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Pesticide Usage in Scotland

A National Statistics Publication for Scotland

Arable crops and Potato stores 2016

Pesticide Usage in Scotland

Arable Crops 2016

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Executive summary

This report presents information from a survey of pesticide use on arable crops grown in Scotland. The survey period covers the 2016 growing season, from post-harvest pesticide applications in 2015 through to harvest in 2016. The crop groups surveyed included cereals, oilseeds, potatoes and legumes.

The estimated area of arable crops grown in Scotland in 2016 was ca. 494,167**.** Spring barley accounted for 49 per cent of the arable crop area, wheat 22 per cent, winter barley ten per cent, winter oilseed rape six per cent and spring oats five per cent. Potatoes, legumes and winter oats together accounted for the remaining eight per cent. Data were collected from a total of 288 holdings, representing seven per cent of the total arable crop area grown in Scotland. Ratio raising was used to produce estimates of national pesticide use from the sampled data.

The estimated total area of arable crops treated with a pesticide formulation was ca. 4,851,771 ha (± three per cent Relative Standard Error, RSE) with a combined weight of ca. 1,490 tonnes (± four per cent RSE). Overall, pesticides were applied to 98 per cent of the arable crop area. Herbicides were applied to 96 per cent of the crop area, fungicides to 94 per cent, growth regulators to 46 per cent, insecticides to 23 per cent and molluscicides to eight per cent. Ninety one per cent of seed was treated with a pesticide.

When the pesticide application data are corrected for the area of crop grown, there is little difference in area treated in 2012, 2014 and 2016. Although, the weight of pesticides applied increased slightly from 2014 to 2016 and 2012 to 2016. There was little change in the area treated by fungicides and growth regulators from 2014 to 2016. The application of herbicides, sulphur and molluscicides increased (5, 12 and 36 per cent respectively), whilst the application of insecticides decreased (27 per cent).

In terms of area treated, the most used foliar fungicide active substance was prothioconazole. Glyphosate and mecoprop-P were the most used herbicides and lambda-cyhalothrin was the most used insecticide active substance. Prochloraz was the most used seed treatment active substance. The herbicides halauxifen-methyl, metobromuron and pyraflufen-ethyl were recorded for the first time in 2016.

Data collected from growers about their Integrated Pest Management (IPM) activities showed that growers were using a variety of IPM methods in relation to risk management and the monitoring and control of insect pests, weeds and diseases.

Introduction

The Scottish Government (SG) is required by legislation[1][2] to carry out post-approval surveillance of pesticide use. This is conducted by the Pesticide Survey Unit at Science and Advice for Scottish Agriculture (SASA), a division of the Scottish Government's Agriculture and Rural Economy Directorate.

This survey is part of a series of annual reports which are produced to detail pesticide usage in Scotland for arable, vegetable, soft fruit and protected edible crops on a biennial basis and for fodder and forage crops every four years. The Scottish survey data are incorporated with England, Wales and Northern Ireland data to provide estimates of annual UK-wide pesticide use. Information on all aspects of pesticide usage in the United Kingdom as a whole may be obtained from the Pesticide Usage Survey Team at Fera Science Ltd, Sand Hutton, York. Also available at:

https://secure.fera.defra.gov.uk/pusstats/surveys/index.cfm

The Scottish Pesticide Usage reports have been designated as Official Statistics since August 2012 and as National Statistics since October 2014. The Chief Statistician (Roger Halliday) acts as the statistics Head of Profession for the Scottish Government and has overall responsibility for the quality, format, content and timing of all Scottish Government national statistics publications, including the pesticide usage reports. As well as working closely with Scottish Government statisticians, SASA receive survey specific statistical support from Biomathematics and Statistics Scotland (BioSS).

All reports are produced according to a published timetable. For further information in relation to Pesticide Survey Unit publications and their compliance with the code of practice please refer to the pesticide usage survey section of the SASA website. The website also contains other useful documentation such as confidentiality and revision policies, user feedback and detailed background information on survey methodology.

Additional information regarding pesticide use can be supplied by the Pesticide Survey unit. Please email psu@sasa.gsi.gov.uk or visit the survey unit webpage:

http://www.sasa.gov.uk/pesticides/pesticide-usage

Structure of report and how to use these statistics

This report is intended to provide data in a useful format to a wide variety of data users. The general trends section provides commentary of recent changes in survey data and longer term trends. The 2016 pesticide usage section summarises the pesticide usage on all arable crops in 2016. Appendix 1 presents all estimated pesticide usage in three formats (area of formulations and area and quantity of active substances). These different measures are provided to satisfy the needs of different data users (see Appendix 3 for examples). Appendix 2 summarises survey statistics including census and holding information, raising factors and survey response rates. Appendix 3 defines many of the terms used throughout the report. Appendix 4 describes the methods used during sampling, data collection and analysis as well as measures undertaken to avoid bias and reduce uncertainty. Any changes in method from previous survey years are also explained.

It is important to note that the figures presented in this report are produced from surveying a sample of holdings rather than a census of all the holdings in Scotland. Therefore the figures are estimates of the total pesticide use for Scotland and should not be interpreted as exact. To give an idea of the precision of estimates, the report includes relative standard errors. A full explanation of standard errors can be found in Appendix 5. Appendix 6 outlines the results of an additional survey which was conducted to collect details of the growers' Integrated Pest Management (IPM) activities (i.e. risk management, pest monitoring and non-chemical methods of control).

Data uses

The data presented here are used for a number of purposes including:

- Informing UK and Scottish Government Policy about the post-approval use of pesticides
- Aiding Government officials in their response to Scottish Parliamentary and Ministerial questions regarding the use of pesticides
- To inform and complement research projects conducted by agricultural research institutions
- To inform and prioritise monitoring strategies of environmental quality bodies
- To provide data to the pesticide industry to allow insight into the use patterns of pesticide products
- To provide information to interested or concerned environmental and wildlife groups and members of the public
- To provide an educational resource for teaching and student research projects

Case studies of how the Scottish dataset has been used are provided on the SASA webpage.

General trends

Crop area

The estimated area of arable crops grown in 2016 was 494,167 hectares (Table 40). This represents a seven per cent decrease from 2014[3] to 2016 and a six per cent decrease from 2012[4] to 2016. Since the last survey, areas of spring oats, combine peas and field beans increased (36, 26 and 9 per cent respectively); while winter oilseed rape, spring barley, winter barley and seed potatoes have decreased (17, 13, 9 and 4 per cent respectively; Table 44, Figures 1 and 2).

In 2016, spring barley accounted for 49 per cent of the arable crop area, wheat 22 per cent, winter barley ten per cent, winter oilseed rape six per cent and spring oats five per cent. The remainder is comprised of potatoes, winter oats and legumes (Figure 3). The largest area of arable crops was in the Aberdeen region, followed by Angus, the Tweed Valley and the Central Lowlands (Figure 4).

Figure 1 Area of cereal crops grown in Scotland 2012-2016

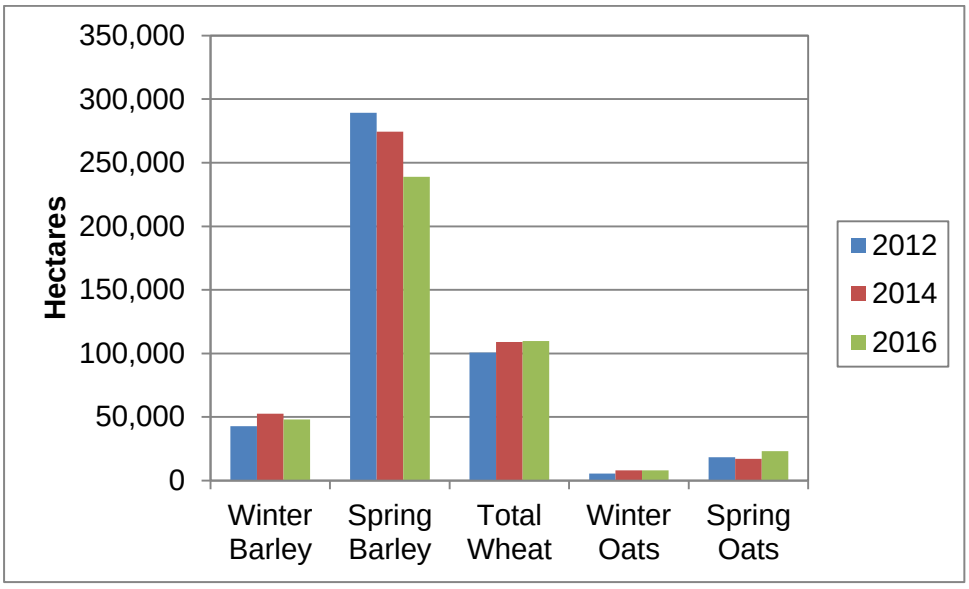
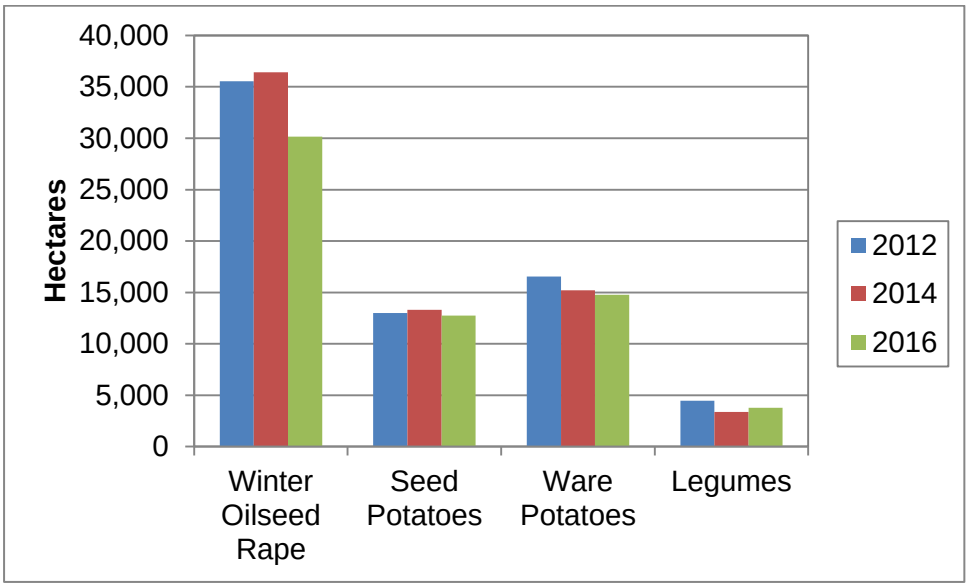


Figure 2 Area of winter oilseed rape, potatoes and legumes grown in Scotland 2012-2016



Note: legumes include field beans and combine peas

Figure 3 Arable crop areas 2016 (percentage of total area)

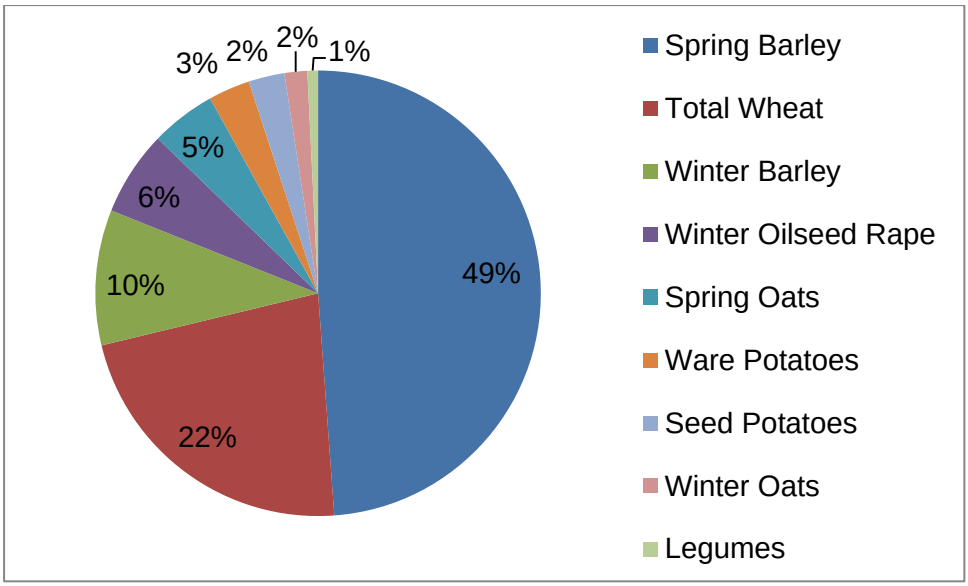
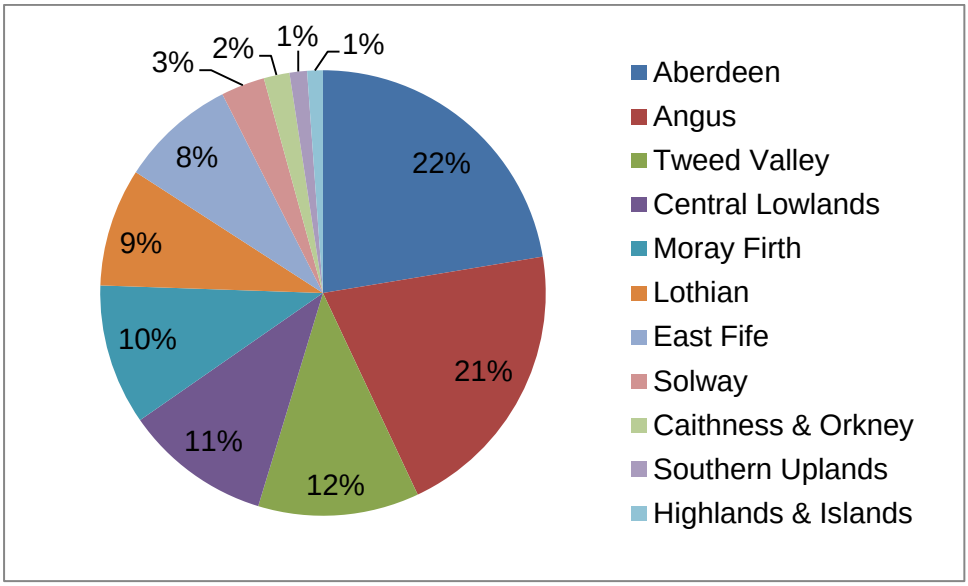


Figure 4 Regional distribution of arable crops in Scotland 2016



Pesticide usage

The majority of arable crops (98 per cent) received a pesticide treatment in 2016. Seed potatoes, winter oilseed rape, winter wheat, winter barley, spring barley and ware potatoes had the highest overall proportion of crop treated with pesticides (≥ 98 per cent, Figures 11 & 12, Table 1). Winter oats, spring wheat, legumes and spring oats had lower proportions of treated crop area (94, 93, 89 and 87 per cent respectively). In terms of the number of applications of pesticides, the treated area of arable crops received on average 4.2 sprays (excluding seed treatments). It should be noted this only applies to the treated proportion of the crop (97 per cent). Ware potatoes received the highest number of applications with an average of 13.5 sprays. In contrast, spring wheat received 2.1 sprays on average (Table 1).

It is estimated that the area of arable crops treated with a pesticide formulation in 2016 was ca. 4,851,771 hectares compared with ca. 5,247,614 hectares in 2014 and ca. 5,085,653 hectares in 2012 (Table 40). This represents a decrease of eight per cent since 2014 and five per cent since 2012. In terms of weight of pesticide applied, 1,490 tonnes was applied in 2016, representing a decrease of one per cent from 2014 and an increase of four per cent from 2012 (Table 40).

In order to make accurate comparisons between the 2016 data and the data collected in previous surveys, it is important to take into account the differences in crop area between the years. Therefore, the number of treated hectares per hectare of crop grown and the total weight of pesticide used per hectare of crop grown were calculated. Once crop area is taken into account, there is little difference in area of total pesticides applied between the surveys. There was no change from 2014 to 2016 and an increase of two per cent from 2012 to 2016 in terms of the total pesticide treated area per area of crop grown (Figure 7). In terms of quantity of pesticides used per hectare of crop

grown, there was an increase of six per cent from 2014 to 2016 and an increase of 11 per cent from 2012 to 2016 (Figure 10).

Fungicides were the most frequently used pesticides on arable crops, followed by herbicides (Figure 6). This pattern was also observed in 2014 and 2012. In 2016, fungicides accounted for 46 per cent of the total pesticide treated area and 44 per cent of the total weight of active substances applied (Figures 5 & 8). When changes in crop area are taken into account, there was a one per cent decrease in area treated with fungicides from 2014 to 2016 and no difference in area treated from 2012 to 2016 (Figure 7). The weight of fungicides applied per hectare increased by eight per cent from 2014 to 2016 and by 16 per cent from 2012 to 2016 (Figure 10). The increase in weight applied, may partly be due to the increased use of chlorothalonil, which is applied at high dose rates.

In 2016, herbicides (including desiccants) accounted for 29 per cent of the total pesticide treated area and 36 per cent of the total weight of active substances applied (Figures 5 & 8). When changes in crop area are taken into account, there was a five per cent increase in the area treated with herbicides from 2014 to 2016 and from 2012 to 2016 and a four per cent increase in quantity of herbicides applied (Figures 7 & 10).

Insecticides accounted for ten per cent of the total pesticide treated area and one per cent of the total weight of active substances applied (Figures 5 & 8). In 2016, pyrethroids accounted for 86 per cent of the area treated with an insecticide (Table 34). When changes in crop area are taken into account, there was a 27 per cent decrease in area treated from 2014 to 2016 and a seven per cent decrease from 2012 to 2016 (Figure 7). The quantity of insecticides applied per hectare of crop grown was found to have decreased by 54 per cent from 2014 to 2016 and by 48 per cent from 2012 to 2016 (Figure 10). The previous survey in 2014 was a high pressure year with weather conditions leading to problems with aphid and leatherjacket populations and increased insecticide use [(3)]. . The withdrawal of the active substance chloropyrifos, used as a treatment for leatherjackets and wheat bulb fly on cereals may also have had an impact on the use of insecticides. The use of chloropyrifos has declined by 93 per cent since the previous survey. As chloropyrifos was applied at high rates, there are larger decreases in weight of insecticides applied than area.

Molluscicides accounted for nine per cent of the total pesticide treated area and one per cent of the total weight of active substances applied (Figures 5 & 8). When changes in crop area are taken into account, there was a 36 per cent increase in area treated from 2014 to 2016 and a 24 per cent decrease from 2012 to 2016 (Figure 7). The quantity of mollusicides applied per hectare of crop grown was found to have increased by 58 per cent from 2014 to 2016 but decreased by 18 per cent from 2012 to 2016 (Figure 10). The mild winter weather allowed slugs to survive into the spring of 2016, which may have resulted in an increase in the use of molluscicides[(5)] from the previous survey.

Growth regulators accounted for four per cent of the total pesticide treated area and 14 per cent of the total weight of active substances applied (Figures 5 & 8). When changes in crop area are taken into account, there was little change in area treated from 2014 to 2016 and an increase of 19 per cent from 2012 to 2016 (Figure 7). The quantity of growth regulators applied per hectare of crop grown increased by nine per cent from 2014 to 2016 and by 24 per cent from 2012 to 2016 (Figure 10).

Seed treatments accounted for two per cent of the total pesticide treated area and two per cent of the total weight of active substances applied (Figures 5 & 8). When changes in crop area are taken into account, there was a two per cent decrease in area treated between 2014 and 2016 and a four per cent decrease between 2012 and 2016 (Figure 7). The weight of seed treatments applied per hectare has increased by one per cent from 2014 and decreased by ten per cent since 2012 (Figure 10).

Sulphur accounted for less than one per cent of the total pesticide treated area and two per cent of the total weight of active substances applied (Figures 5 & 8). When changes in crop area are taken into account, there was a 12 per cent increase in area treated from 2014 to 2016 and a 78 per cent increase from 2012 to 2016 (Figure 7). The quantity of sulphur applied per hectare of crop grown increased by 66 per cent from 2014 to 2016 and 89 per cent from 2012 to 2016 (Figure 10). It should be noted some of the sulphur use may be for crop nutrition purposes. However, the increase may also have been influenced by use of sulphur as a fungicide on organic crops encountered in this survey.

Three active substances were recorded for the first time in the 2016 arable survey. These included the herbicide halauxifen-methyl, a new active substance developed for targeting broad-leaved weeds in cereal crops and the herbicides metobromuron and pyraflufen-ethyl (Table 39).

Whilst the overall use of pesticides in 2016 has shown minor changes from the previous survey, there has been major variation in the use of some individual active substances. For example, there were substantial increases in the use of the growth regulator chlormequat chloride (457 per cent by weight applied) on winter wheat, winter barley and spring barley since the previous survey (Table 38). Use of the molluscicide metaldehyde has increased by 96 per cent by area treated and 112 per cent by weight applied (Tables 37 & 38). This could be partly due to changes in authorisation for molluscicides. All products containing methiocarb were withdrawn from use on 19th September 2015, therefore the use of metaldehyde and ferric phosphate increased. The use of the seed treatment imazalil has increased by 110 per cent by area treated. The use of the herbicide picolinafen increased by 90 per cent by area treated, whilst the herbicide chlorotoluron decreased by 93 per cent by weight applied.

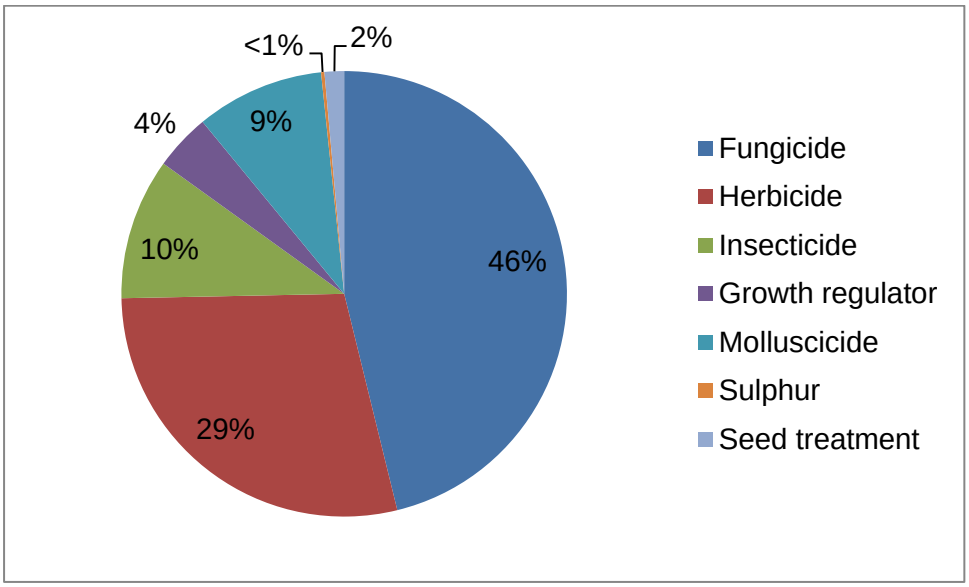
For the first time in this series of reports, insecticides, fungicides and herbicides have been classified into groups according to their mode of action (Tables 34-36).

Winter oilseed rape insecticide use

In December 2013, the European Commission amended the approval conditions for three neonicotinoid insecticides; clothianidin, imidacloprid and thiamethoxam due to concern that there was insufficient information to fully describe their risk to pollinators. In the UK, the main impact of these restrictions was the loss of insecticidal seed treatments for oilseed rape. In the absence of seed treatments, growers are reliant on foliar insecticides for insect control in the autumn crop establishment period. As the restrictions were imposed after the 2014 oilseed rape crops were drilled, 2016 is the first in this series of surveys to reflect crops grown without insecticidal seed treatments.

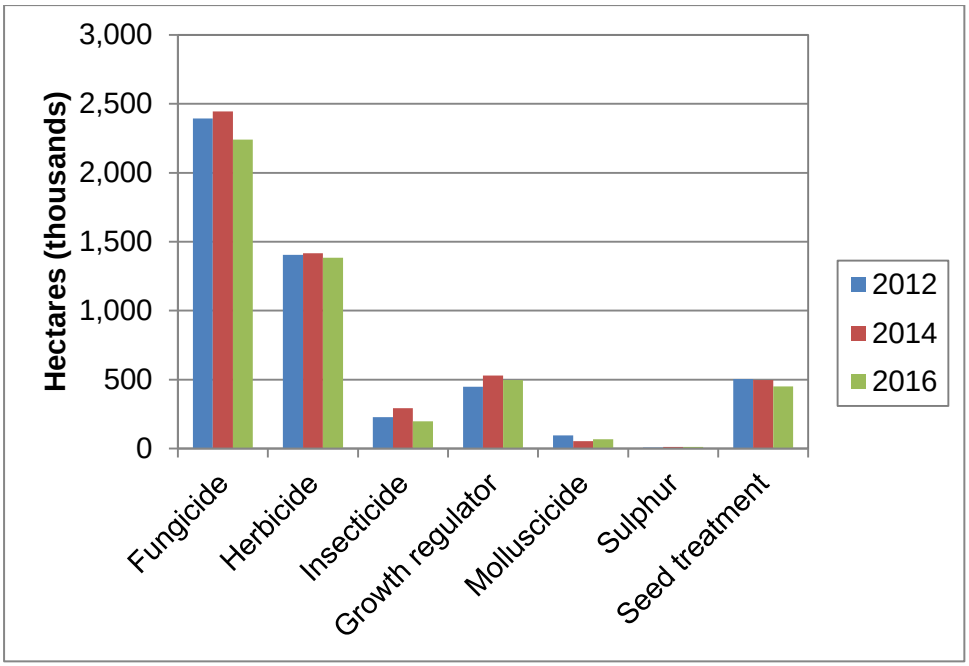
Overall insecticide use on winter oilseed rape was 9 per cent lower in this survey than in 2014 (43,782 ha and 805 kg in 2016 and 47,987 ha and 886 kg in 2014). However, there was a 17 per cent decrease in the area of winter oilseed rape grown between the two surveys (36,420 and 30,141 ha in 2014 and 2016 respectively). This decrease in crop area was influenced by late harvest in 2015 coupled with adverse weather conditions which made autumn drilling conditions difficult[6][7]. Taking crop area into account, there was a 10 per cent increase (in relation to both spray area and weight) in foliar insecticides applications to winter oilseed rape crops in 2016 in comparison with 2014. A more detailed analysis of the effect of the loss neonicotinoid seed treatments on Scottish crops can be found in the reports of two earlier surveys which focussed on the impact of the first two years of the restrictions on Scottish winter oilseed rape cultivation[7][8].

