.3		
Area grown (m^2)	191,584		432,266		281,166	