Figure 5 Use of pesticide on arable crops (percentage of total area treated with formulations) - 2016



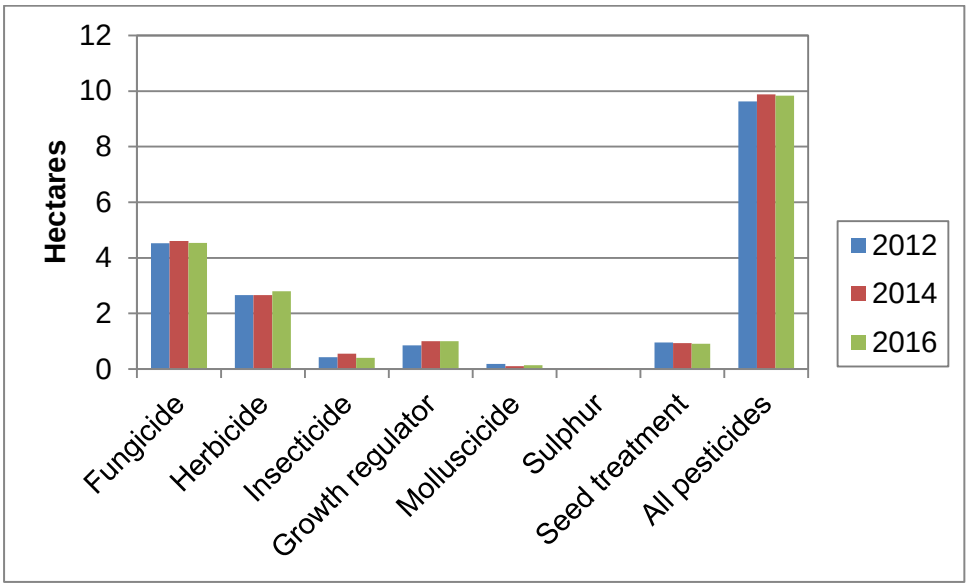
Note: insecticide includes nematicides

Figure 6 Area of arable crops treated with major pesticide groups in Scotland 2012-2016



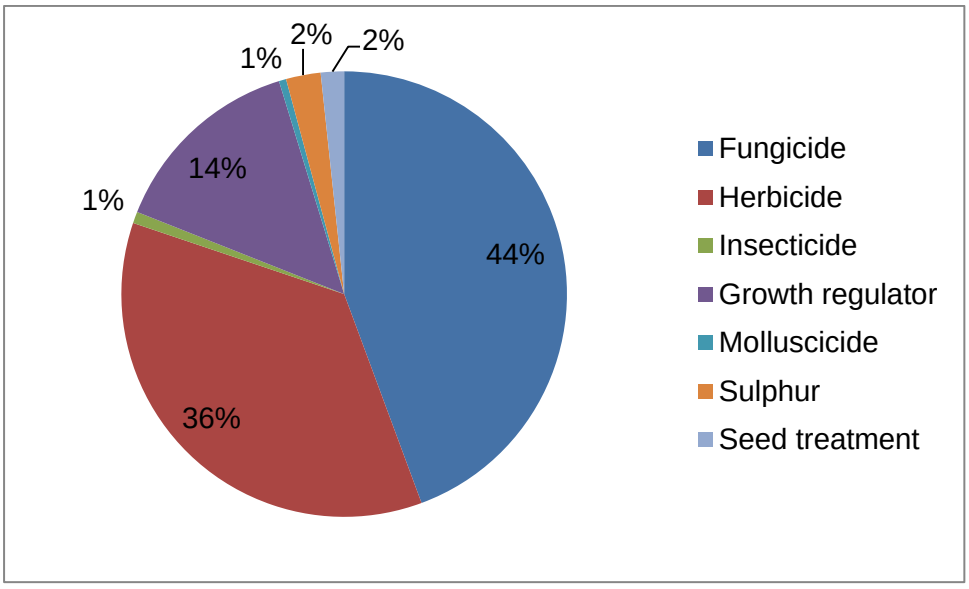
Note: insecticide includes nematicides

Figure 7 **Number of pesticide treated hectares (formulations) per hectare of crop grown in Scotland 2012-2016**



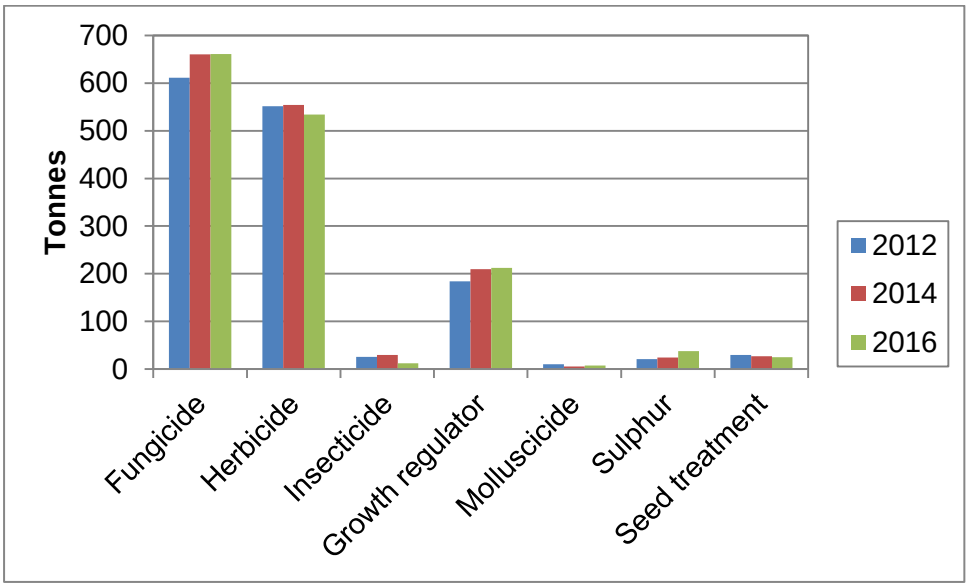
Note: insecticide includes nematicides

Figure 8 **Use of pesticides on arable crops (percentage of total quantity of active substances applied) - 2016**



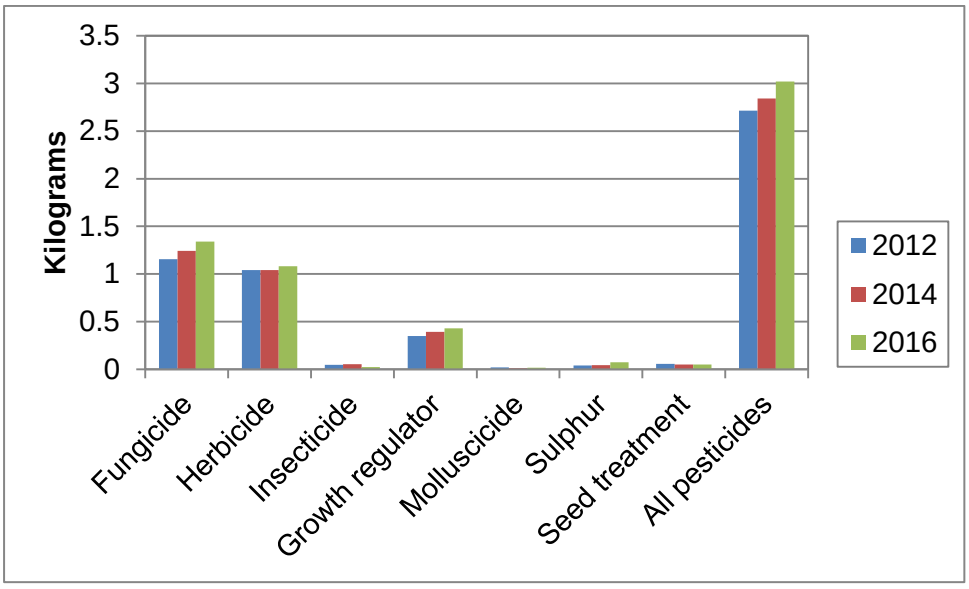
Note: insecticide includes nematicides

Figure 9 Quantity of the major pesticide groups applied to arable crops in Scotland 2012-2016



Note: insecticide includes nematicides

Figure 10 Weight of pesticide (kg) applied per hectare of crop grown in Scotland 2012-2016



Note: insecticide includes nematicides

Figure 11 Percentage of cereal crops treated with pesticides 2016

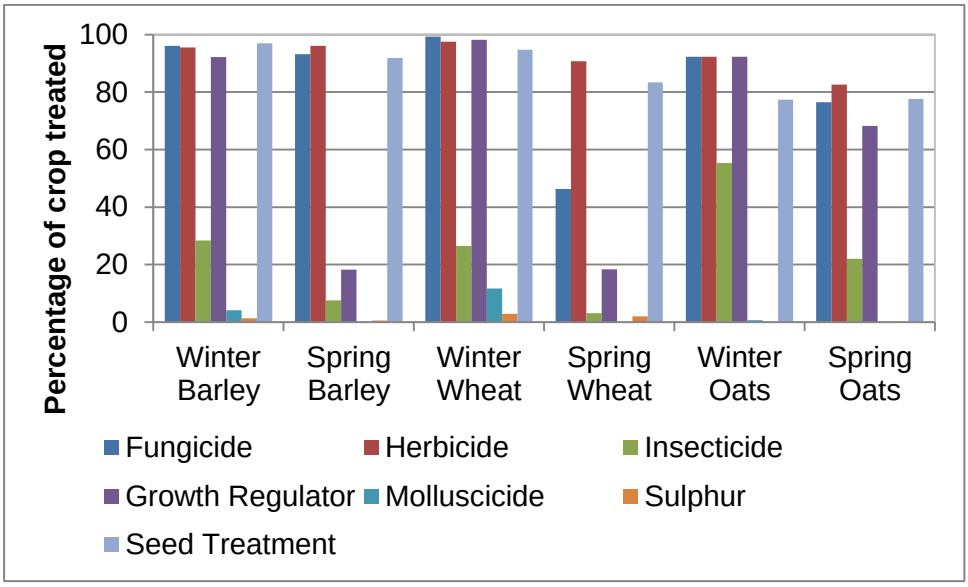
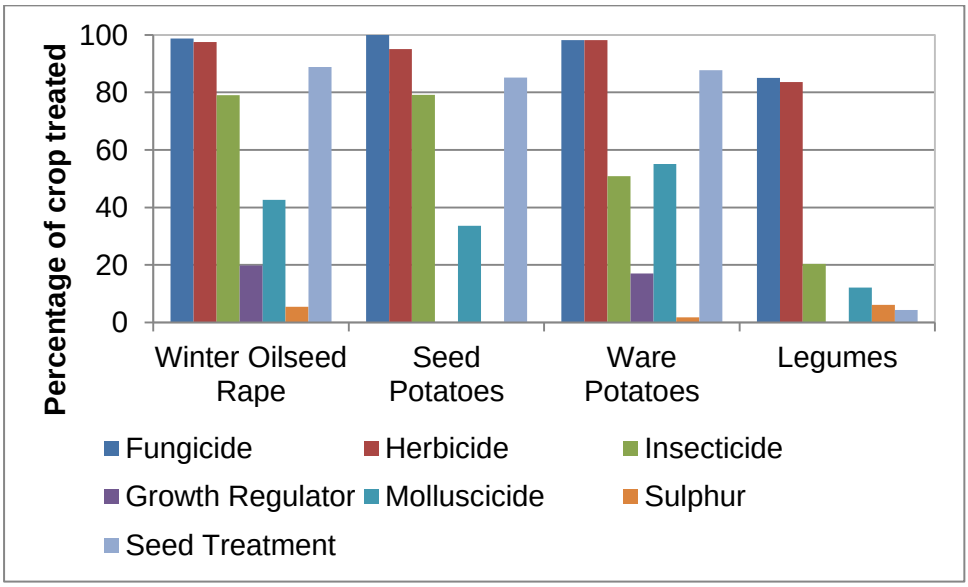
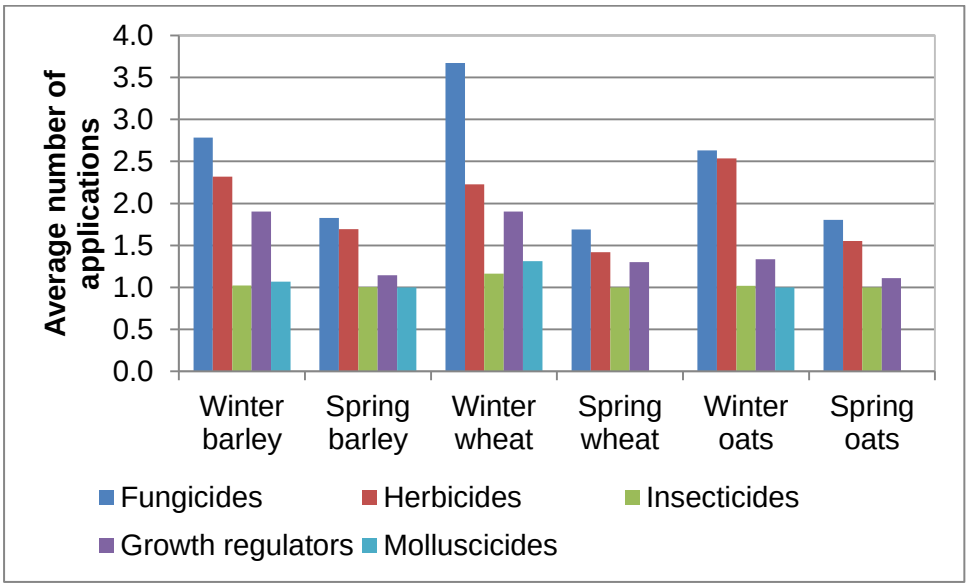


Figure 12 Percentage of winter oilseed rape, potatoes and legumes treated with pesticides 2016



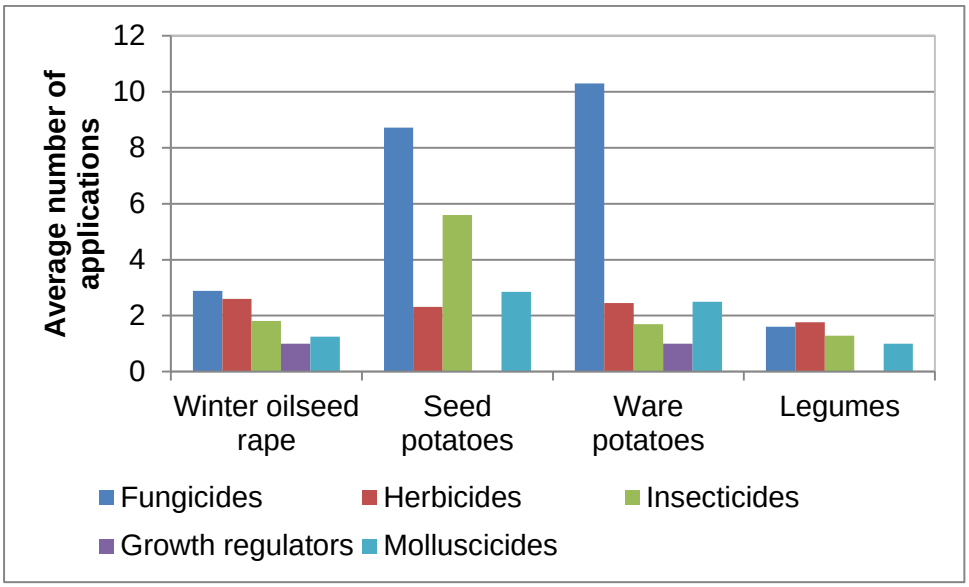
Note: legumes includes dry harvest peas and field beans. Insecticide includes nematicides

Figure 13 Average number of pesticide applications on treated area of cereal crops



Note: See Table 1 for percentage of crop treated

Figure 14 Average number of pesticide applications on treated area of winter oilseed rape, potato and legume crops



Note: See Table 1 for percentage of crop treated. Insecticide includes nematicides

Integrated pest management

For the first time in this series of surveys, additional data collection was conducted in relation to grower adoption of Integrated Pest Management (IPM) measures. This is a summary of the data; please refer to Appendix 6 for the full dataset. Growers were asked a series of questions about the IPM activities that they implemented for their arable crop production. Unlike the other statistics in this report, the figures relating to IPM are not raised (i.e. are not national estimates) but represent only the responses of those surveyed.

In total IPM data was collected from 113 farmers, representing 123 holdings and 52 per cent of the sampled arable crop area (four per cent of census area). Of these farmers, 76 per cent did not have an IPM plan, 15 per cent of farmers completed their own IPM plan and nine per cent had a plan completed by their agronomist (Figure 57). Despite the majority of farmers not completing an IPM plan, uptake of a wide range of IPM activities was encountered. Farmers were asked about their IPM activities in relation to three categories; risk management, pest monitoring and pest control.

A number of risk management measures were reported by the farmers surveyed (Table 52). The majority of farmers (88 per cent) used crop rotation to manage their risk of pest damage. Nearly all farmers (96 per cent) tested their soils in order to tailor inputs to improve crop performance. Ninety three per cent of farmers managed their seed bed production to reduce pest risk and just under half of farmers amended cultivation methods at sowing to try to increase crop success. Over ninety per cent of farmers surveyed considered risk management when selecting seeds and/or varieties. Nearly a third of respondents (27 per cent) sowed catch or cover crops as part of their crop production cycle and 88 per cent of farmers sampled adopted techniques to protect or enhance populations of beneficial insects.

A number of pest monitoring activities were also recorded (Table 53). Almost all farmers (99 per cent) reported that they regularly monitored crop growth stages and all farmers monitored and identified pests on their crops. Over two thirds of farmers (68 per cent) used action thresholds when monitoring pest populations. Fifty eight per cent of respondents also used specialist diagnostics when dealing with pests that were more problematic to identify or monitor.

The pest control measures reported by the growers surveyed are presented in Table 54. Over two thirds of farmers (68 per cent) used non-chemical control in partnership or instead of chemical control. Seventy three per cent of farmers targeted their pesticide applications using monitoring data and followed anti-resistance strategies. Finally, all respondents stated that they monitored the success of their crop protection measures.

2016 Pesticide usage

Winter barley

- An estimated 48,030 hectares of winter barley were grown in Scotland in 2016, a decrease of nine per cent since 2014
- 99 per cent of the crop was treated with a pesticide
- Pesticides were applied to 549,472 treated hectares
- 172,938 kilograms of pesticide were applied in total
- 42 per cent of pesticides applied were fungicides, 27 per cent herbicides, 20 per cent growth regulators, eight per cent seed treatments, three per cent insecticides and under one per cent molluscicides and sulphur (Figure 15)
- Winter barley received on average 4.7 pesticide sprays (Table 1). These sprays included 2.8 fungicide applications and 2.3 herbicide applications (applied to 96 per cent and 95 per cent of the crop area respectively), 1.9 applications of growth regulators (applied to 92 per cent) and one application of insecticides (applied to 28 per cent)
- In relation to timings of pesticide applications, 67 per cent of insecticide applications were in October, 51 per cent of growth regulator applications were in April and 44 per cent of fungicide applications were in May (Figure 16)
- Where reasons were given, 65 per cent of fungicide use was for disease control/precaution (Figure 17). Where the disease was specified *Rynchosporium* was the most commonly reported
- 35 per cent of herbicide use was for general weed control, 27 per cent for desiccation/harvest aid, 15 per cent for annual broad-leaved weeds and 12 per cent for annual meadow grass (Figure 18)
- 92 per cent of insecticide use was for aphids
- The most common varieties encountered were KWS Glacier and KWS Cassia, accounting for 19 and 16 per cent of the sample area respectively
- The average reported yield was 7.5 t/ha

Summary of pesticide use on winter barley:

Pesticide group	Formulation area treated (ha)	Weight of pesticides applied (kg)	% of crop area treated	Most used formulations (ha)
Fungicides	229,193	61,446	96	Chlorothalonil (40,181)
Herbicides	146,121	64,101	95	Glyphosate (32,374)
Insecticides	13,983	92	28	Lambda-cyhalothrin (9,398)
Growth regulators	110,227	43,001	92	Chlormequat (38,321)
Molluscicides	2,110	337	4	Metaldehyde (2,110)
Sulphur	1,275	2,550	1	N/A
Seed treatments	46,564	1,411	97	Prochloraz/triticonazole (19,533)

N/A = not applicable

Figure 15 Use of pesticides on winter barley (percentage of total area treated with formulations) - 2016

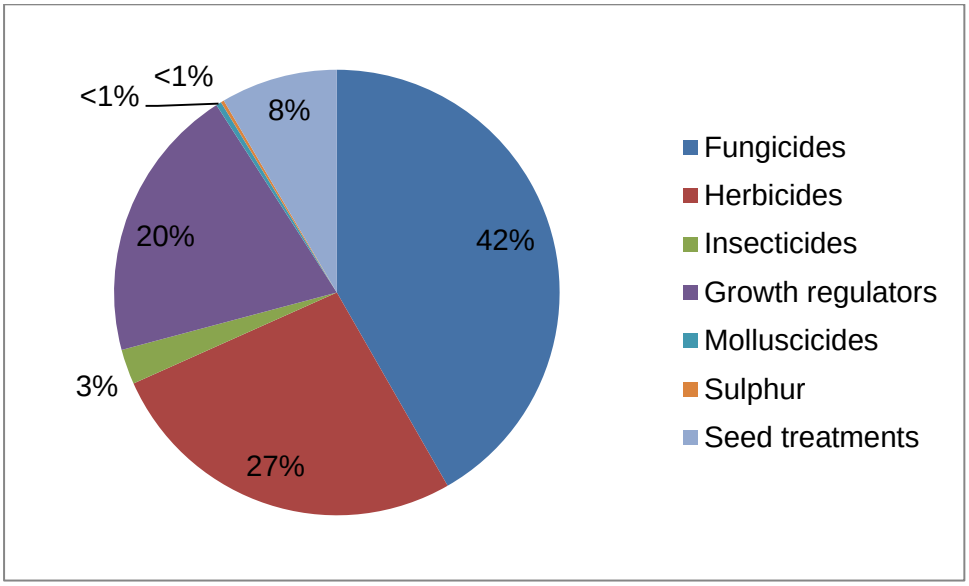


Figure 16 Timing of pesticide applications on winter barley - 2016

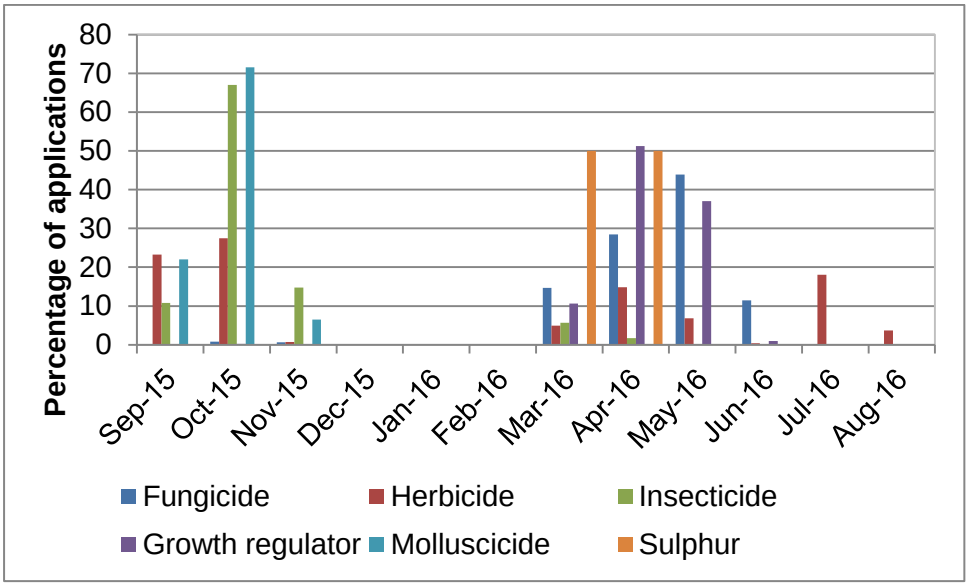


Figure 17 Reasons for use of fungicides on winter barley (where specified)

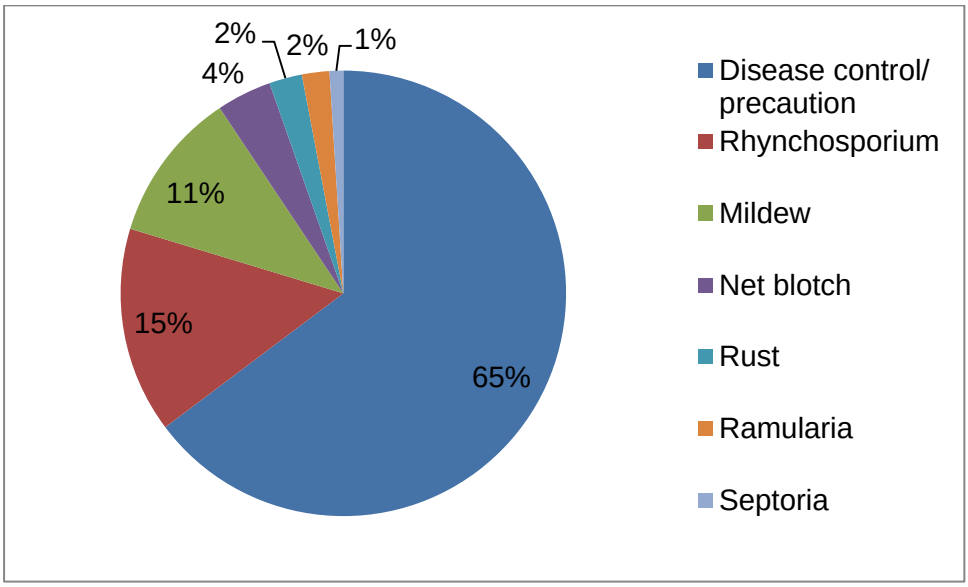
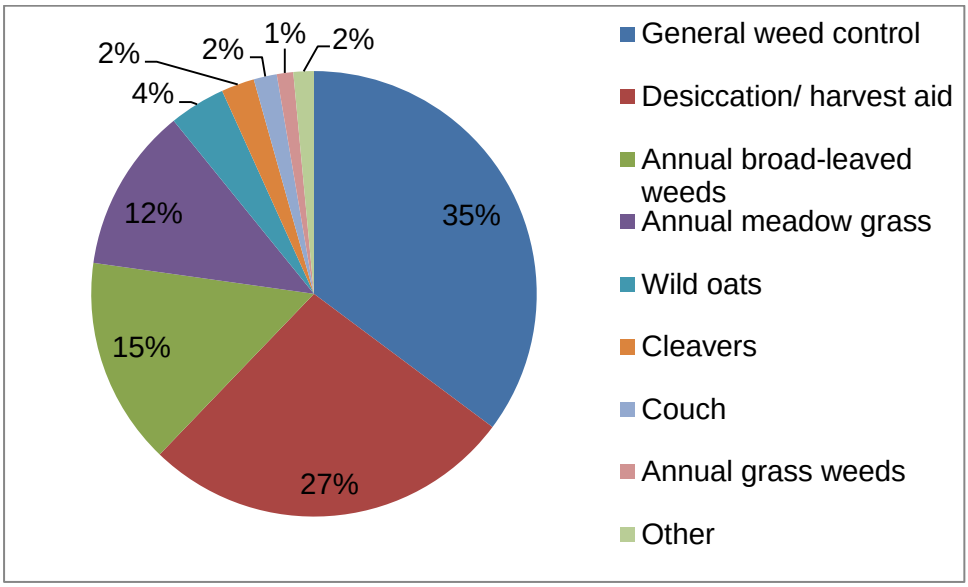


Figure 18 Reasons for use of herbicides on winter barley (where specified)



Note: 'Other' includes chickweed, brome and volunteer potatoes

Spring barley

- An estimated 238,901 hectares of spring barley were grown in Scotland in 2016, representing a decrease of 13 per cent since 2014
- 98 per cent of the crop was treated with a pesticide
- Pesticides were applied to 1,573,403 treated hectares
- 395,732 kilograms of pesticide were used in total on the crop
- 42 per cent of pesticides applied were fungicides, 40 per cent herbicides, 14 per cent seed treatments, three per cent growth regulators, one per cent insecticides and under one per cent molluscicides and sulphur (Figure 19)
- The spring barley crop received on average 2.6 pesticide applications (Table 1). These included 1.8 fungicide applications and 1.7 herbicide applications (applied to 93 per cent and 96 per cent of the crop area respectively and 1.1 applications of growth regulators (applied to 18 per cent)
- In relation to timings of pesticide applications, 42 per cent of herbicides were applied in May and 72 per cent of insecticides were applied in June (Figure 20). Fungicides and growth regulators were applied from May to July
- Where reasons were given, 79 per cent of fungicide use was for disease control/precaution (Figure 21) Where the disease was specified *Rhynchosporium* was the most commonly reported
- 61 per cent of herbicide use was for general weed control, 12 per cent for annual broad-leaved weeds and 12 per cent for desiccation/harvest aid (Figure 22)
- 71 per cent of insecticide was for aphids and 16 per cent was for leaf miners (Figure 23)
- Concerto was the most common variety, accounting for 58 per cent of the sample area
- The average reported yield was 5.8 t/ha

Summary of pesticide use on spring barley:

Pesticide group	Formulation area treated (ha)	Weight of pesticides applied (kg)	% of crop area treated	Most used formulations (ha)
Fungicides	661,513	160,525	93	Chlorothalonil (133,652)
Herbicides	621,755	208,422	96	Metsulfuron-methyl/ Thifensulfuron-methyl (92,288)
Insecticides	18,228	372	8	Lambda-cyhalothrin (16,091)
Growth regulators	50,830	10,473	18	Chlormequat (13,423), Trinexapac-ethyl (13,203)
Molluscicides	141	49	<0.5	Metaldehyde (141)
Sulphur	1,394	10,480	1	N/A
Seed treatments	219,543	5,410	92	Fluopyram/prothioconazole/ tebuconazole (94,126)

N/A = not applicable

Figure 19 Use of pesticides on spring barley (percentage of total area treated with formulations) - 2016

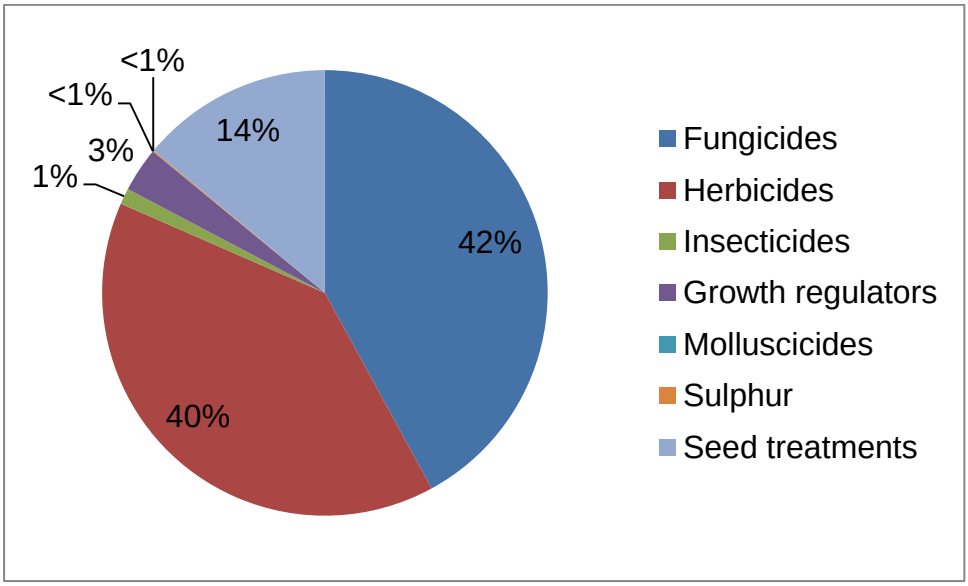


Figure 20 Timing of pesticide applications on spring barley - 2016

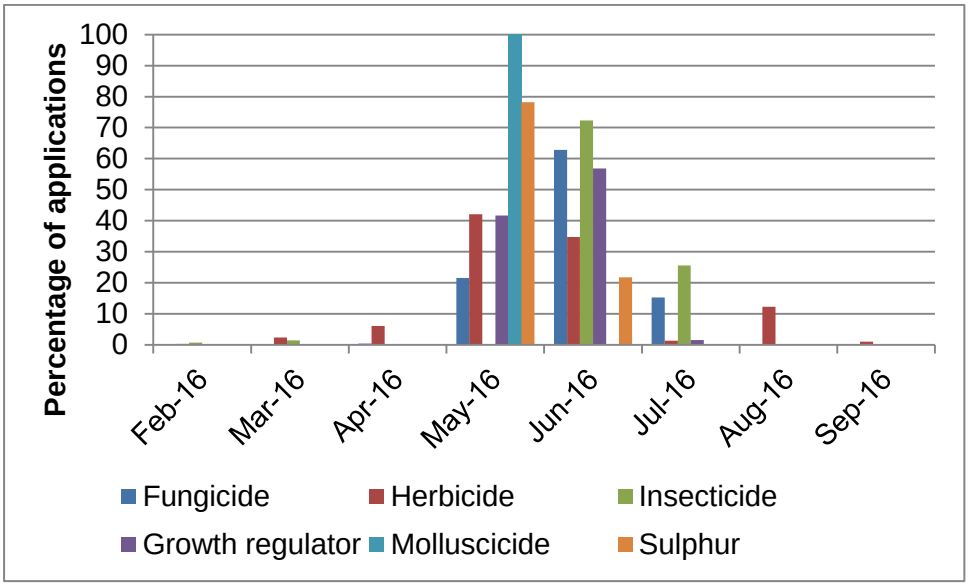
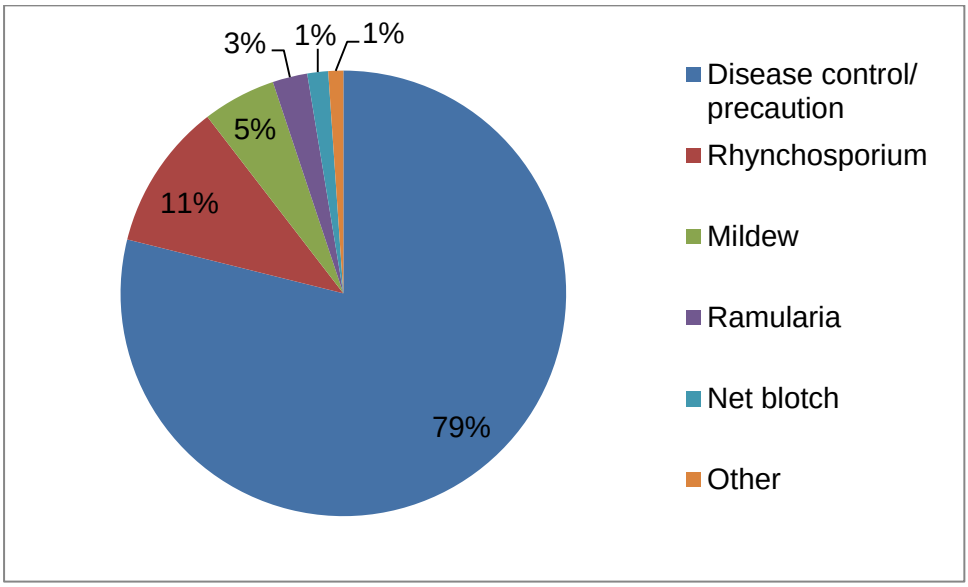
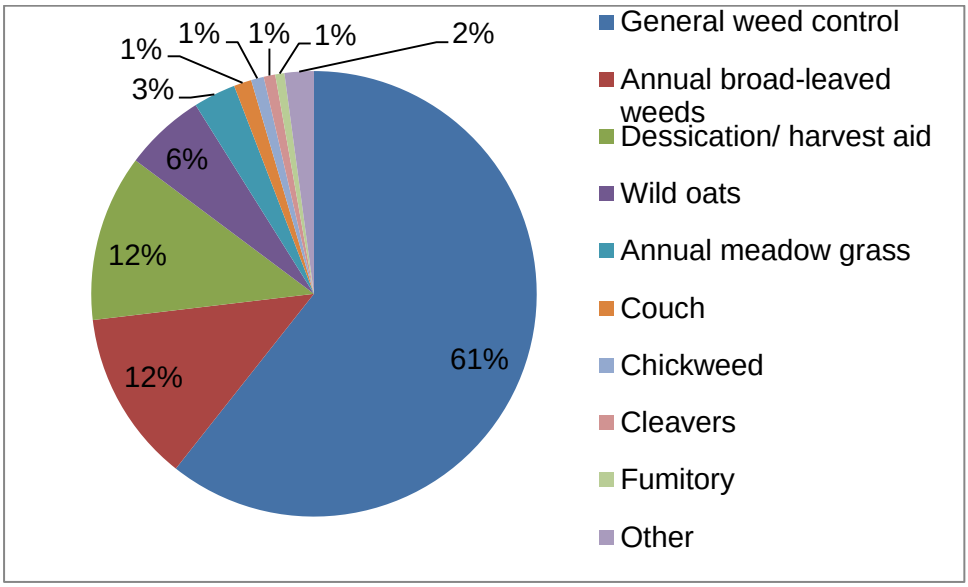


Figure 21 Reasons for use of fungicides on spring barley (where specified)



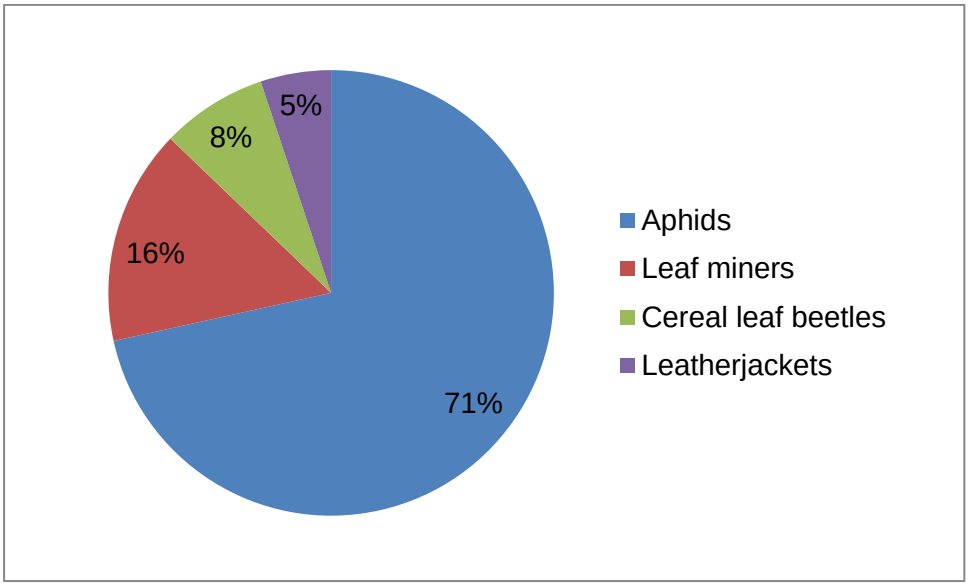
Note: 'Other' includes ear diseases, fusarium and keep green

Figure 22 Reasons for use of herbicides on spring barley (where specified)



Other includes volunteer rape, field pansy, marigolds, knotgrass, mayweed, annual grass weeds, volunteer potatoes, speedwell, docks and redshank

Figure 23 Reasons for use of insecticides on spring barley (where specified)



Winter wheat

- An estimated 102,753 hectares of winter wheat were grown in Scotland in 2014. This represents a decrease of three per cent since 2014.
- 99 per cent of the crop was treated with a pesticide
- Pesticides were applied to 1,526,366 treated hectares
- 487,552 kilograms of pesticides were applied to the crop
- 51 per cent of pesticides applied were fungicides, 20 per cent herbicides, 19 per cent growth regulators, seven per cent seed treatments, two per cent insecticides, one per cent molluscicides and under one per cent sulphur (Figure 24)
- The winter wheat crop received on average 5.3 pesticide applications (Table 1). These included 3.7 fungicide and 2.2 herbicide applications (applied to 99 per cent and 98 per cent of the crop area respectively), 1.9 applications of growth regulators (applied to 98 per cent), 1.2 insecticide applications (applied to 27 per cent) and 1.3 molluscicide applications (applied to 12 per cent)
- Molluscicide applications were between September and February; fungicide and growth regulator applications were applied between March and June (Figure 25). 30 per cent of herbicide applications were in October and insecticide applications were mainly in October and June
- Where reasons were given, 62 per cent of fungicide use was for disease control/precaution (Figure 26). Where the disease was specified *Septoria* was the most commonly reported
- 44 per cent of herbicide use was for general weed control and 20 per cent for annual broad leaved weeds (Figure 27)
- 99 per cent of insecticide applications were for aphids and one per cent leatherjackets
- The most common varieties encountered were Istabraq, Viscount, Myriad and Leeds accounting for 13, 13, 12 and 11 per cent of the sample area respectively
- The average reported yield was 9 t/ha

Summary of pesticide use on winter wheat:

Pesticide group	Formulation area treated (ha)	Weight of pesticides applied (kg)	% of crop area treated	Most used formulations (ha)
Fungicides	783,338	228,684	99	Chlorothalonil (220,141)
Herbicides	310,331	119,221	98	Glyphosate (40,350), Pendimethalin/picolinafen (40,048)
Insecticides	31,718	800	27	Lambda-cyhalothrin (26,696)
Growth regulators	280,413	122,992	98	Chlormequat (117,740)
Molluscicides	16,169	2,042	12	Metaldehyde (13,432)
Sulphur	4,325	7,681	3	N/A
Seed treatments	100,073	6,132	95	Prochloraz/triticonazole (35,562)

N/A = not applicable

Figure 24 Use of pesticides on winter wheat (percentage of total area treated with formulations) - 2016

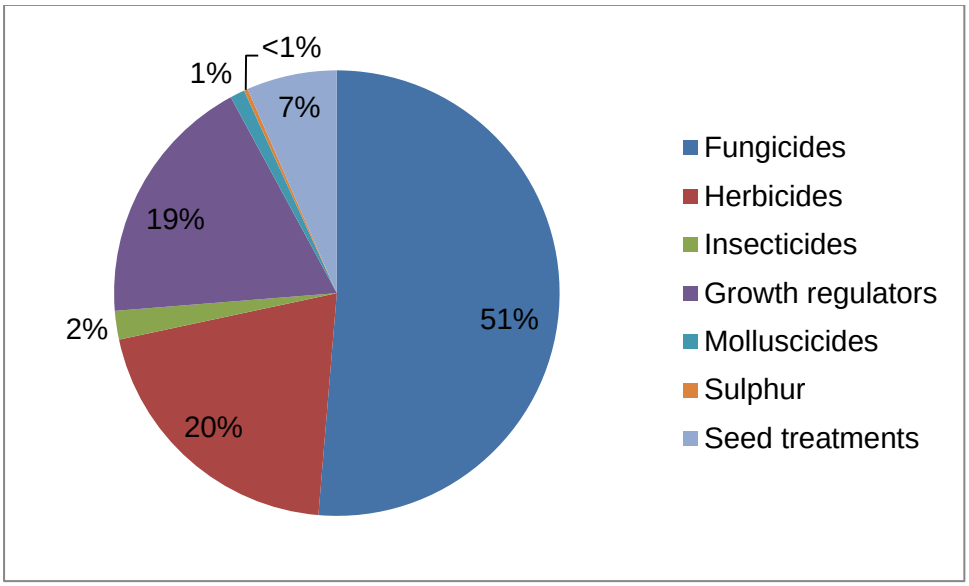


Figure 25 Timing of pesticide applications on winter wheat - 2016

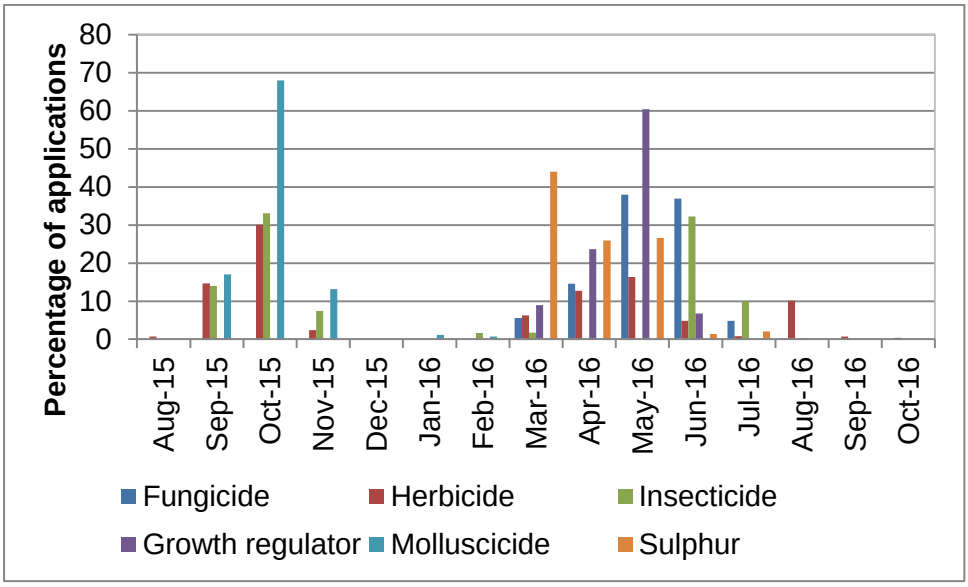
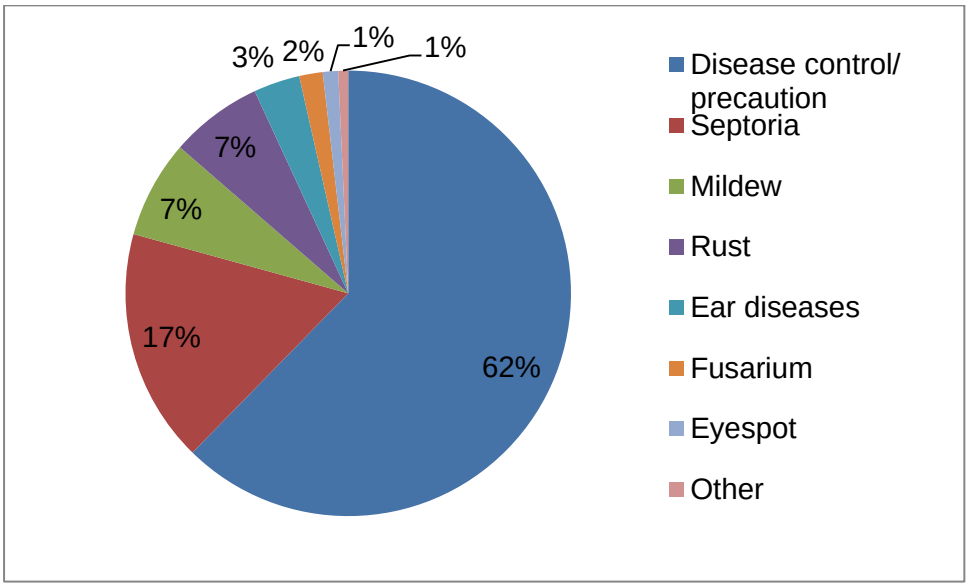
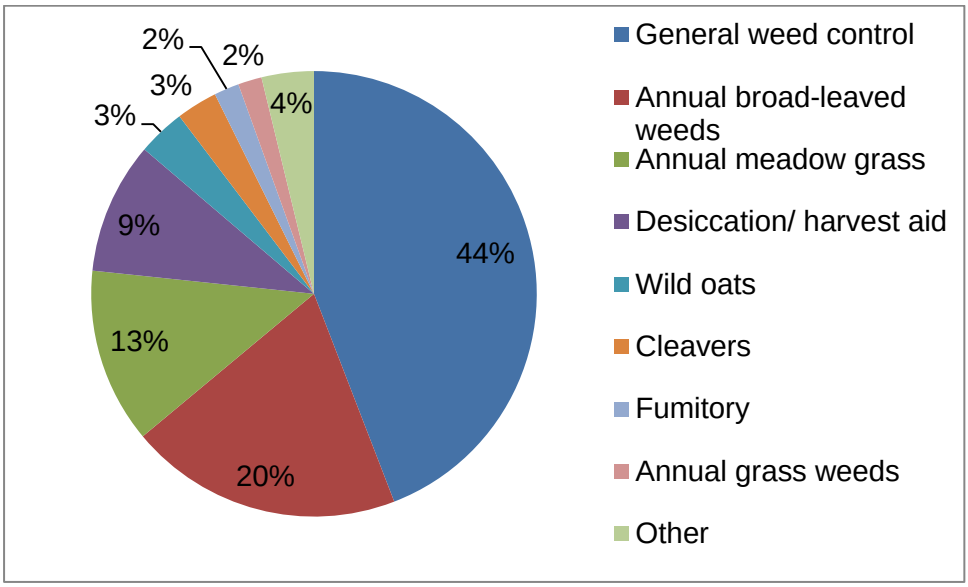


Figure 26 Reasons for use of fungicides on winter wheat (where specified)



Note: 'Other' includes Sooty mould

Figure 27 Reasons for use of herbicides on winter wheat (where specified)



Note: 'Other' includes brome, mayweed, chickweed, ryegrass, volunteer beans, volunteer cereals, volunteer rape, volunteer potatoes, forget-me-not, groundsel, nettles and speedwell

Spring wheat

This crop was not recorded separately in the Agricultural Census. Based upon the proportions of spring and winter wheat encountered in the survey, it was estimated that 6,843 hectares of spring wheat were grown in Scotland in 2016. This represents an increase of 132 per cent from the 2014 survey.

- 93 per cent of the crop was treated with a pesticide
- Pesticides were applied to 31,481 treated hectares
- 9,408 kilograms of pesticides were applied to the crop
- 37 per cent of pesticides applied were herbicides, 33 per cent were fungicides, 18 per cent seed treatments, seven per cent growth regulators, four per cent sulphur and one per cent insecticides (Figure 28)
- No molluscicide applications were recorded on spring wheat
- The spring wheat crop received on average 2.1 pesticide applications (Table 1) These included 1.4 herbicide applications (applied to 91 per cent of the crop area), 1.7 fungicide applications (applied to 46 per cent) and 1.3 growth regulator applications (applied to 18 per cent)
- In relation to timings of pesticide applications, 47 per cent of herbicides were applied in June (Figure 29). Growth regulators were applied in May and June and fungicides were applied from May to July
- Where reasons were given, 73 per cent of fungicide use was for disease control/precaution (Figure 30)
- 83 per cent of herbicide use was for general weed control (Figure 31)
- Where reasons were given, all insecticide use was for wheat bulb fly
- The most common varieties encountered were Tybalt and Belepi, accounting for 28 and 21 per cent of the sampled area respectively
- The average reported yield was 5.5 t/ha

Summary of pesticide use on spring wheat:

Pesticide group	Formulation area treated (ha)	Weight of pesticides applied (kg)	% of crop area treated	Most used formulations (ha)
Fungicides	10,208	2,568	46	Chlorothalonil (3,124)
Herbicides	11,690	3,450	91	Fluroxypyr (3,231)
Insecticides	216	60	3	Lambda-cyhalothrin (134)
Growth regulators	2,326	1,122	18	Chlormequat (1,388)
Sulphur	1,331	2,130	2	N/A
Seed treatments	5,708	78	83	Fludioxonil (4,918)

N/A = not applicable

Figure 28 Use of pesticides on spring wheat (percentage of total area treated with formulations) - 2016

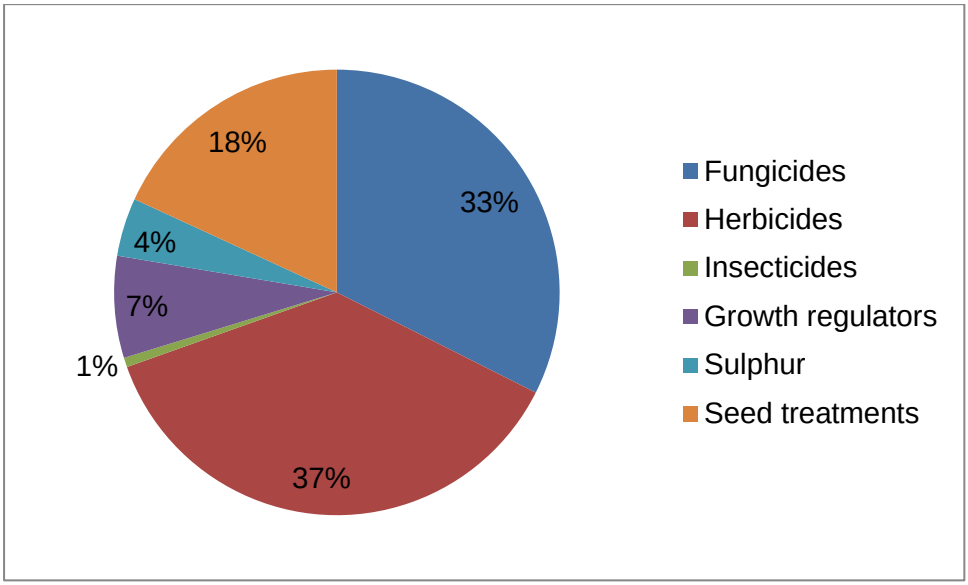


Figure 29 Timing of pesticide applications on spring wheat - 2016

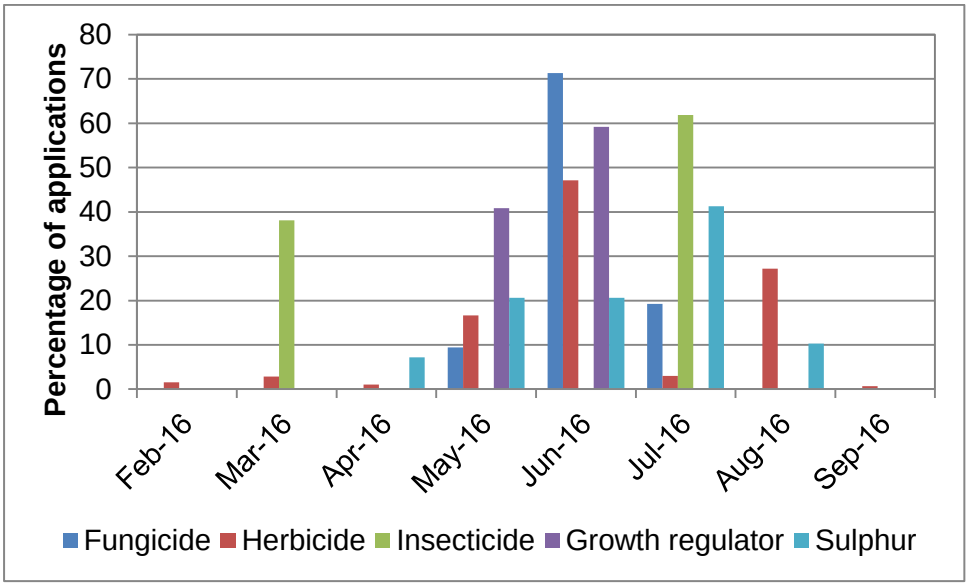


Figure 30 Reasons for use of fungicides on spring wheat (where specified) - 2016

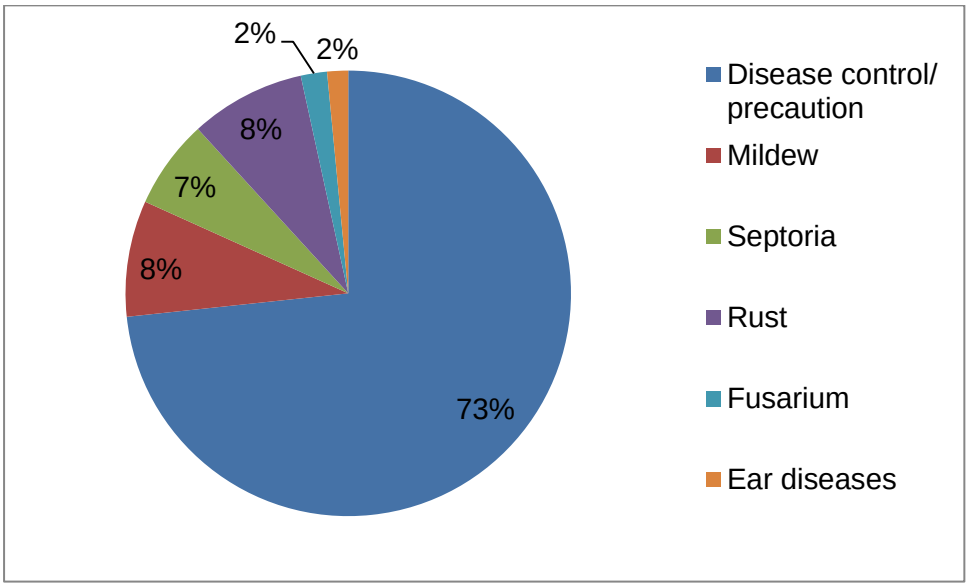
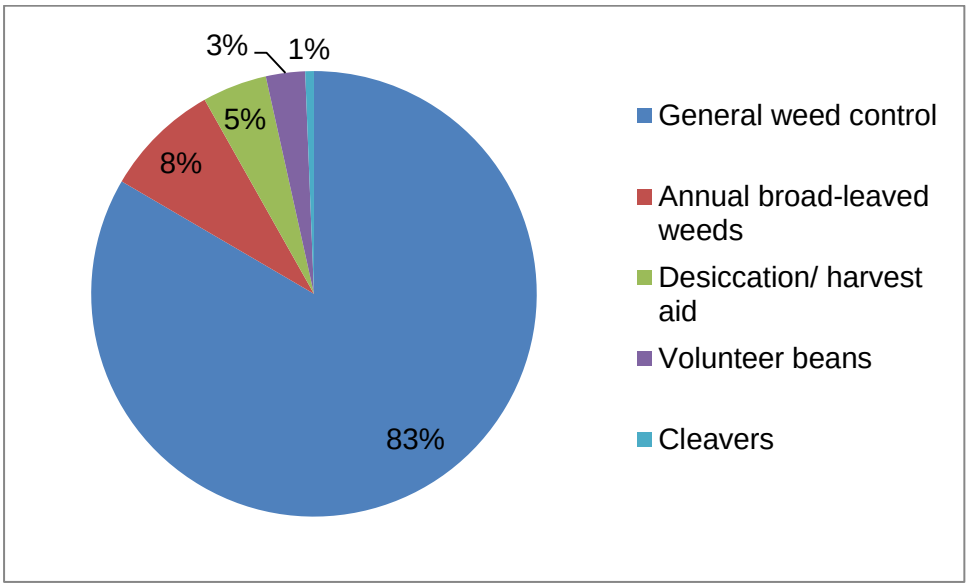


Figure 31 Reasons for use of herbicides on spring wheat (where specified) - 2016



Winter oats

- An estimated 8,091 hectares of winter oats were grown in Scotland in 2016, an increase of one per cent since 2014
- 94 per cent of the winter oat crop was treated with a pesticide
- Pesticides were applied to 76,006 treated hectares
- 17,612 kilograms of pesticides were applied to the crop
- 38 per cent of pesticides applied were fungicides, 28 per cent herbicides, 20 per cent growth regulators, eight per cent seed treatments, six per cent insecticides and under one per cent molluscicides (Figure 32)
- No sulphur was applied to the winter oats crop
- The winter oats crop received on average 4.4 pesticide applications (Table 1). These included 2.6 fungicide, 2.5 herbicide and 1.3 growth regulator applications (applied to 92 per cent of the crop area) and one insecticide application (applied to 55 per cent)
- In relation to timings of pesticide applications, 36 per cent of herbicides were applied in May and 56 per cent of insecticide applications were applied in June (Figure 33). Fungicides and growth regulators were applied from March to June
- Where reasons were given, 47 per cent of fungicide applications were for general disease control (Figure 34). Where the disease was specified, mildew was the most commonly reported
- 46 per cent of herbicide use was for general weed control, 17 per cent was for annual broad-leaved weeds and 17 per cent was for desiccation/harvest aid (Figure 35)
- Where reasons were given, all insecticide use was for control of aphids
- The most common variety encountered was Gerald accounting for 65 per cent of the sampled area
- The average reported yield was 7.4 t/ha

Summary of pesticide use on winter oats

Pesticide group	Formulation area treated (ha)	Weight of pesticides applied (kg)	% of crop area treated	Most used formulations (ha)
Fungicides	28,580	3,295	92	Proquinazid (4,673), Fenpropimorph (4,653)
Herbicides	21,461	6,592	92	Glyphosate (3,797), Fluroxypyr (3,688), Diflufenican/flufenacet (3,574)
Insecticides	4,559	23	55	Lambda-cyhalothrin (3,770)
Growth regulators	15,041	7,485	92	Chlormequat (7,376)
Molluscicides	100	8	1	Ferric phosphate (50), Metaldehyde (50)
Seed treatments	6,264	210	77	Fludioxonil (1,908)

Figure 32 Use of pesticides on winter oats (percentage of total area treated with formulations) – 2016

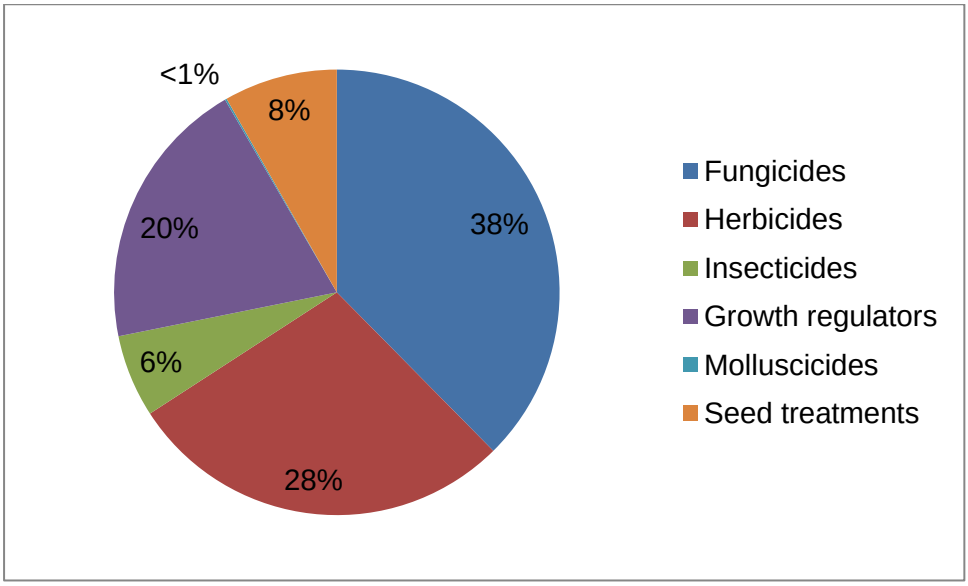


Figure 33 Timing of pesticide applications on winter oats – 2016

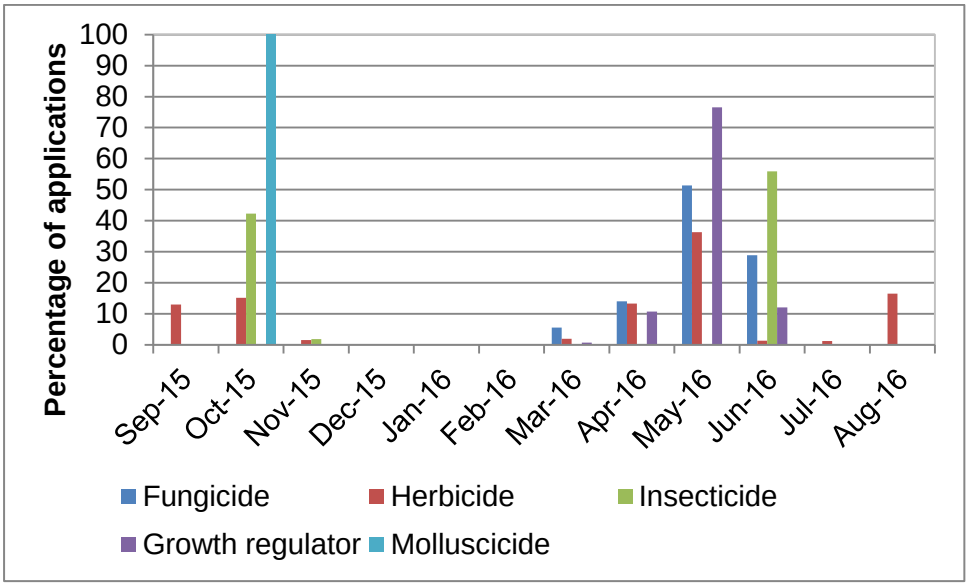


Figure 34 Reasons for use of fungicides on winter oats (where specified)

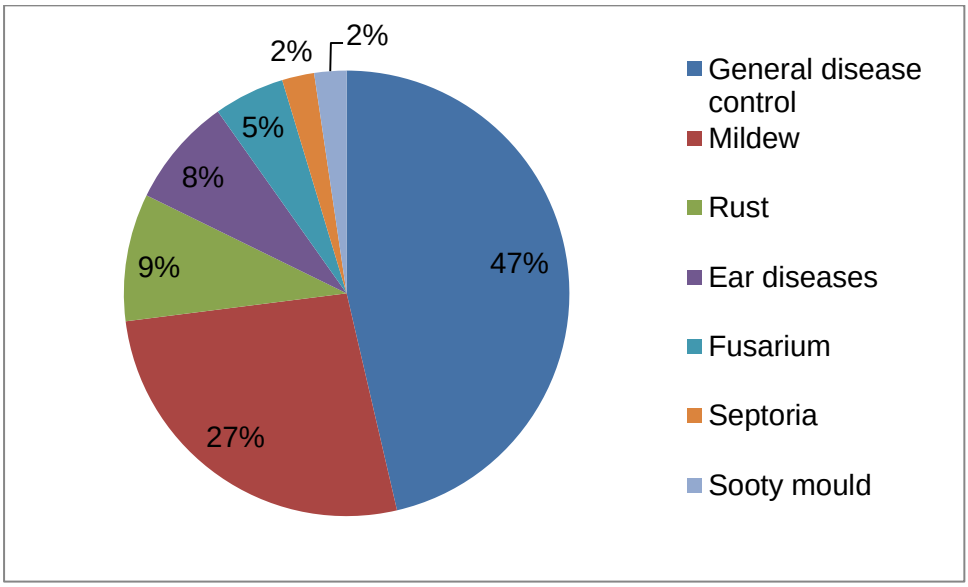
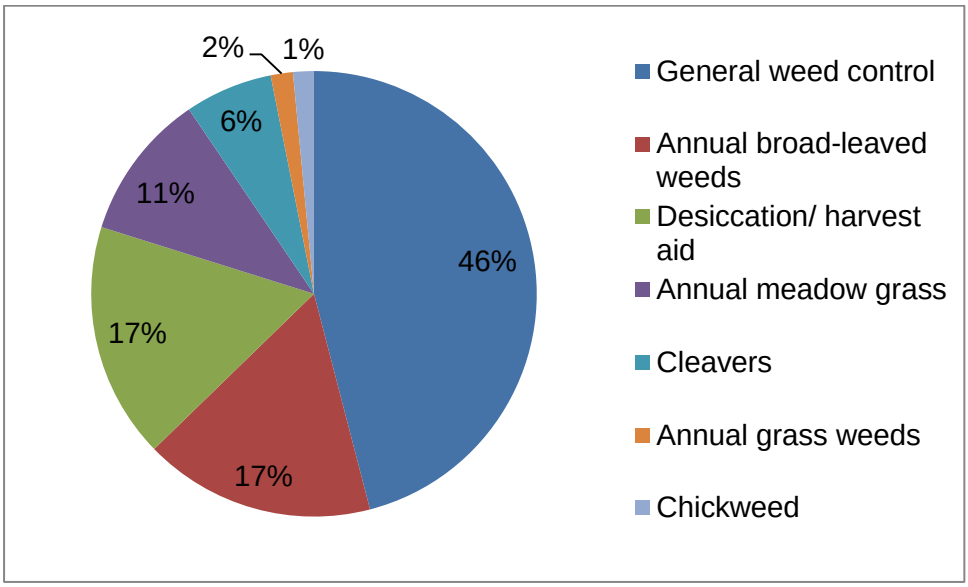


Figure 35 Reasons for use of herbicides on winter oats (where specified)



Spring oats

- An estimated 23,119 hectares of spring oats were grown in 2016, representing a 36 per cent increase from 2014
- 87 per cent of the spring oat crop was treated with a pesticide
- Pesticide formulations were applied to 129,689 treated hectares
- 36,253 kilograms of pesticides were used in total on the crop
- 33 per cent of pesticides applied were fungicides, 33 per cent herbicides, 16 per cent growth regulators, 14 per cent seed treatments, four per cent insecticides and under one per cent sulphur (Figure 36)
- No molluscicides were applied to the spring oats crop
- The spring oat crop received on average 2.6 pesticide sprays (Table 1). These included 1.6 herbicide applications (applied to 83 per cent of the crop area), 1.8 fungicide applications (applied to 77 per cent), 1.1 growth regulator applications (applied to 68 per cent) and an average of one insecticide application (applied to 22 per cent)
- 43 per cent of herbicides were applied in May and 70 per cent of insecticides were applied in June (Figure 37). Fungicides and growth regulators were applied from May to July
- Where reasons were given, 68 per cent of fungicide use was for disease control/precaution (Figure 38). Where the disease was specified, mildew was the most commonly reported
- 74 per cent of herbicide use was for general weed control and 12 per cent was for annual broad-leaved weeds (Figure 39)
- 72 per cent of insecticide use was for aphids and 22 per cent was for general pests (Figure 40)
- The most common varieties encountered were Canyon, Firth and Aspen, accounting for 30, 28 and 21 per cent of the sample area surveyed respectively
- The average reported yield was 6.3 t/ha

Summary pesticide use on spring oats

Pesticide group	Formulation area treated (ha)	Weight of pesticides applied (kg)	% of crop area treated	Most used formulations (ha)
Fungicides	42,798	6,034	77	Proquinazid (6,948)
Herbicides	43,317	16,297	83	Mecoprop-P(6,811), Metsulfuron-methyl/tribenuron-methyl (6,804),Glyphosate (6,540)
Insecticides	5,090	92	22	Lambda-cyhalothrin (4,995)
Growth regulators	20,455	13,150	68	Chlormequat (11,990)
Sulphur	87	139	<0.5	N/A
Seed treatments	17,942	541	78	Fludioxonil (7,304)

N/A = not applicable

Figure 36 Use of pesticides on spring oats (percentage of total area treated with formulations) - 2016

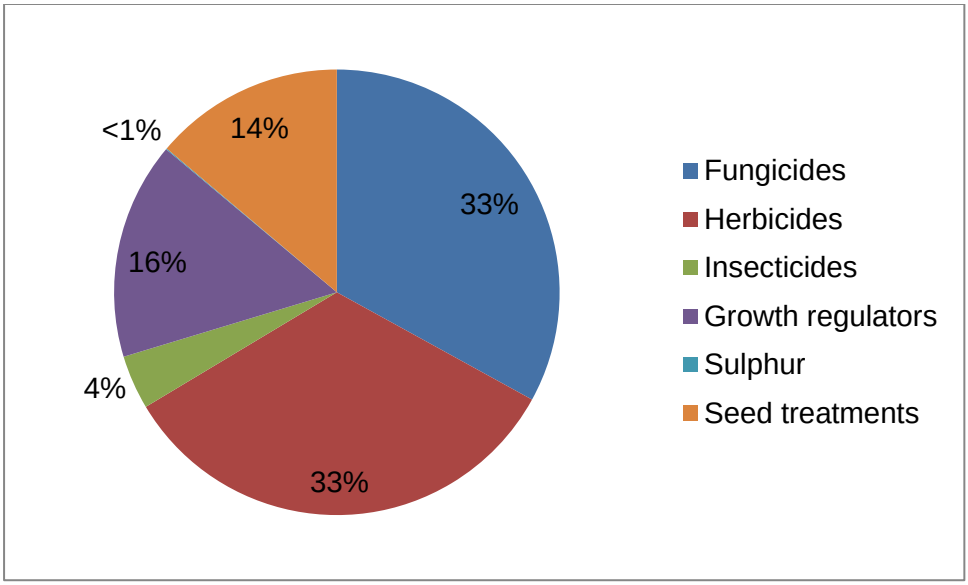


Figure 37 Timing of pesticide applications on spring oats - 2016

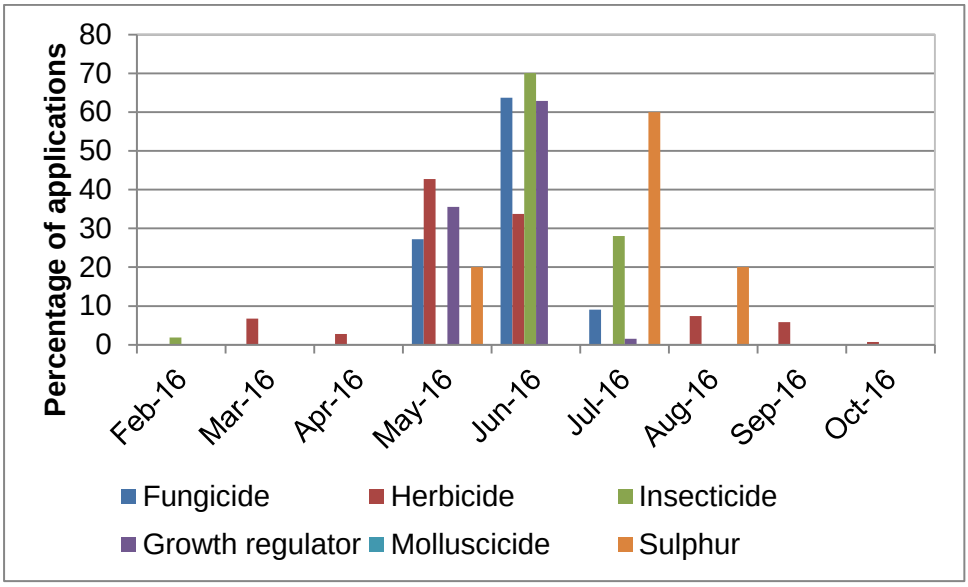


Figure 38 Reasons for use of fungicides on spring oats (where specified)

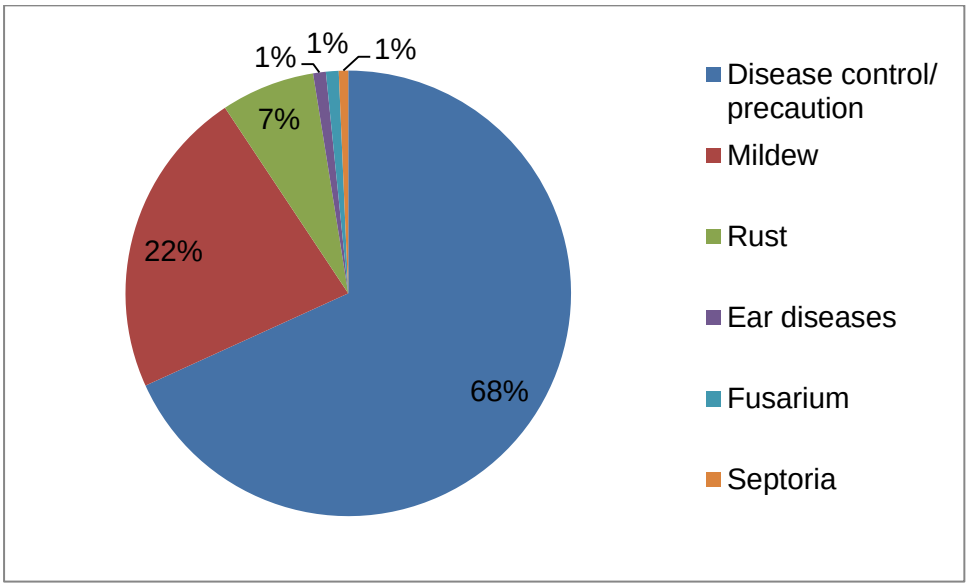


Figure 39 Reasons for use of herbicides on spring oats (where specified)

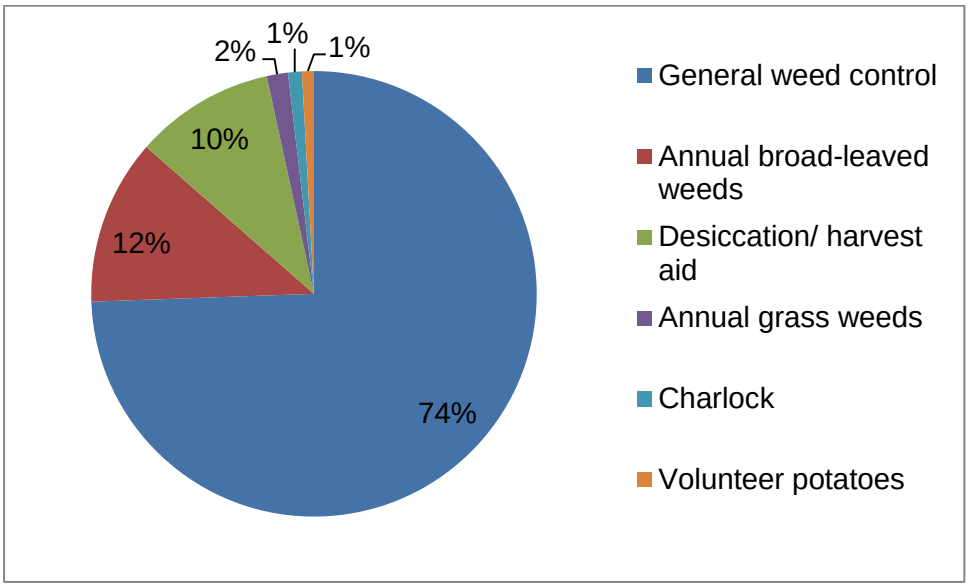
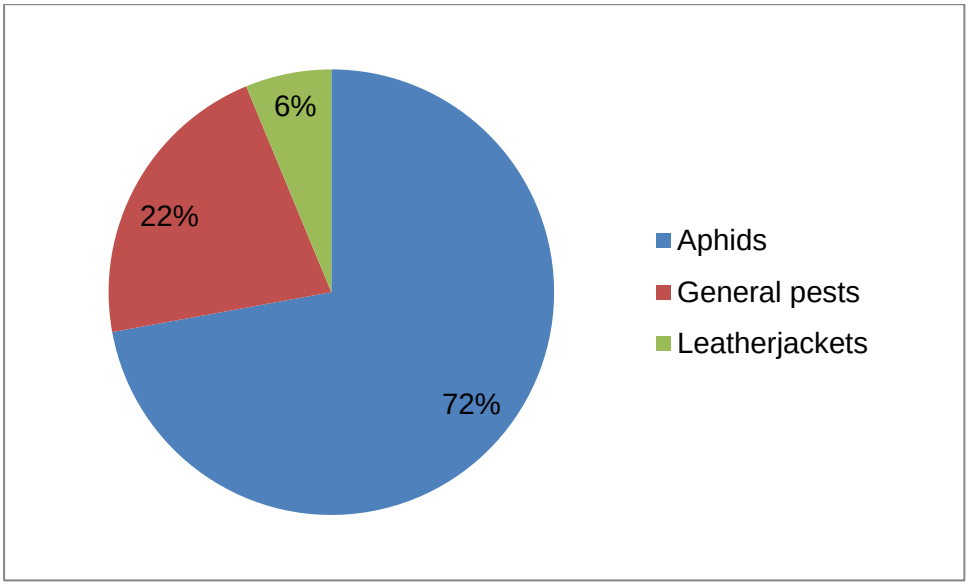


Figure 40 Reasons for use of insecticides on spring oats (where specified)



Winter oilseed rape

- An estimated 30,142 hectares of winter oilseed rape were grown in Scotland in 2016, representing a 17 per cent decrease from 2014
- 99 per cent of the winter oilseed rape crop was treated with a pesticide
- Pesticides were applied to 286,833 treated hectares
- 93,171 kilograms of pesticide were applied to the crop
- 35 per cent of pesticides applied were fungicides, 32 per cent herbicides, 15 per cent insecticides, nine per cent seed treatments, six per cent molluscicides, two per cent growth regulators and one per cent sulphur (Figure 41)
- The winter oilseed rape crop received on average 5.9 pesticide applications (Table 1). These included 2.9 fungicide and 2.6 herbicide applications (applied to 99 per cent and 98 per cent of the crop area respectively), 1.8 insecticide applications (applied to 79 per cent), 1.3 molluscicide applications (applied to 43 per cent) and one growth regulator application (applied to 20 per cent)
- 29 per cent of herbicides and 47 per cent of molluscicides were applied in September after sowing, 89 per cent of growth regulators were applied in April, 38 per cent of fungicides and 30 per cent of insecticide applications were in May (Figure 42)
- Where reasons were given, 48 per cent of fungicide use was for general disease control (Figure 43). Where the disease was specified, light leaf spot was the most commonly reported
- 27 per cent of herbicide use was for desiccation/harvest aid and 26 per cent was for general weed control (Figure 44)
- 21 per cent of insecticide use was for winter stem weevil, 20 per cent was for pollen beetle and 19 per cent was for seed weevil (Figure 45)
- The most common varieties encountered were Anastasia and Mentor, accounting for 20 and 18 per cent of the sample area respectively
- The average reported yield was 3.7 t/ha

Summary of pesticide use on winter oilseed rape

Pesticide group	Formulation area treated (ha)	Weight of pesticides applied (kg)	% of crop area treated	Most used formulations (ha)
Fungicides	100,681	19,361	99	Prothioconazole/tebuconazole (18,510),Prothioconazole (17,112)
Herbicides	90,409	56,768	98	Glyphosate (23,010)
Insecticides	43,782	805	79	Lambda-cyhalothrin (22,438)
Growth regulators	5,965	1,098	20	Mepiquat chloride/ Metconazole (5,965)
Molluscicides	16,234	1,846	43	Metaldehyde (14,353)
Sulphur	2,973	12,995	5	N/A
Seed treatments	26,789	298	89	Prochloraz/thiram (25,368)

N/A – not applicable

Figure 41 Use of pesticides on winter oilseed rape (percentage of total area treated with formulations) - 2016

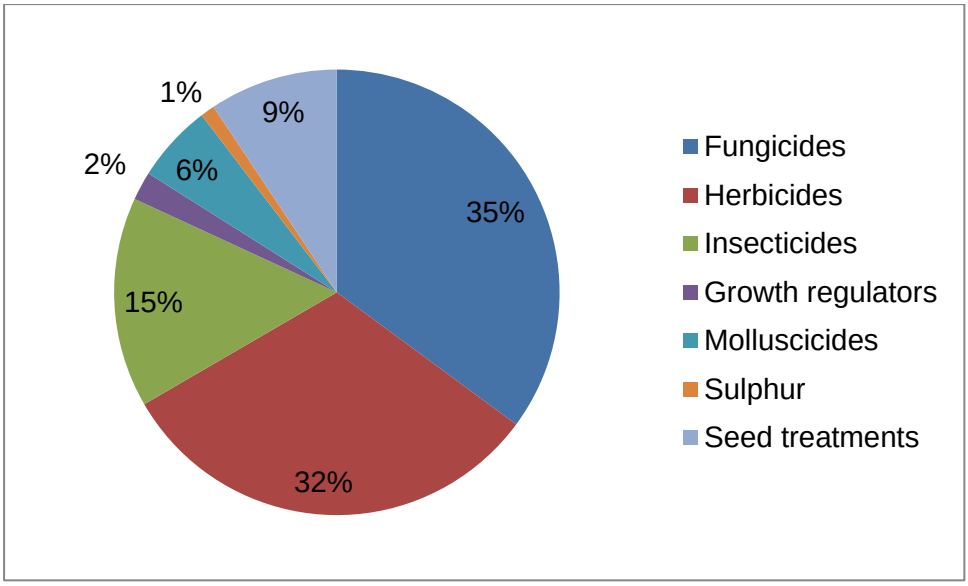


Figure 42 Timing of pesticide applications on winter oilseed rape - 2016

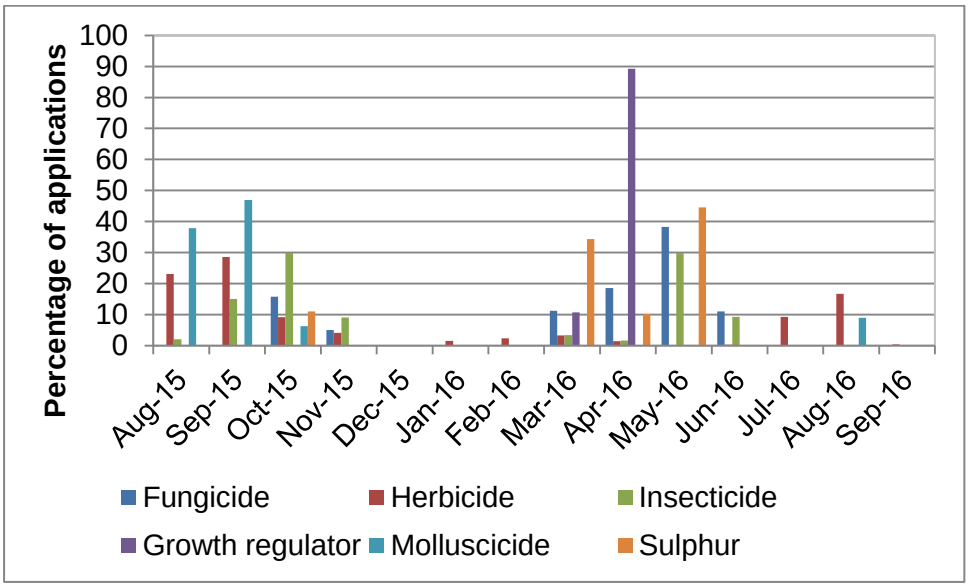


Figure 43 Reasons for use of fungicides on winter oilseed rape (where specified)

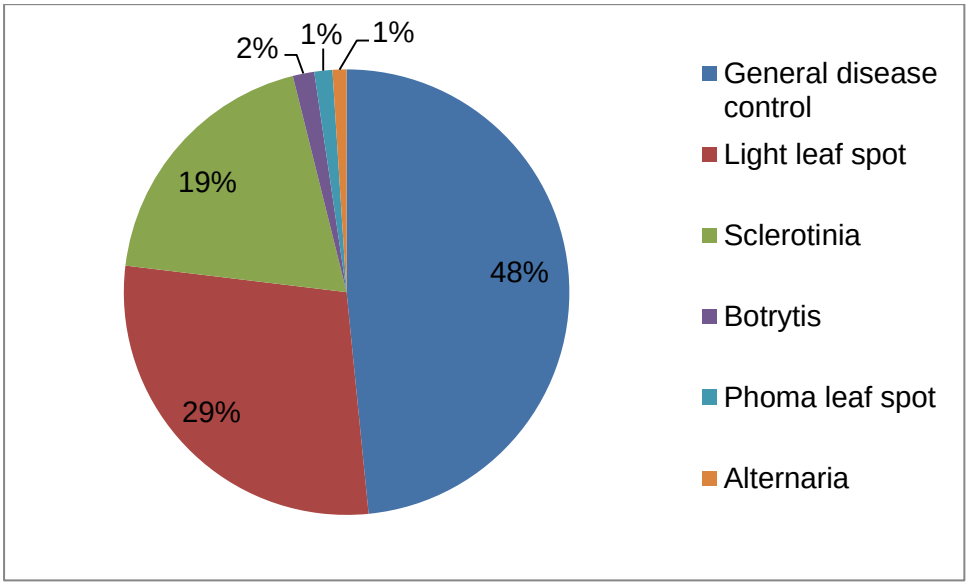
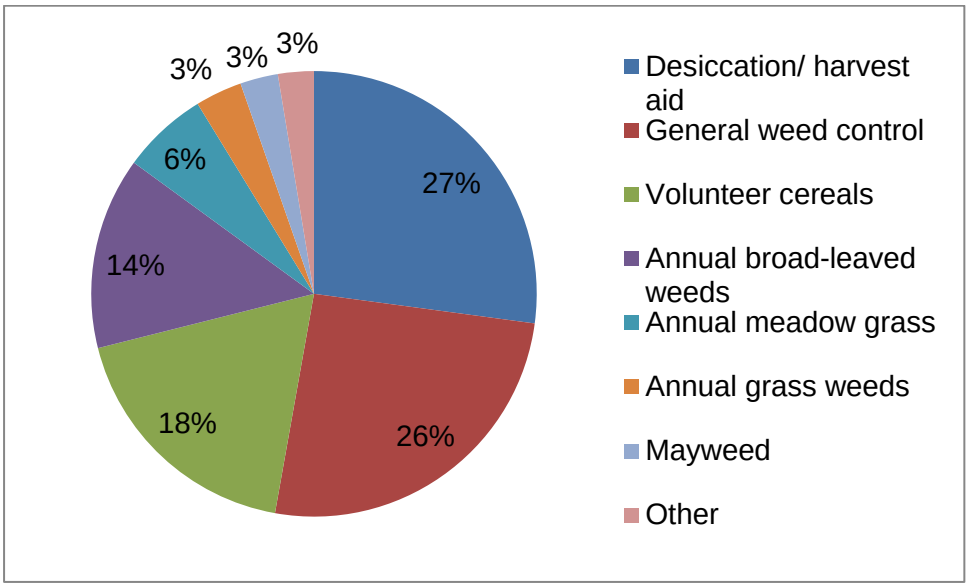
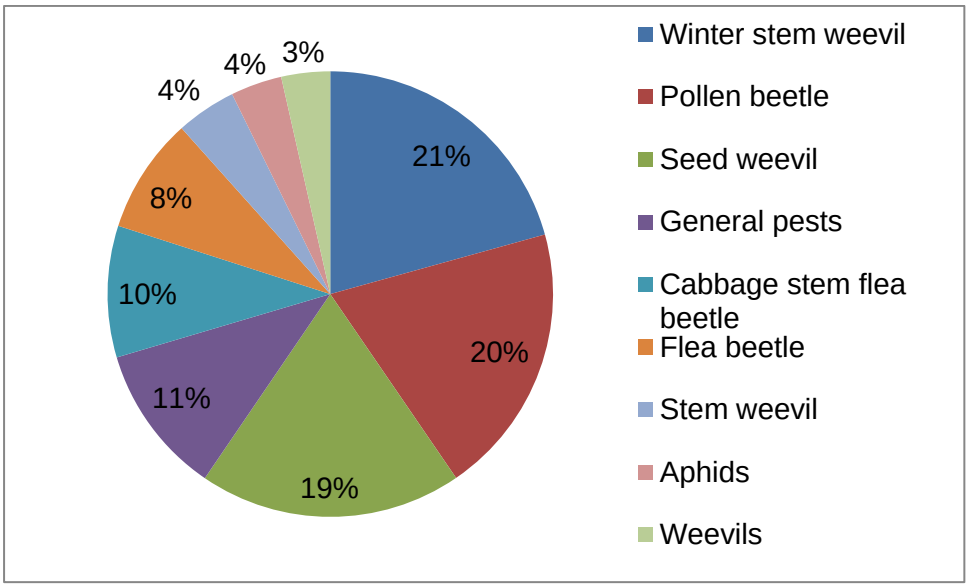


Figure 44 Reasons for use of herbicides on winter oilseed rape (where specified)



Note: 'Other' includes brome, wild oats, cleavers and ryegrass

Figure 45 Reasons for use of insecticides on winter oilseed rape (where specified)



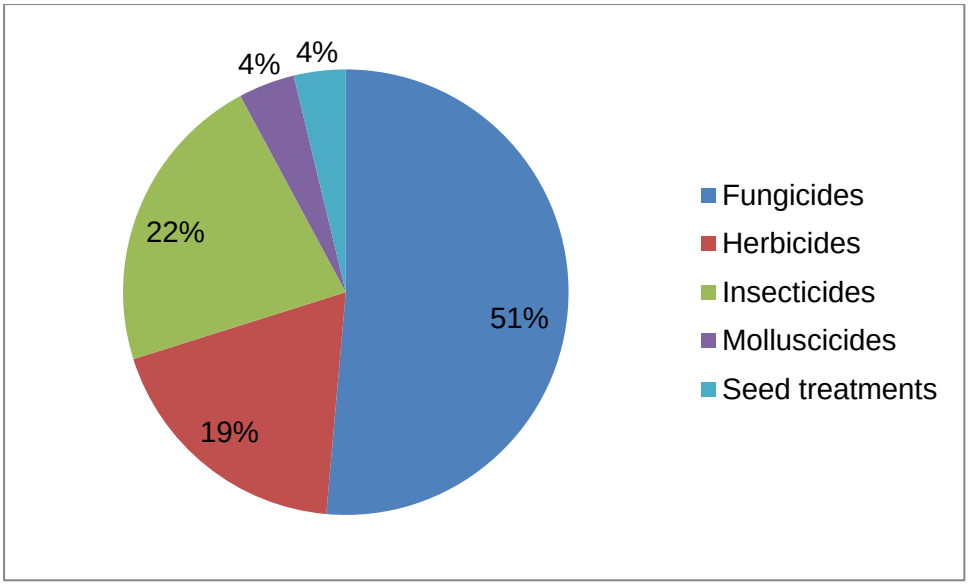
Seed potatoes

- An estimated 12,760 hectares of seed potatoes were grown in Scotland in 2016, a four per cent decrease from 2014
- 100 per cent of the seed potato crop was treated with a pesticide
- Pesticides were applied to 299,402 treated hectares
- 101,861 kilograms of pesticide were applied in total
- 51 per cent of pesticides applied were fungicides, 22 per cent insecticides/nematicides, 19 per cent herbicides, four per cent molluscicides and four per cent seed treatments (Figure 46)
- No growth regulators or sulphur were applied to the seed potato crop
- The seed potato crop received on average 11.1 pesticide applications (Table 1). These sprays included 8.7 fungicide applications (applied to 100 per cent of the crop area), 2.3 herbicide applications (applied to 95 per cent), 5.6 insecticide/nematicide applications (applied to 79 per cent) and 2.9 molluscicide applications (applied to 34 per cent)
- In relation to timing of pesticide applications, 46 per cent of fungicide, 56 per cent of insecticide/nematicide and 43 per cent of molluscicide applications were applied in July, 34 per cent of herbicide applications were in August (Figure 47)
- Where reasons were given, over 99 per cent of fungicide use was for blight
- 49 per cent of herbicide use was for desiccation/ harvest aid and 42 per cent was for general weed control (Figure 48)
- The only specified reason for use of insecticides on seed potatoes was for aphids
- The most common variety encountered was Hermes, accounting for 16 per cent of the sample area
- The average reported yield was 36.5 t/ha

Summary of pesticide use on seed potatoes

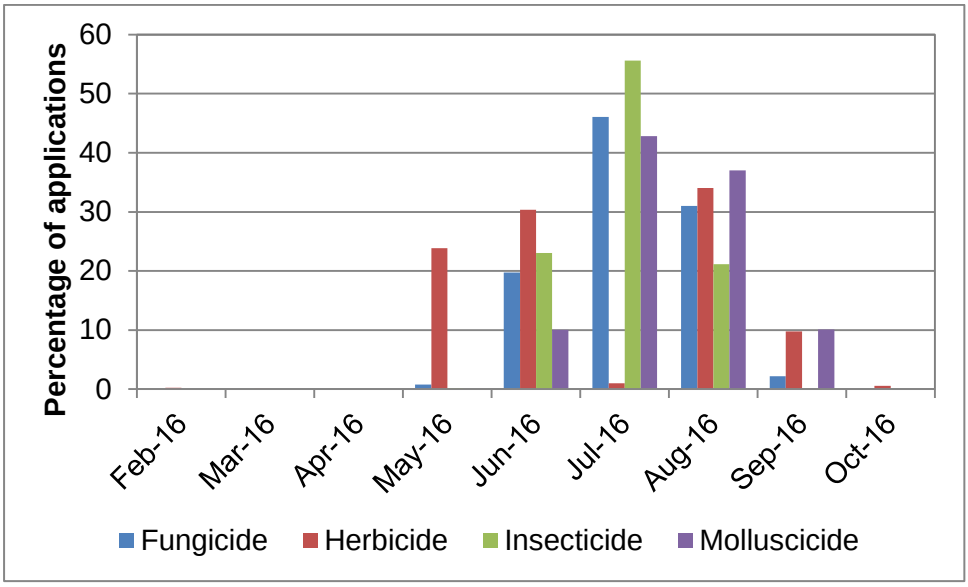
Pesticide group	Formulation area treated (ha)	Weight of pesticides applied (kg)	% of crop area treated	Most used formulations (ha)
Fungicides	153,885	70,353	100	Cymoxanil (26,642),cyazofamid (25,695)
Herbicides	56,119	21,887	95	Diquat (26,004)
Insecticides/ nematicides	65,899	2,271	79	Lambda-cyhalothrin (26,378)
Molluscicides	12,247	1,329	34	Metaldehyde (10,548)
Seed treatments	11,253	6,021	85	Pencycuron (7,097)

Figure 46 Use of pesticides on seed potatoes (percentage of total area treated with formulations) - 2016



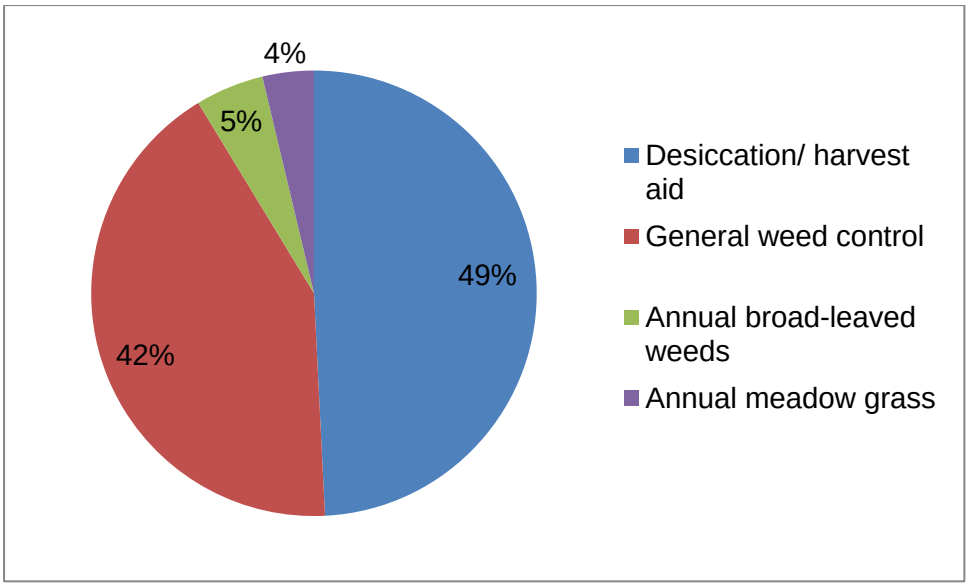
Note: insecticides include nematicides

Figure 47 Timing of pesticide applications on seed potatoes - 2016



Note: insecticides include nematicides

Figure 48 Reasons for use of herbicides on seed potatoes (where specified)



Ware potatoes

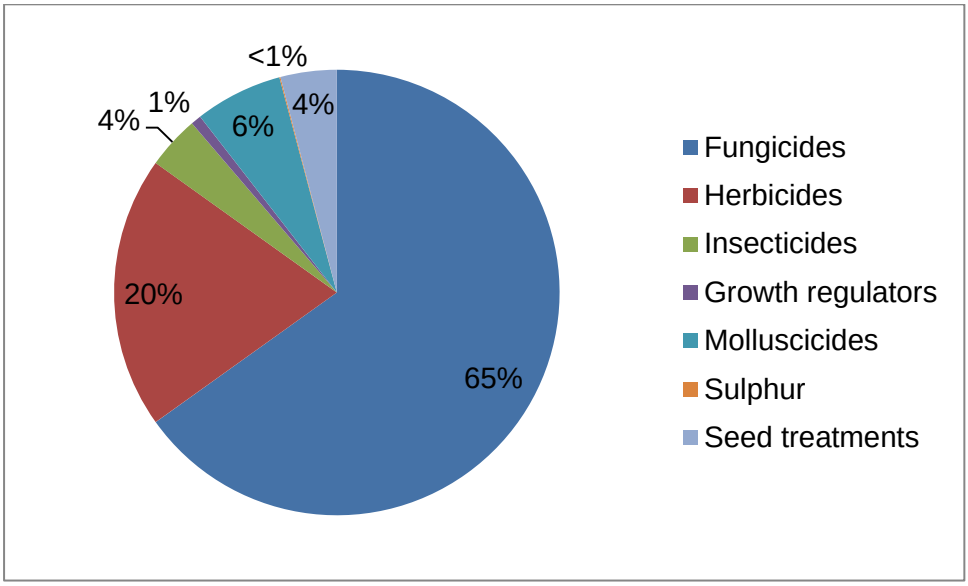
- An estimated 14,766 hectares of ware potatoes were grown in Scotland in 2016, a decrease of three per cent since 2014
- 98 per cent of the crop was treated with a pesticide
- Pesticides were applied to 332,979 treated hectares
- 155,171 kilograms of pesticide were applied in total
- 65 per cent of pesticides applied were fungicides, 20 per cent herbicides, six per cent molluscicides, four per cent insecticides/nematicides, four per cent seed treatments, one per cent growth regulators and under one per cent sulphur (Figure 49)
- The ware potato crop received on average 13.5 pesticide sprays (Table 1). These sprays included 10.3 fungicide and 2.4 herbicide applications (applied to 98 per cent of the crop area), 2.5 molluscicide applications (applied to 55 per cent), 1.7 insecticide/nematicide applications (applied to 51 per cent) and one growth regulator application (applied to 17 per cent)
- 38 per cent of herbicide applications were in May, 40 per cent of fungicide applications, 56 per cent of insecticide applications and 48 per cent of molluscicide applications were in July. 94 per cent of growth regulator applications were in August (Figure 50)
- Where reasons were given, over 99 per cent of fungicide use was for blight and under one per cent was for *Alternaria* and rust.
- 52 per cent of herbicide use was for general weed control and 41 per cent was for desiccation/harvest aid (Figure 51)
- 85 per cent of insecticide/nematicide use was for aphids and 15 per cent was for nematodes
- The most common varieties encountered were Osprey and Maris Piper, accounting for 21 and 16 per cent of the sampled area respectively
- The average reported yield was 47.3 t/ha

Summary of pesticide use on ware potatoes

Pesticide group	Formulation area treated (ha)	Weight of pesticides applied (kg)	% of crop area treated	Most used formulations (ha)
Fungicides	216,811	104,862	98	Cyazofamid (36,409)
Herbicides	65,808	27,482	98	Diquat (30,200)
Insecticides/ nematicides	12,820	7,895	51	Esfenvalerate (5,585)
Growth regulators	2,515	7,338	17	Maleic hydrazide (2,515)
Molluscicides	21,185	2,177	55	Metaldehyde (16,816)
Sulphur	265	424	2	N/A
Seed treatments	13,575	4,993	88	Pencycuron (7,097)

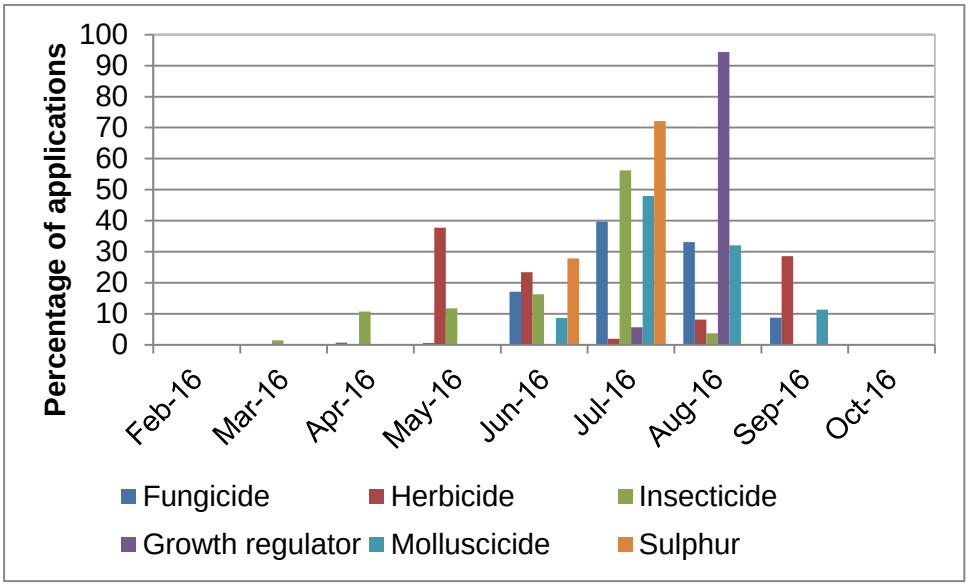
N/A = not applicable

Figure 49 Use of pesticides on ware potatoes (percentage of total area treated with formulations) - 2016



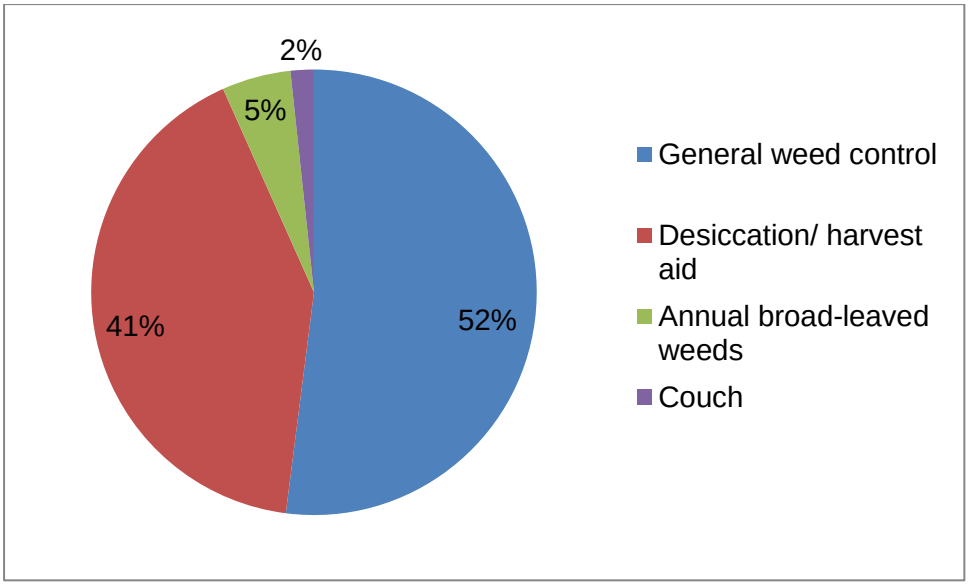
Note: insecticides include nematicides

Figure 50 Timing of pesticide applications on ware potatoes - 2016



Note: insecticides include nematicides

Figure 51 Reasons for use of herbicides on ware potatoes (where specified)



Legumes

The legumes category includes dry harvest peas and field beans. These crops have been combined as too few holdings were encountered to report the pesticide use for each crop separately

- An estimated 3,777 hectares of legumes were grown in Scotland in 2016, representing a 12 per cent increase from 2014
- 89 per cent of the legume crop was treated with a pesticide
- Pesticides were applied to 15,936 treated hectares
- 9,790 kilograms of pesticide were applied in total
- 51 per cent of pesticides applied were herbicides, 38 per cent fungicides, six per cent insecticides, three per cent molluscicides and one per cent sulphur and seed treatments (Figure 52)
- No growth regulators were applied to the legume crops
- Legumes received on average 3.3 pesticide sprays (Table 1). These sprays included 1.6 fungicide applications and 1.8 herbicide applications (applied to 85 per cent and 84 per cent of the crop area respectively), 1.3 insecticide applications (applied to 20 per cent) and one molluscicide application (applied to 12 per cent)
- In relation to timings of pesticide applications, all molluscicides were applied in October and 33 per cent of herbicides were applied in March (Figure 53). Fungicides were applied from May to July and insecticides were applied in June and July
- Where reasons were given, 44 per cent of fungicide use was for chocolate spot and 41 per cent was for general disease control (Figure 54)
- 41 per cent of herbicide use was for general weed control and 22 per cent was for annual broad-leaved weeds (Figure 55)
- 72 per cent of insecticide use was for general pests and 28 per cent was for weevils
- The most common variety encountered was Fuego, accounting for 42 per cent of the sample area

Summary of pesticide use on legumes:

Pesticide group	Formulation area treated (ha)	Weight of pesticides applied (kg)	% of crop area treated	Most used formulations (ha)
Fungicides	6,042	2,525	85	Chlorothalonil/cyproconazole (3,503)
Herbicides	8,053	6,107	84	Glyphosate (1,908)
Insecticides	989	10	20	Lambda-cyhalothrin (472), Zeta-cypermethrin (439)
Molluscicides	458	55	12	Metaldehyde (458)
Sulphur	230	1,068	6	N/A
Seed treatments	164	25	4	Thiram (164)

N/A = not applicable

Figure 52 Use of pesticides on legumes (percentage of total area treated with formulations) - 2016

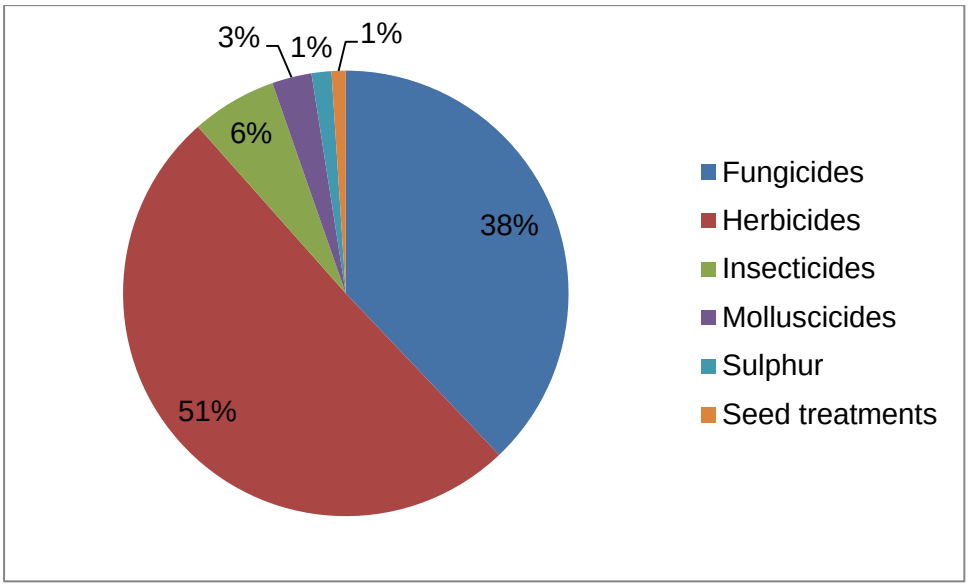


Figure 53 Timing of pesticide applications on legumes - 2016

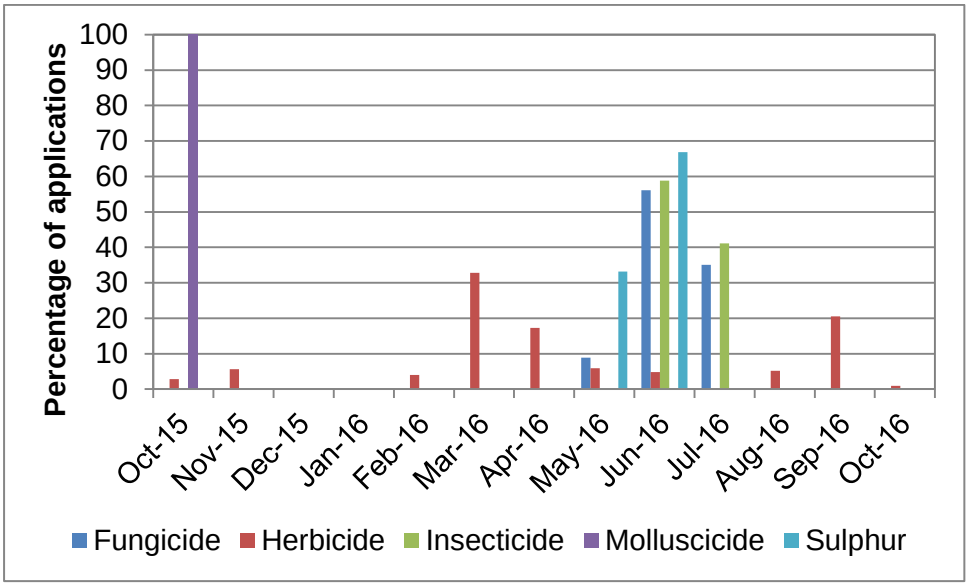


Figure 54 Reasons for use of fungicides on legumes (where specified)

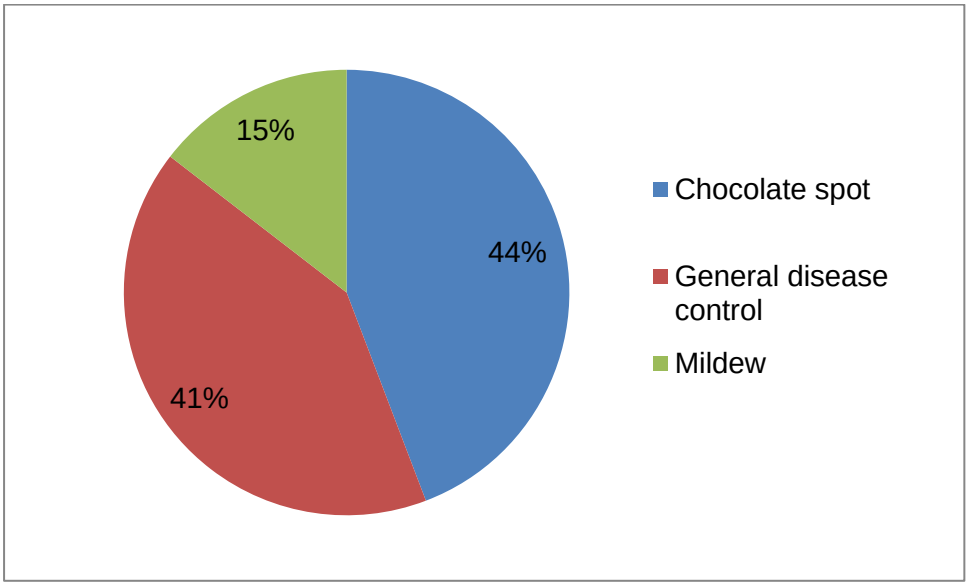
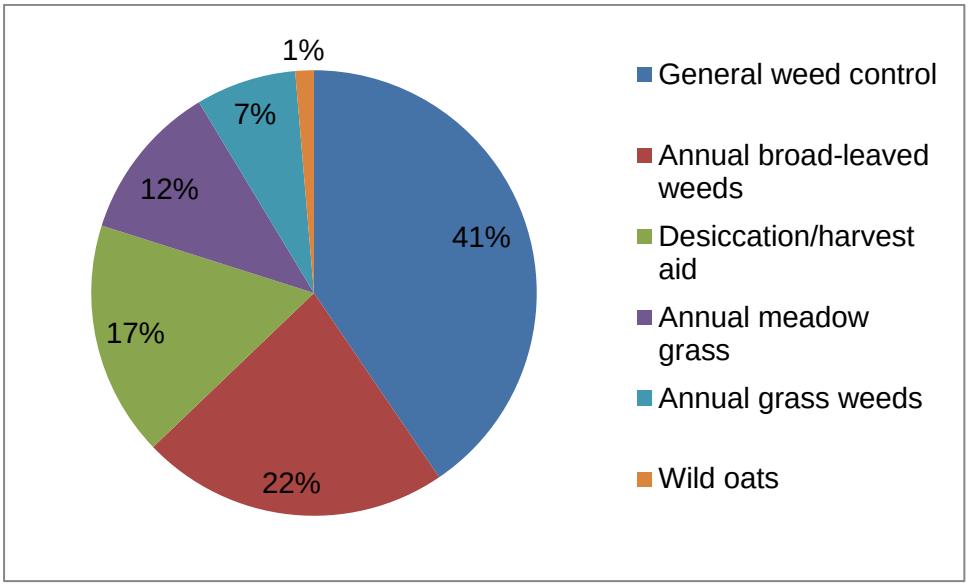


Figure 55 Reasons for use of herbicides on legumes (where specified)



Appendix 1 – Estimated application tables

Table 1 Percentage of each crop treated with pesticides and mean number of spray applications - 2016

	Fungicides		Herbicides		Insecticides[2]		Molluscicides	
	%	sp apps	%	sp apps	%	sp apps	%	sp apps
Winter barley	96	2.8	95	2.3	28	1.0	4	1.1
Spring barley	93	1.8	96	1.7	8	1.0	<0.5	1.0
Winter wheat	99	3.7	98	2.2	27	1.2	12	1.3
Spring wheat	46	1.7	91	1.4	3	1.0	0	0.0
Winter oats	92	2.6	92	2.5	55	1.0	1	1.0
Spring oats	77	1.8	83	1.6	22	1.0	0	0.0
Winter oilseed rape	99	2.9	98	2.6	79	1.8	43	1.3
Seed potatoes	100	8.7	95	2.3	79	5.6	34	2.9
Ware potatoes	98	10.3	98	2.4	51	1.7	55	2.5
Legumes	85	1.6	84	1.8	20	1.3	12	1.0
Total arable crops[1]	**94**	**2.9**	**96**	**2.0**	**23**	**1.7**	**8**	**1.7**

(1) Includes winter rye and triticale

(2) Includes nematicides

Cont…

Table 1 Percentage of each crop treated with pesticides and mean number of spray applications - 2016 continued

	Growth regulators		Any pesticide (excluding STs)		Seed treatments	Any pesticide (including STs)
	%	sp apps	%	sp apps	%	%
Winter barley	92	1.9	98	4.7	97	99
Spring barley	18	1.1	98	2.6	92	98
Winter wheat	98	1.9	99	5.3	95	99
Spring wheat	18	1.3	93	2.1	83	93
Winter oats	92	1.3	94	4.4	77	94
Spring oats	68	1.1	86	2.6	78	87
Winter oilseed rape	20	1.0	99	5.9	89	99
Seed potatoes	0	0.0	100	11.1	85	100
Ware potatoes	17	1.0	98	13.5	88	98
Legumes	0	0.0	89	3.3	4	89
Total arable crops(1)	**46**	**1.6**	**97**	**4.2**	**91**	**98**

(1) Includes winter rye and triticale

Note: STs = seed treatments

The average number of spray applications is calculated only on the areas using each pesticide group and therefore the minimum number of applications is always going to be one (see appendix 3 – definitions and notes for details).

Table 2 Cereals seed treatment formulations - 2016

Area (ha) and percentage of crop treated

Seed treatments	Winter barley		Spring barley		Winter wheat		Spring wheat		Winter oats		Spring oats		All cereals (1)	2014 (2)
	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	**(ha)**	(ha)
Carboxin/thiram	785	2	2,799	1	569	1	0	0	0	0	1,159	5	**5,312**	5,425
Clothianidin/prothioconazole	1,686	4	0	0	6,855	7	0	0	1,447	18	0	0	**9,988**	16,499
Difenoconazole/fludioxonil	0	0	0	0	0	0	0	0	0	0	0	0	**813**	43
Difenoconazole/fludioxonil/ tebuconazole	367	1	0	0	0	0	0	0	0	0	0	0	**367**	0
Fludioxonil	1,597	3	2,506	1	12,686	12	4,918	72	1,908	24	7,304	32	**31,951**	22,631
Fludioxonil/tefluthrin	0	0	0	0	786	1	0	0	0	0	0	0	**786**	454
Fluopyram/prothioconazole/ tebuconazole	16,438	34	94,126	39	0	0	0	0	0	0	0	0	**110,564**	96,402
Fluquinconazole	0	0	0	0	1,901	2	0	0	0	0	0	0	**1,901**	1,853
Fluquinconazole/prochloraz	830	2	0	0	17,906	17	0	0	0	0	0	0	**18,736**	14,858
Imazalil/ipconazole	2,014	4	24,868	10	4,776	5	0	0	0	0	0	0	**31,659**	9,057
Ipconazole	0	0	244	<0.5	0	0	0	0	0	0	0	0	**244**	4,835
Prochloraz/triticonazole	19,533	41	81,347	34	35,562	35	708	10	1,714	21	3,976	17	**144,410**	180,007
Prothioconazole	478	1	3,634	2	7,152	7	83	1	268	3	1,338	6	**13,051**	15,591
Prothioconazole/tebuconazole	0	0	2,286	1	6,454	6	0	0	926	11	3,038	13	**12,704**	197

(1) Includes winter rye and triticale

(2) Includes triticale

Cont…

Table 2 Cereals seed treatment formulations - 2016 continued

Area (ha) and percentage of crop treated

Seed treatments	Winter barley		Spring barley		Winter wheat		Spring wheat		Winter oats		Spring oats		All cereals (1)	2014 (2)
	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	**(ha)**	(ha)
Silthiofam	0	0	0	0	2,322	2	0	0	0	0	0	0	**2,322**	272
Unspecified seed treatment (3)	2,837	6	7,732	3	3,104	3	0	0	0	0	1,128	5	**14,801**	31,517
All seed treatments	**46,564**	**97**	**219,543**	**92**	**100,073**	**95**	**5,708**	**83**	**6,264**	**77**	**17,942**	**78**	**399,608**	**415,382**
No information seed treatment (3)	83	<0.5	3,212	1	2,288	2	297	4	461	6	0	0	**6,340**	2,580
No seed treatment	1,384	3	15,284	6	2,858	3	838	12	1,367	17	5,177	22	**27,732**	45,077
Area grown	48,030		238,901		102,753		6,843		8,091		23,119		**432,077**	461,474

(1) Includes winter rye and triticale
(2) Includes triticale
(3) Refer to Appendix 3 for definitions

Table 3 Cereal insecticide and molluscicide formulations - 2016

Area (ha) and percentage of crop treated

Insecticides	**Winter barley**		**Spring barley**		**Winter wheat**		**Spring wheat**		**Winter oats**		**Spring oats**		**All cereals** (1)	**2014**(2)
	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	**(ha)**	(ha)
Alpha-cypermethrin	0	0	0	0	280	<0.5	0	0	0	0	0	0	**280**	1,678
Chlorpyrifos	0	0	392	<0.5	1,104	1	83	1	0	0	95	<0.5	**1,674**	23,466
Cypermethrin	1,497	3	0	0	1,511	1	0	0	0	0	0	0	**3,008**	5,145
Deltamethrin	0	0	1,649	1	0	0	0	0	0	0	0	0	**1,649**	2,570
Esfenvalerate	2,405	5	97	0	1,808	2	0	0	0	0	0	0	**4,310**	16,790
Lambda-cyhalothrin	9,398	19	16,091	7	26,696	23	134	2	3,770	46	4,995	22	**62,763**	80,462
Zeta-cypermethrin	684	1	0	0	317	<0.5	0	0	789	10	0	0	**1,791**	11,536
All insecticides	**13,983**	**28**	**18,228**	**8**	**31,718**	**27**	**216**	**3**	**4,559**	**55**	**5,090**	**22**	**75,473**	**141,647**
Molluscicides														
Ferric phosphate	0	0	0	0	2,715	2	0	0	50	1	0	0	**2,765**	1,461
Metaldehyde	2,110	4	141	<0.5	13,432	10	0	0	50	1	0	0	**15,733**	7,227
Methiocarb	0	0	0	0	22	<0.5	0	0	0	0	0	0	**22**	2,468
All mollusicides	**2,110**	**4**	**141**	**<0.5**	**16,169**	**12**	**0**	**0**	**100**	**1**	**0**	**0**	**18,520**	**11,155**
Area grown	48,030		238,901		102,753		6,843		8,091		23,119		**432,077**	461,474

(1) Includes winter rye and triticale
(2) Includes triticale

Table 4 Cereals fungicide and sulphur formulations - 2016

Area (ha) and percentage of crop treated

Fungicides	Winter barley		Spring barley		Winter wheat		Spring wheat		Winter oats		Spring oats		All cereals (1)	2014(2)
	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	**(ha)**	(ha)
Azoxystrobin	0	0	1,395	1	778	1	0	0	0	0	721	3	**3,221**	12,370
Azoxystrobin/chlorothalonil	2,022	4	6,167	3	8,960	9	83	1	0	0	0	0	**17,232**	14,559
Azoxystrobin/cyproconazole	0	0	0	0	109	<0.5	0	0	1,336	17	672	3	**2,117**	3,282
Bixafen/fluoxastrobin/ prothioconazole	0	0	0	0	5,664	5	0	0	0	0	0	0	**5,664**	7,441
Bixafen/prothioconazole	10,036	15	25,796	9	17,301	14	0	0	0	0	0	0	**53,133**	70,945
Bixafen/prothioconazole/ spiroxamine	0	0	0	0	19,872	17	0	0	0	0	0	0	**19,872**	13,688
Bixafen/prothioconazole/ tebuconazole	0	0	0	0	9,655	8	0	0	0	0	0	0	**9,655**	5,099
Boscalid/epoxiconazole	0	0	6,119	3	38,427	34	0	0	0	0	0	0	**46,487**	46,463
Boscalid/epoxiconazole/ pyraclostrobin	0	0	0	0	644	1	0	0	0	0	0	0	**644**	2,887
Chlorothalonil	40,181	63	133,652	48	220,141	89	3,124	38	0	0	0	0	**397,294**	251,612
Chlorothalonil/cyproconazole	0	0	1,922	1	6,919	7	0	0	0	0	0	0	**8,841**	20,526
Chlorothalonil/cyproconazole/ propiconazole	563	1	2,282	1	6,924	7	45	1	0	0	0	0	**9,813**	25,191
Chlorothalonil/penthiopyrad	997	2	4,400	2	17,736	11	548	8	0	0	0	0	**23,680**	25,308
Chlorothalonil/picoxystrobin	8,058	15	30,388	13	4,160	4	0	0	0	0	0	0	**42,605**	45,939

(1) Includes winter rye and triticale
(2) Includes triticale

Cont…

Table 4 Cereals fungicide and sulphur formulations - 2016 continued

Area (ha) and percentage of crop treated

Fungicides	Winter barley		Spring barley		Winter wheat		Spring wheat		Winter oats		Spring oats		All cereals (1)	2014(2)
	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	**(ha)**	(ha)
Chlorothalonil/propiconazole	0	0	852	<0.5	454	<0.5	0	0	0	0	0	0	**1,306**	103
Chlorothalonil/proquinazid	2,678	6	0	0	8,227	6	167	2	0	0	0	0	**11,073**	11,822
Chlorothalonil/tebuconazole	658	1	0	0	28,874	25	0	0	0	0	0	0	**29,532**	28,231
Copper oxychloride	1,079	1	555	<0.5	0	0	0	0	0	0	0	0	**1,634**	0
Cyflufenamid	0	0	2,469	1	8,223	8	83	1	2,862	35	2,970	12	**16,606**	22,541
Cyproconazole	0	0	0	0	303	<0.5	0	0	0	0	0	0	**303**	2,497
Cyproconazole/penthiopyrad	0	0	0	0	4,530	4	0	0	0	0	0	0	**4,530**	0
Cyprodinil	14,515	26	10,370	4	0	0	0	0	0	0	0	0	**24,885**	47,617
Cyprodinil/isopyrazam	10,039	21	15,967	7	0	0	0	0	0	0	0	0	**26,006**	27,461
Dimoxystrobin/epoxiconazole	0	0	0	0	972	1	0	0	0	0	0	0	**972**	523
Epoxiconazole	0	0	4,807	2	40,302	37	545	7	4,576	57	4,315	14	**55,300**	84,480
Epoxiconazole/fenpropimorph	3,122	6	2,271	1	8,279	7	46	1	0	0	660	3	**14,379**	5,911
Epoxiconazole/fenpropimorph/ kresoxim-methyl	0	0	6,874	3	484	<0.5	0	0	678	8	662	2	**8,699**	9,320
Epoxiconazole/fenpropimorph/ metrafenone	266	1	4,211	1	5,923	5	231	2	1,177	12	3,153	14	**14,960**	41,891

(1) Includes winter rye and triticale
(2) Includes triticale

Cont…

Table 4 Cereals fungicide and sulphur formulations - 2016 continued

Area (ha) and percentage of crop treated

Fungicides	Winter barley		Spring barley		Winter wheat		Spring wheat		Winter oats		Spring oats		All cereals (1)	2014(2)
	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	**(ha)**	(ha)
Epoxiconazole/fluxapyroxad	2,545	5	2,207	1	49,283	29	66	1	0	0	0	0	**54,199**	19,000
Epoxiconazole/fluxapyroxad/ pyraclostrobin	2,548	5	20,738	9	8,259	8	0	0	51	1	489	2	**32,085**	15,528
Epoxiconazole/folpet	908	2	309	<0.5	2,454	2	0	0	0	0	0	0	**3,670**	0
Epoxiconazole/isopyrazam	0	0	392	<0.5	0	0	0	0	0	0	0	0	**392**	7,014
Epoxiconazole/metconazole	0	0	0	0	19,032	17	239	3	0	0	0	0	**19,271**	38,660
Epoxiconazole/metrafenone	373	1	0	0	3,668	3	0	0	184	2	1,560	7	**5,785**	7,286
Epoxiconazole/prochloraz	223	<0.5	1,633	1	11,309	8	537	5	0	0	0	0	**13,722**	18,265
Epoxiconazole/pyraclostrobin	0	0	2,328	1	6,806	7	120	2	270	3	341	1	**10,030**	17,615
Fenpropimorph	14,988	28	14,572	6	2,894	3	111	2	4,653	54	3,835	17	**41,866**	51,291
Fenpropimorph/pyraclostrobin	6,966	15	11,364	5	2,025	2	0	0	109	1	2,710	12	**23,173**	32,261
Fluoxastrobin/prothioconazole	1,523	3	3,466	1	3,124	3	0	0	3,708	46	2,015	9	**13,835**	21,517
Fluoxastrobin/prothioconazole/ trifloxystrobin	10,630	13	63,985	19	695	1	212	3	0	0	0	0	**75,684**	70,741
Fluxapyroxad	373	1	7,581	3	27,333	23	193	2	0	0	1,243	5	**36,724**	34,475
Fluxapyroxad/metconazole	223	<0.5	0	0	3,145	3	1,382	20	0	0	0	0	**4,750**	10,093

(1) Includes winter rye and triticale
(2) Includes triticale

Cont…

Table 4 Cereals fungicide and sulphur formulations - 2016 continued

Area (ha) and percentage of crop treated

Fungicides	Winter barley		Spring barley		Winter wheat		Spring wheat		Winter oats		Spring oats		All cereals (1)	2014(2)
	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	**(ha)**	(ha)
Fluxapyroxad/pyraclostrobin	2,459	5	3,245	1	5,135	5	0	0	0	0	0	0	**10,838**	0
Folpet	6,311	12	26,255	11	17,329	15	297	4	0	0	0	0	**50,191**	101,045
Isopyrazam	3,698	8	11,179	5	0	0	0	0	0	0	0	0	**14,877**	13,506
Mancozeb	0	0	0	0	1,642	1	0	0	0	0	0	0	**1,642**	6,906
Metconazole	0	0	0	0	0	0	380	6	0	0	0	0	**380**	1,656
Metrafenone	0	0	0	0	441	<0.5	0	0	868	11	1,880	8	**3,190**	12,419
Penthiopyrad	1,255	3	3,833	2	328	<0.5	0	0	0	0	0	0	**5,416**	19,245
Penthiopyrad/picoxystrobin	0	0	0	0	0	0	0	0	0	0	86	0	**86**	521
Picoxystrobin	0	0	0	0	454	<0.5	0	0	175	2	219	1	**848**	1,245
Prochloraz	0	0	0	0	2,676	3	0	0	0	0	0	0	**2,676**	2,180
Prochloraz/proquinazid/ tebuconazole	5,278	7	7,008	3	14,870	14	713	6	182	2	1,505	7	**29,556**	29,616
Prochloraz/tebuconazole	0	0	1,809	1	13,112	12	0	0	0	0	0	0	**14,921**	28,435
Proquinazid	1,488	3	1,259	1	17,529	17	250	4	4,673	45	6,948	23	**32,961**	40,680
Prothioconazole	9,547	19	24,973	9	28,523	28	83	1	0	0	931	4	**64,057**	79,824

(1) Includes winter rye and triticale
(2) Includes triticale

Cont…

Table 4 Cereals fungicide and sulphur formulations - 2016 continued

Area (ha) and percentage of crop treated

Fungicides	Winter barley		Spring barley		Winter wheat		Spring wheat		Winter oats		Spring oats		All cereals (1)	2014 (2)
	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	**(ha)**	(ha)
Prothioconazole/spiroxamine	29,255	36	94,473	31	8,735	8	0	0	0	0	3,507	14	**135,970**	139,948
Prothioconazole/spiroxamine/ Tebuconazole	0	0	4,192	2	0	0	0	0	0	0	0	0	**4,192**	1,965
Prothioconazole/tebuconazole	13,109	24	48,342	17	31,051	28	611	5	952	7	495	2	**95,591**	78,311
Prothioconazole/trifloxystrobin	11,552	18	36,122	13	3,106	3	0	0	0	0	14	0	**50,794**	39,621
Pyraclostrobin	0	0	0	0	3,261	3	0	0	536	7	835	4	**4,632**	10,356
Spiroxamine	2,059	4	0	0	1,583	2	0	0	0	0	0	0	**3,970**	16,319
Tebuconazole	4,102	8	1,732	0.4	29,675	29	142	2	1,592	20	1,032	4	**38,372**	32,255
Trifloxystrobin	3,566	7	8,021	3	0	0	0	0	0	0	0	0	**11,587**	6,322
All fungicides	**229,193**	**96**	**661,513**	**93**	**783,338**	**99**	**10,208**	**46**	**28,580**	**92**	**42,798**	**77**	**1,762,377**	**1,877,867**
Sulphur	**1,275**	**1**	**1,394**	**1**	**4,325**	**3**	**1,331**	**2**	**0**	**0**	**87**	**<0.5**	**8,412**	**9,482**
Area grown	48,030		238,901		102,753		6,843		8,091		23,119		**432,077**	461,474

(1) Includes winter rye and triticale
(2) Includes triticale

Table 5 Cereals herbicide and growth regulator formulations - 2016

Area (ha) and percentage of crop treated

Herbicides	Winter barley		Spring barley		Winter wheat		Spring wheat		Winter oats		Spring oats		All cereals (1)	2014 (2)
	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	**(ha)**	(ha)
2,4-D	0	0	520	<0.5	0	0	0	0	0	0	0	0	**520**	0
2,4-D/MCPA	0	0	2,975	1	0	0	0	0	0	0	0	0	**2,975**	14
2,4-DB	0	0	5,535	2	0	0	207	3	0	0	0	0	**5,742**	6,542
2,4-DB/MCPA	0	0	473	<0.5	0	0	0	0	0	0	0	0	**473**	0
Amidosulfuron	0	0	0	0	83	<0.5	0	0	0	0	0	0	**413**	274
Amidosulfuron/iodosulfuron-methyl-sodium	759	2	491	<0.5	0	0	0	0	0	0	0	0	**1,250**	1,406
Bromoxynil	0	0	225	<0.5	156	<0.5	0	0	0	0	0	0	**381**	0
Bromoxynil/ioxynil	0	0	1,153	<0.5	0	0	0	0	0	0	0	0	**1,153**	22,798
Carfentrazone-ethyl	0	0	0	0	143	<0.5	0	0	0	0	0	0	**143**	0
Carfentrazone-ethyl/ flupyrsulfuron-methyl	0	0	0	0	0	0	0	0	324	4	0	0	**324**	1,153
Carfentrazone-ethyl /mecoprop-P	0	0	0	0	143	<0.5	0	0	0	0	0	0	**143**	75
Chlorotoluron/diflufenican	0	0	0	0	238	<0.5	0	0	0	0	0	0	**238**	43,216
Chlorotoluron/diflufenican /pendimethalin	5,893	12	518	<0.5	1,387	1	0	0	0	0	0	0	**7,798**	0
Clodinafop-propargyl	0	0	0	0	9,529	9	0	0	0	0	0	0	**9,695**	5,087

(1) Includes winter rye and triticale
(2) Includes triticale

Cont…

Table 5 Cereals herbicide and growth regulator formulations -2016 continued

Area (ha) and percentage of crop treated

Herbicides	Winter barley		Spring barley		Winter wheat		Spring wheat		Winter oats		Spring oats		All cereals (1)	2014(2)
	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	**(ha)**	(ha)
Clopyralid	522	1	0	0	0	0	0	0	0	0	0	0	**522**	0
Clopyralid/florasulam	0	0	634	<0.5	0	0	0	0	0	0	582	3	**1,215**	0
Clopyralid/florasulam/fluroxypyr	2,229	5	22,084	9	3,016	3	0	0	64	1	2,449	11	**29,842**	31,871
Dicamba/MCPA/mecoprop-P	0	0	783	<0.5	0	0	0	0	0	0	984	4	**1,766**	11,313
Dicamba/mecoprop-P	7	<0.5	59,033	25	2,706	3	278	4	608	8	4,485	19	**67,117**	59,775
Dichlorprop-P/MCPA/ mecoprop-P	385	1	4,867	2	1,061	1	128	2	0	0	608	3	**7,049**	17,077
Diflufenican	13,141	27	20,168	8	24,127	23	165	2	184	2	2,700	12	**60,583**	27,992
Diflufenican/florasulam	0	0	1,204	1	123	<0.5	0	0	0	0	0	0	**1,326**	0
Diflufenican/flufenacet	14,239	30	15,806	7	22,663	22	1,382	20	3,574	44	680	3	**61,054**	61,458
Diflufenican/flufenacet/ flurtamone	4,918	10	0	0	10,971	10	0	0	0	0	0	0	**15,889**	743
Diflufenican/flupyrsulfuron-methyl	312	1	0	0	3,671	4	0	0	1,227	15	0	0	**5,211**	8,075
Diflufenican/flurtamone	3,002	6	0	0	666	1	0	0	0	0	0	0	**3,668**	4,913
Diflufenican/iodosulfuron-methyl-sodium/mesosulfuron-methyl	0	0	0	0	11,253	11	0	0	0	0	0	0	**11,253**	7,794
Diflufenican/pendimethalin	1,860	4	0	0	2,790	3	0	0	0	0	0	0	**4,649**	11,898

(1) Includes winter rye and triticale
(2) Includes triticale

Cont…

Table 5 Cereals herbicide and growth regulator formulations -2016 continued

Area (ha) and percentage of crop treated

Herbicides	Winter barley		Spring barley		Winter wheat		Spring wheat		Winter oats		Spring oats		All cereals (1)	2014 (2)
	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	**(ha)**	(ha)
Diquat	75	<0.5	0	0	0	0	0	0	0	0	0	0	**75**	650
Fenoxaprop-P-Ethyl	0	0	3,674	2	1,868	2	0	0	0	0	0	0	**5,542**	1,437
Florasulam	1,022	2	1,485	1	2,314	2	60	1	0	0	0	0	**4,880**	0
Florasulam/fluroxypyr	5,341	11	8,791	4	13,555	13	0	0	762	9	1,223	5	**29,769**	24,089
Florasulam/pyroxsulam	0	0	0	0	2,943	3	0	0	0	0	0	0	**2,943**	7,064
Flufenacet	1,155	2	0	0	0	0	0	0	0	0	0	0	**1,155**	0
Flufenacet/pendimethalin	2,133	4	2,477	1	2,325	2	0	0	0	0	0	0	**6,935**	10,272
Flufenacet/picolinafen	143	<0.5	0	0	0	0	0	0	0	0	0	0	**143**	0
Flupyrsulfuron-methyl	1,033	2	0	0	20,324	20	0	0	184	2	0	0	**21,541**	11,918
Flupyrsulfuron-methyl/pyroxsulam	0	0	0	0	0	0	0	0	0	0	0	0	**165**	0
Flupyrsulfuron-methyl/thifensulfuron-methyl	0	0	0	0	0	0	0	0	994	12	0	0	**994**	2,471
Fluroxypyr	4,698	10	51,916	22	17,860	17	3,231	47	3,688	46	1,520	7	**83,242**	69,179
Fluroxypyr/halauxifen-methyl	0	0	259	<0.5	0	0	0	0	0	0	0	0	**259**	0
Glyphosate	32,374	65	86,236	35	40,350	37	873	10	3,797	47	6,540	27	**171,119**	132,474

(1) Includes winter rye and triticale
(2) Includes triticale

Cont…

Table 5 Cereals herbicide and growth regulator formulations -2016 continued

Area (ha) and percentage of crop treated

Herbicides	Winter barley		Spring barley		Winter wheat		Spring wheat		Winter oats		Spring oats		All cereals (1)	2014 (2)
	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	**(ha)**	(ha)
Iodosulfuron-methyl-sodium	0	0	0	0	156	<0.5	0	0	0	0	0	0	**156**	3,021
Iodosulfuron-methyl-sodium/ mesosulfuron-methyl	0	0	0	0	3,650	4	0	0	0	0	0	0	**3,650**	4,051
MCPA	0	0	4,022	2	156	<0.5	0	0	0	0	320	1	**4,498**	19,819
Mecoprop-P	4,303	9	78,962	33	23,872	23	820	9	2,371	29	6,811	29	**117,839**	128,412
Metsulfuron-methyl	2,425	5	7,321	3	2,439	2	0	0	759	9	1,585	7	**14,528**	29,513
Metsulfuron-methyl/ thifensulfuron-methyl	1,453	3	92,288	39	6,728	7	2,278	33	0	0	0	0	**102,747**	105,959
Metsulfuron-methyl/ tribenuron-methyl	3,374	7	35,197	15	6,735	7	15	<0.5	2,420	30	6,804	29	**55,577**	48,785
Pendimethalin	12,233	25	6,134	3	16,892	16	1,516	22	137	2	680	3	**39,493**	33,728
Pendimethalin/picolinafen	15,695	33	17,367	7	40,048	38	165	2	0	0	929	4	**74,303**	38,457
Picolinafen	0	0	0	0	156	<0.5	0	0	0	0	0	0	**156**	769
Pinoxaden	6,709	14	35,015	15	3,141	3	148	2	0	0	0	0	**45,012**	82,337
Prosulfocarb	347	1	0	0	1,900	2	0	0	0	0	0	0	**2,248**	5,645
Sulfosulfuron	0	0	0	0	132	<0.5	0	0	0	0	0	0	**132**	0
Thifensulfuron-methyl	830	2	592	<0.5	1,185	1	0	0	0	0	0	0	**2,607**	5,735

(1) Includes winter rye and triticale
(2) Includes triticale

Cont…

Table 5 Cereals herbicide and growth regulator formulations – 2016 continued

Area (ha) and percentage of crop treated

Herbicides	Winter barley		Spring barley		Winter wheat		Spring wheat		Winter oats		Spring oats		All cereals (1)	2014 (2)
	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	**(ha)**	(ha)
Thifensulfuron-methyl/tribenuron-methyl	1,645	3	39,480	17	3,656	4	425	6	109	1	4,283	19	**49,597**	61,922
Tribenuron-methyl	1,867	4	12,682	5	3,218	3	0	0	260	3	136	1	**18,164**	27,011
Unspecified herbicide (3)	0	0	1,392	1	0	0	0	0	0	0	0	0	**1,392**	334
All herbicides	**146,121**	**95**	**621,755**	**96**	**310,331**	**98**	**11,690**	**91**	**21,461**	**92**	**43,317**	**83**	**1,163,254**	1,187,398
Growth regulators														
2-Chloroethylphosphonic acid	13,005	27	10,732	4	16,187	15	83	1	0	0	0	0	**40,743**	61,510
2-Chloroethylphosphonic acid/chlormequat	5,011	10	3,277	1	9,399	9	0	0	0	0	0	0	**17,687**	20,613
2-Chloroethylphosphonic acid/chlormequat chloride	1,959	4	336	<0.5	2,596	3	0	0	0	0	0	0	**4,891**	0
2-Chloroethylphosphonic acid/mepiquat	4,633	6	32	<0.5	952	1	0	0	0	0	0	0	**5,617**	13,438
2-Chloroethylphosphonic acid/mepiquat chloride	0	0	0	0	3,619	4	0	0	0	0	0	0	**3,619**	0
Chlormequat	38,321	67	13,423	6	117,740	82	1,388	18	7,376	86	11,990	49	**195,441**	188,096
Chlormequat chloride	0	0	125	<0.5	2,817	3	0	0	0	0	0	0	**2,941**	0

(1) Includes winter rye and triticale
(2) Includes triticale
(3) Refer to Appendix 3 for definition

Cont…

Table 5 Cereals herbicide and growth regulator formulations – 2016 continued

Area (ha) and percentage of crop treated

Growth regulators	Winter barley		Spring barley		Winter wheat		Spring wheat		Winter oats		Spring oats		All cereals (1)	2014(2)
	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	**(ha)**	(ha)
Chlormequat/imazaquin	0	0	0	0	17,959	14	0	0	0	0	0	0	**17,959**	16,240
Mepiquat chloride /prohexadione-calcium	13,219	24	8,913	4	14,419	13	0	0	1,412	17	3,821	17	**41,784**	53,851
Prohexadione-calcium/ trinexapac-ethyl	0	0	790	<0.5	995	1	0	0	0	0	0	0	**1,785**	0
Trinexapac-ethyl	34,078	54	13,203	6	93,732	70	856	12	6,254	59	4,644	20	**156,509**	168,120
All growth regulators	**110,227**	**92**	**50,830**	**18**	**280,413**	**98**	**2,326**	**18**	**15,041**	**92**	**20,455**	**68**	**488,976**	525,448
Area grown	48,030		238,901		102,753		6,843		8,091		23,119		**432,077**	461,474

(1) Includes winter rye and triticale
(2) Includes triticale

Table 6 Winter oilseed rape seed treatment formulations - 2016

Area (ha) and percentage of crop treated

Seed treatments	Winter oilseed rape		2014
	(ha)	(%)	(ha)
Prochloraz/thiram	25,368	84	7,585
Thiram	1,021	3	0
Unspecified seed treatment[1]	400	1	12,534
All seed treatments	**26,789**	**89**	**50,288**
No information seed treatment[1]	759	3	367
No seed treatment	2,594	9	275
Area grown	30,142		36,419

(1) Refer to Appendix 3 for definitions

Table 7 Winter oilseed rape insecticide and molluscicide formulations - 2016

Area (ha) and percentage of crop treated

Insecticides	Winter oilseed rape		2014
	(ha)	(%)	(ha)
Acetamiprid	168	1	0
Alpha-cypermethrin	1,399	5	2,896
Cypermethrin	985	3	2,219
Deltamethrin	326	1	402
Indoxacarb	589	2	0
Lambda-cyhalothrin	22,438	43	16,339
Tau-fluvalinate	11,035	32	16,290
Thiacloprid	1,856	6	0
Zeta-cypermethrin	4,986	17	9,842
All insecticides	**43,782**	**79**	**47,987**
Molluscicides			
Ferric Phosphate	1,187	4	1,306
Metaldehyde	14,353	39	12,887
Methiocarb	694	2	3,905
All molluscicides	**16,234**	**43**	**18,098**
Area grown	30,142		36,419

Table 8 Winter oilseed rape fungicide and sulphur formulations - 2016

Area (ha) and percentage of crop treated

Fungicides[1]	Winter oilseed rape		2014
	(ha)	(%)	(ha)
Azoxystrobin	4,577	12	4,357
Azoxystrobin/cyproconazole	860	3	3,562
Azoxystrobin/isopyrazam	700	2	0
Bixafen/prothioconazole/tebuconazole	3,193	11	5,652
Boscalid	7,931	26	7,790
Boscalid/dimoxystrobin	1,251	4	0
Boscalid/metconazole	4,873	16	10,341
Copper oxychloride	514	1	0
Difenoconazole	209	1	0
Fenpropimorph	609	2	0
Fluopyram/propiconazole	1,448	5	0
Fluopyram/prothioconazole	6,756	22	4,995
Iprodione/thiophanate-methyl	1,062	4	1,253
Penthiopyrad/picoxystrobin	4,569	14	0
Picoxystrobin	5,380	18	7,155
Prochloraz	894	3	151
Prochloraz/tebuconazole	9,425	27	7,808
Prothioconazole	17,112	37	17,578
Prothioconazole/tebuconazole	18,510	38	38,699
Tebuconazole	8,645	22	11,012
Thiophanate-methyl	2,163	7	0
All fungicides	**100,681**	**99**	**160,020**
Sulphur	**2,973**	**5**	**1,072**
Area grown	30,142		36,419

(1) It should be noted that the fungicides metconazole and tebuconazole, both have plant growth regulating properties on oilseed rape and therefore can have a dual purpose on this crop

Table 9 Winter oilseed rape herbicide and growth regulator formulations - 2016

Area (ha) and percentage of crop treated

Herbicides	Winter oilseed rape		2014
	(ha)	(%)	(ha)
Aminopyralid/propyzamide	1,528	5	824
Carbetamide	573	2	0
Clomazone	9,617	32	7,328
Clomazone/metazachlor	296	1	3,426
Clopyralid	23	<0.5	269
Clopyralid/picloram	2,075	7	910
Dimethachlor	412	1	748
Dimethenamid-P/metazachlor	2,552	8	488
Dimethenamid-P/ metazachlor/quinmerac	1,093	4	4,295
Diquat	1,021	3	1,577
Fluazifop-P-butyl	4,135	14	7,485
Glyphosate	23,010	76	25,872
Metazachlor	14,501	48	18,873
Metazachlor/quinmerac	6,420	21	7,414
Propaquizafop	12,589	41	12,634
Propyzamide	3,597	12	3,718
Quizalofop-P-ethyl	3,475	12	2,791
Quizalofop-P-tefuryl	3,490	12	6,650
All herbicides	**90,409**	**98**	**105,740**
Growth regulators[(1)]			
Mepiquat Chloride/Metconazole	5,965	20	3,692
All growth regulators	**5,965**	**20**	**3,692**
Area grown	30,142		36,419

(1) It should be noted that the fungicides metconazole and tebuconazole, both have plant growth regulating properties on oilseed rape and therefore can have a dual purpose on this crop.

Table 10 Potato seed treatment formulations - 2016

Area (ha) and percentage of crop treated

Seed treatments	Seed potatoes		Ware potatoes		All potatoes	2014
	(ha)	(%)	(ha)	(%)	**(ha)**	(ha)
Fludioxonil	930	7	95	1	**1,025**	0
Flutolanil	1,762	14	2,526	17	**4,288**	3,163
Imazalil	251	2	1,232	8	**1,484**	1,971
Imazalil/pencycuron	0	0	452	3	**452**	2,024
Imazalil/thiabendazole	1,043	8	1,651	11	**2,694**	4,226
Pencycuron	7,097	56	7,619	52	**14,716**	17,497
Unspecified seed treatment(1)	169	1	0	0	**169**	783
All seed treatments	**11,253**	**85**	**13,575**	**88**	**24,828**	**29,663**
No information seed treatment(1)	582	5	288	2	**869**	0
No seed treatment	1,309	10	1,526	10	**2,835**	1,884
Area grown	12,760		14,766		**27,526**	28,511

(1) Refer to Appendix 3 for definitions

Table 11 Potato insecticide and molluscicide formulations - 2016

Area (ha) and percentage of crop treated

Insecticides/nematicides	**Seed potatoes**		**Ware potatoes**		**All potatoes**	**2014**
	(ha)	(%)	(ha)	(%)	**(ha)**	(ha)
Acetamiprid	1,890	13	105	1	**1,996**	2,164
Cypermethrin	239	2	0	0	**239**	1,211
Esfenvalerate	20,882	69	5,585	25	**26,467**	28,427
Flonicamid	2,190	17	1,662	6	**3,852**	6,831
Fosthiazate	127	1	2,288	15	**2,415**	0
Lambda-cyhalothrin	26,378	71	1,351	7	**27,729**	36,247
Oxamyl	0	0	761	5	**761**	3,514
Pymetrozine	6,060	40	975	5	**7,035**	5,432
Thiacloprid	6,681	40	92	1	**6,773**	12,766
Thiamethoxam	1,101	7	0	0	**1,101**	4,379
Zeta-cypermethrin	351	2	0	0	**351**	0
All insecticides	**65,899**	**79**	**12,820**	**51**	**78,719**	**102,147**
Molluscicides						
Ferric phosphate	1,699	13	4,369	12	**6,068**	1,814
Metaldehyde	10,548	34	16,816	52	**27,364**	9,479
All molluscicides	**12,247**	**34**	**21,185**	**55**	**33,432**	**24,918**
Area grown	12,760		14,766		**27,526**	28,511

Table 12 Potato fungicide and sulphur formulations - 2016

Area (ha) and percentage of crop treated

Fungicides	**Seed potatoes**		**Ware potatoes**		**All potatoes**	**2014**
	(ha)	(%)	(ha)	(%)	**(ha)**	(ha)
Ametoctradin/dimethomorph	7,018	36	8,281	42	**15,299**	19,514
Amisulbrom	6,398	21	11,684	42	**18,082**	14,876
Azoxystrobin	1,182	9	2,916	20	**4,098**	3,459
Benthiavalicarb Isopropyl/mancozeb	5,849	21	3,190	16	**9,039**	10,867
Chlorothalonil/cymoxanil	152	1	147	<0.5	**299**	0
Copper oxychloride	1,690	4	0	0	**1,690**	0
Cyazofamid	25,695	88	36,409	77	**62,104**	62,110
Cymoxanil	26,642	67	33,502	66	**60,143**	72,528
Cymoxanil/famoxadone	1,645	10	2,247	14	**3,891**	8,119
Cymoxanil/fluazinam	577	4	5,265	20	**5,842**	0
Cymoxanil/mancozeb	19,760	57	34,053	66	**53,813**	61,641
Cymoxanil/mandipropamid	2,407	19	127	<0.5	**2,534**	0
Cymoxanil/propamocarb hydrochloride	1,800	11	8,127	23	**9,927**	7,607
Cymoxanil/zoxamide	2,367	12	2,407	10	**4,773**	0
Difenoconazole/mandipropamid	0	0	2,331	8	**2,331**	962
Dimethomorph/fluazinam	298	2	3,233	8	**3,531**	1,072
Dimethomorph/mancozeb	6,017	23	7,532	34	**13,549**	8,405
Fenamidone/propamocarb hydrochloride	3,610	19	1,632	8	**5,242**	5,552

Cont…

Table 12 Potato fungicide and sulphur formulations - 2016 continued

Area (ha) and percentage of crop treated

Fungicides	**Seed potatoes**		**Ware potatoes**		**All potatoes**	**2014**
	(ha)	(%)	(ha)	(%)	**(ha)**	(ha)
Fluazinam	16,987	73	24,584	70	**41,571**	54,111
Fluopicolide/propamocarb hydrochloride	4,772	30	6,946	26	**11,718**	17,507
Mancozeb	2,303	14	1,838	8	**4,141**	6,693
Mancozeb/metalaxyl-M	0	0	74	<0.5	**74**	0
Mancozeb/zoxamide	848	7	1,025	7	**1,874**	3,780
Mandipropamid	15,870	75	19,261	63	**35,131**	43,786
All fungicides	**153,885**	**100**	**216,811**	**98**	**370,696**	**402,924**
Sulphur	**0**	**0**	**265**	**2**	**265**	**0**
Area grown	12,760		14,766		**27,526**	28,511

Table 13 Potato herbicide and growth regulator formulations - 2016

Area (ha) and percentage of crop treated

Herbicides	**Seed potatoes**		**Ware potatoes**		**All potatoes**	**2014**
	(ha)	(%)	(ha)	(%)	**(ha)**	(ha)
Carfentrazone-ethyl	10,952	73	7,950	52	**18,902**	20,437
Clomazone	94	1	1,908	13	**2,002**	1,836
Cycloxydim	383	3	1,566	11	**1,950**	574
Diquat	26,004	93	30,200	92	**56,204**	53,080
Flufenacet/metribuzin	1,792	14	1,380	9	**3,172**	733
Glyphosate	138	1	68	<0.5	**206**	422
Linuron	7,234	57	9,095	62	**16,329**	13,985
Metobromuron	0	0	525	4	**525**	0
Metribuzin	8,606	67	10,305	70	**18,911**	18,801
Pendimethalin	0	0	947	6	**947**	2,012
Propaquizafop	0	0	284	2	**284**	428
Prosulfocarb	788	6	352	2	**1,140**	2,205
Pyraflufen-ethyl	127	1	722	5	**850**	0
Rimsulfuron	0	0	505	3	**505**	613
All herbicides	**56,119**	**95**	**65,808**	**98**	**121,927**	**115,397**
Growth regulators						
Maleic hydrazide	0	0	2,515	17	**2,515**	1,613
All growth regulators	**0**	**0**	**2,515**	**17**	**2,515**	**1,613**
Area grown	12,760		14,766		**27,526**	28,511

Table 14 Legume seed treatment formulations - 2016

Area (ha) and percentage of crop treated

Seed treatments	**Legumes**		**2014**
	(ha)	(%)	(ha)
Thiram	164	4	540
All seed treatments	**164**	**4**	**540**
No information seed treatment(1)	387	10	355
No seed treatment	3,226	85	2,486
Area grown	3,777		3,381

(1) Refer to Appendix 3 for definition

Table 15 Legume insecticide and molluscicide formulations - 2016

Area (ha) and percentage of crop treated

Insecticides	**Legumes**		**2014**
	(ha)	(%)	(ha)
Esfenvalerate	78	2	128
Lambda-cyhalothrin	472	12	933
Zeta-cypermethrin	439	6	53
All insecticides	**989**	**20**	**1,581**
Molluscicides			
Metaldehyde	458	12	0
All molluscicides	**458**	**12**	**0**
Area grown	3,777		3,381

Table 16 Legume fungicide and sulphur formulations - 2016

Area (ha) and percentage of crop treated

Fungicides	**Legumes**		**2014**
	(ha)	(%)	(ha)
Azoxystrobin	1,047	20	809
Boscalid/pyraclostrobin	629	17	748
Chlorothalonil	219	6	0
Chlorothalonil/cyproconazole	3,503	67	1,549
Metalaxyl-M	179	5	69
Tebuconazole	465	12	174
All fungicides	**6,042**	**85**	**4,222**
Sulphur	**230**	**6**	**914**
Area grown	3,777		3,381

Table 17 Legume herbicide formulations - 2016

Area (ha) and percentage of crop treated

Herbicides	**Legumes**		**2014**
	(ha)	(%)	(ha)
Carbetamide	458	12	0
Clomazone	748	20	300
Clomazone/linuron	179	5	0
Clomazone/metazachlor	0	0	0
Clomazone/pendimethalin	364	10	0
Diquat	651	17	1,215
Fluazifop-P-butyl	65	2	0
Glyphosate	1,908	49	1,855
Imazamox/pendimethalin	1,148	30	2,246
Linuron	811	21	53
Pendimethalin	1,394	37	766
Propaquizafop	326	9	674
All herbicides	**8,053**	**84**	**7,109**
Area grown	3,777		3,381

Table 18 Cereal seed treatment active substances - 2016

Area treated (ha), percentage of crop treated and quantity (kg) of active substances for all crops

Seed treatments	Winter barley		Spring barley		Winter wheat		Spring wheat		Winter oats		Spring oats		All cereals (1)	All cereals (1)
	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	**(ha)**	(kg)
Carboxin	785	2	2,799	1	569	1	0	0	0	0	1,159	5	**5,312**	616
Clothianidin	1,686	4	0	0	6,855	7	0	0	1,447	18	0	0	**9,988**	840
Difenoconazole	367	1	0	0	0	0	0	0	0	0	0	0	**1,181**	4
Fludioxonil	1,964	4	2,506	1	13,471	13	4,918	72	1,908	24	7,304	32	**33,917**	322
Fluopyram	16,438	34	94,126	39	0	0	0	0	0	0	0	0	**110,564**	219
Fluquinconazole	830	2	0	0	19,807	19	0	0	0	0	0	0	**20,637**	3,059
Imazalil	2,014	4	24,868	10	4,776	5	0	0	0	0	0	0	**31,659**	301
Ipconazole	2,014	4	25,112	11	4,776	5	0	0	0	0	0	0	**31,902**	121
Prochloraz	20,363	42	81,347	34	53,468	52	708	10	1,714	21	3,976	17	**163,146**	3,940
Prothioconazole	18,601	39	100,046	42	20,461	20	83	1	2,642	33	4,376	19	**146,306**	1,794
Silthiofam	0	0	0	0	2,322	2	0	0	0	0	0	0	**2,322**	117
Tebuconazole	16,805	35	96,412	40	6,454	6	0	0	926	11	3,038	13	**123,635**	693
Tefluthrin	0	0	0	0	786	1	0	0	0	0	0	0	**786**	31
Thiram	785	2	2,799	1	569	1	0	0	0	0	1,159	5	**5,312**	616
Triticonazole	19,533	41	81,347	34	35,562	35	708	10	1,714	21	3,976	17	**144,410**	1,140

(1) Includes winter rye and triticale

Cont…

Table 18 Cereal seed treatment active substances - 2016 continued

Area treated (ha), percentage of crop treated and quantity (kg) of active substances for all crops

Seed treatments	**Winter barley**		**Spring barley**		**Winter wheat**		**Spring wheat**		**Winter oats**		**Spring oats**		**All cereals** (1)	**All cereals** (1)
	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	**(ha)**	(kg)
Unspecified seed treatment(2)	2,837	6	7,732	3	3,104	3	0	0	0	0	1,128	5	**14,801**	N/A
All seed treatments	**105,021**	**97**	**519,096**	**92**	**172,981**	**95**	**6,416**	**83**	**10,351**	**77**	**26,115**	**78**	**845,878**	13,815
No information seed treatment(2)	83	<0.5	3,212	1	2,288	2	297	4	461	6	0	0	**6,340**	
No seed treatment	1,384	3	15,284	6	2,858	3	838	12	1,367	17	5,177	22	**27,732**	
Area grown	48,030		238,901		102,753		6,843		8,091		23,119		**432,077**	

(1) Includes winter rye and triticale
(2) Refer to Appendix 3 for definitions
N/A = not applicable

Table 19 Cereal insecticide and molluscicide active substances - 2016

Area treated (ha), percentage of crop treated and quantity (kg) of active substances for all crops

Insecticides	**Winter barley**		**Spring barley**		**Winter wheat**		**Spring wheat**		**Winter oats**		**Spring oats**		**All cereals** (1)	**All cereals** (1)
	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	**(ha)**	(kg)
Alpha-cypermethrin	0	0	0	0	280	0	0	0	0	0	0	0	**280**	4
Chlorpyrifos	0	0	392	<0.5	1,104	1	83	1	0	0	95	<0.5	**1,674**	1,046
Cypermethrin	1,497	3	0	0	1,511	1	0	0	0	0	0	1,497	**3,008**	72
Deltamethrin	0	0	1,649	1	0	0	0	0	0	0	0	0	**1,649**	10
Esfenvalerate	2,405	5	97	<0.5	1,808	2	0	0	0	0	0	2,405	**4,310**	12
Lambda-cyhalothrin	9,398	19	16,091	7	26,696	23	134	2	3,770	46	4,995	9,398	**62,763**	282
Zeta-cypermethrin	684	1	0	0	317	<0.5	0	0	789	10	0	684	**1,791**	22
All insecticides	**13,983**	**28**	**18,228**	**8**	**31,718**	**27**	**216**	**3**	**4,559**	**55**	**5,090**	**13,983**	**75,473**	**1,447**
Mollusicides														
Ferric Phosphate	0	0	0	0	2,715	2	0	0	50	1	0	0	**2,765**	370
Metaldehyde	2,110	4	141	<0.5	13,432	10	0	0	50	1	0	0	**15,733**	2,064
Methiocarb	0	0	0	0	22	<0.5	0	0	0	0	0	0	**22**	2
All molluscicides	**2,110**	**4**	**141**	**<0.5**	**16,169**	**12**	**0**	**0**	**100**	**1**	**0**	**0**	**18,520**	**2,436**
Area grown	48,030		238,901		102,753		6,843		8,091		23,119		**432,077**	

(1) Includes winter rye and triticale

Table 20 Cereal fungicide and sulphur active substances - 2016

Area treated (ha), percentage of crop treated and quantity (kg) of active substances for all crops

Fungicides	Winter barley		Spring barley		Winter wheat		Spring wheat		Winter oats		Spring oats		All cereals (1)	All cereals (1)
	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	**(ha)**	(kg)
Azoxystrobin	2,022	4	7,562	3	9,847	10	83	1	1,336	17	1,392	6	**22,569**	1,884
Bixafen	10,036	15	25,796	9	52,492	45	0	0	0	0	0	0	**88,324**	4,491
Boscalid	0	0	6,119	3	39,070	35	0	0	0	0	0	0	**47,130**	9,525
Chlorothalonil	55,156	83	177,701	64	290,987	96	3,597	40	0	0	0	0	**527,638**	237,464
Copper oxychloride	1,079	1	555	<0.5	0	0	0	0	0	0	0	0	**1,634**	713
Cyflufenamid	0	0	2,469	1	8,223	8	83	1	2,862	35	2,970	12	**16,606**	127
Cyproconazole	563	1	4,204	2	18,785	18	45	1	1,336	17	672	3	**25,605**	1,169
Cyprodinil	24,554	39	26,337	11	0	0	0	0	0	0	0	0	**50,891**	9,950
Dimoxystrobin	0	0	0	0	972	1	0	0	0	0	0	0	**972**	67
Epoxiconazole	9,985	19	51,612	19	171,602	86	1,665	15	6,936	83	11,181	44	**255,961**	15,926
Fenpropimorph	25,342	49	39,292	16	18,263	15	389	5	6,508	66	11,020	42	**101,627**	21,566
Fluoxastrobin	12,152	16	67,451	20	9,483	9	212	3	3,708	46	2,015	9	**95,183**	3,484
Fluxapyroxad	8,148	17	33,771	14	93,154	67	1,641	23	51	1	1,733	7	**138,596**	7,415
Folpet	7,219	14	26,563	11	19,783	17	297	4	0	0	0	0	**53,862**	22,599
Isopyrazam	13,738	29	27,537	12	0	0	0	0	0	0	0	0	**41,275**	2,510
Kresoxim-methyl	0	0	6,874	3	484	<0.5	0	0	678	8	662	2	**8,699**	464
Mancozeb	0	0	0	0	1,642	1	0	0	0	0	0	0	**1,642**	1,397
Metconazole	223	<0.5	0	0	22,177	20	2,001	28	0	0	0	0	**24,401**	777

(1) Includes winter rye and triticale

Cont…

Table 20 Cereal fungicide and sulphur active substances - 2016 continued

Area treated (ha), percentage of crop treated and quantity (kg) of active substances for all crops

Fungicides	**Winter barley**		**Spring barley**		**Winter wheat**		**Spring wheat**		**Winter oats**		**Spring oats**		**All cereals** (1)	**All cereals** (1)
	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	**(ha)**	(kg)
Metrafenone	639	1	4,211	1	10,031	9	231	2	2,229	25	6,593	29	**23,935**	1,413
Penthiopyrad	2,252	5	8,233	3	22,594	16	548	8	0	0	86	<0.5	**33,712**	3,499
Picoxystrobin	8,058	15	30,388	13	4,614	4	0	0	175	2	305	1	**43,539**	3,119
Prochloraz	5,501	8	10,451	4	40,863	32	1,250	11	182	2	1,505	7	**59,771**	10,590
Propiconazole	563	1	3,133	1	7,378	7	45	1	0	0	0	0	**11,119**	708
Proquinazid	9,444	16	8,268	3	40,627	35	963	10	4,854	47	8,453	29	**73,422**	1,634
Prothioconazole	85,174	94	301,349	85	127,182	84	905	9	4,660	53	6,962	29	**527,426**	43,564
Pyraclostrobin	11,973	25	37,674	16	26,129	21	120	2	965	12	4,375	19	**81,402**	5,926
Spiroxamine	31,315	39	98,665	32	30,190	23	0	0	0	0	3,507	14	**164,003**	27,001
Tebuconazole	23,146	34	63,083	22	125,693	78	1,406	12	2,725	29	3,033	13	**220,217**	19,267
Trifloxystrobin	25,748	38	108,128	35	3,801	4	212	3	0	0	14	0	**138,065**	5,458
All fungicides	**374,029**	**96**	**1,177,426**	**93**	**1,196,071**	**99**	**15,694**	**46**	**39,205**	**92**	**66,476**	**77**	**2,879,227**	**463,707**
Sulphur	**1,275**	**1**	**1,394**	**1**	**4,325**	**3**	**1,331**	**2**	**0**	**0**	**87**	**<0.5**	**8,412**	**22,980**
Area grown	48,030		238,901		102,753		6,843		8,091		23,119		**432,077**	

(1) Includes winter rye and triticale

Table 21 Cereal herbicide and growth regulator active substances - 2016

Area treated (ha), percentage of crop treated and quantity (kg) of active substances for all crops

Herbicides	Winter barley		Spring barley		Winter wheat		Spring wheat		Winter oats		Spring oats		All cereals (1)	All cereals (1)
	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	**(ha)**	(kg)
2,4-D	0	0	3,495	1	0	0	0	0	0	0	0	0	**3,495**	2,873
2,4-DB	0	0	6,007	3	0	0	207	3	0	0	0	0	**6,215**	5,322
Amidosulfuron	759	2	491	0	83	<0.5	0	0	0	0	0	0	**1,663**	38
Bromoxynil	0	0	1,378	1	156	<0.5	0	0	0	0	0	0	**1,533**	186
Carfentrazone-ethyl	0	0	0	0	143	<0.5	0	0	324	4	0	0	**467**	8
Chlorotoluron	5,893	12	518	<0.5	1,626	2	0	0	0	0	0	0	**8,037**	3,654
Clodinafop-propargyl	0	0	0	0	9,529	9	0	0	0	0	0	0	**9,695**	274
Clopyralid	2,751	6	22,718	9	3,016	3	0	0	64	1	3,030	13	**31,580**	2,074
Dicamba	7	<0.5	59,816	25	2,706	3	278	4	608	8	5,469	24	**68,884**	4,321
Dichlorprop-P	385	1	4,867	2	1,061	1	128	2	0	0	608	3	**7,049**	3,217
Diflufenican	37,845	79	36,172	15	71,059	66	1,547	23	4,986	62	3,380	15	**157,797**	8,095
Diquat	75	<0.5	0	0	0	0	0	0	0	0	0	0	**75**	30
Fenoxaprop-P-ethyl	0	0	3,674	2	1,868	2	0	0	0	0	0	0	**5,542**	300
Florasulam	8,592	18	34,197	14	21,950	19	60	1	826	10	4,253	18	**69,976**	181
Flufenacet	21,621	45	18,282	8	35,283	34	1,382	20	3,574	44	680	3	**83,532**	11,125
Flupyrsulfuron-methyl	1,345	3	0	0	23,910	23	0	0	2,729	34	0	0	**28,149**	189
Fluroxypyr	12,267	25	82,363	34	34,431	31	3,231	47	4,514	56	5,191	22	**142,425**	15,743
Flurtamone	7,920	16	0	0	11,638	11	0	0	0	0	0	0	**19,557**	1,200
Glyphosate	32,374	65	86,236	35	40,350	37	873	10	3,797	47	6,540	27	**171,119**	135,969

(1) Includes winter rye and triticale

Cont…

Table 21 Cereal herbicide and growth regulator active substances - 2016 continued

Area treated (ha), percentage of crop treated and quantity (kg) of active substances for all crops

Herbicides	Winter barley		Spring barley		Winter wheat		Spring wheat		Winter oats		Spring oats		All cereals (1)	All cereals (1)
	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	**(ha)**	(kg)
Halauxifen-methyl	0	0	259	0.1	0	0	0	0	0	0	0	0	**259**	1
Iodosulfuron-methyl-sodium	759	2	491	<0.5	15,059	15	0	0	0	0	0	0	**16,309**	34
Ioxynil	0	0	1,153	0.5	0	0	0	0	0	0	0	0	**1,153**	81
MCPA	385	1	13,119	5	1,217	1	128	2	0	0	1,912	8	**16,761**	7,557
Mecoprop-P	4,695	10	141,012	59	27,782	26	1,226	15	2,979	37	12,888	56	**191,282**	110,755
Mesosulfuron-methyl	0	0	0	0	14,903	15	0	0	0	0	0	0	**14,903**	105
Metsulfuron-methyl	7,251	15	134,806	56	15,902	15	2,293	34	3,179	39	8,388	36	**172,852**	597
Pendimethalin	32,764	68	25,410	11	60,377	58	1,681	25	137	2	1,609	7	**123,978**	95,989
Picolinafen	15,838	33	17,367	7	40,204	38	165	2	0	0	929	4	**74,601**	2,186
Pinoxaden	6,709	14	35,015	15	3,141	3	148	2	0	0	0	0	**45,012**	1,156
Prosulfocarb	347	1	0	0	1,900	2	0	0	0	0	0	0	**2,248**	3,596
Pyroxsulam	0	0	0	0	2,943	3	0	0	0	0	0	0	**3,108**	58
Sulfosulfuron	0	0	0	0	132	<0.5	0	0	0	0	0	0	**132**	3
Thifensulfuron-methyl	3,927	8	131,576	55	11,569	11	2,702	39	1,103	14	4,283	19	**155,161**	3,559
Tribenuron-methyl	6,886	14	87,359	36	13,609	13	440	6	2,788	34	11,223	49	**123,338**	1,009
Unspecified herbicide(2)	0	0	1,392	1	0	0	0	0	0	0	0	0	**1,392**	N/A
All herbicides	**211,396**	**95**	**949,173**	**96**	**467,546**	**98**	**16,489**	**91**	**31,607**	**92**	**70,384**	**83**	**1,759,278**	**421,484**

(1) Includes winter rye and triticale (2) Refer to Appendix 3 for definition.

Cont…

N/A = not applicable

Table 21 Cereal herbicide and growth regulator active substances -2016 continued

Area treated (ha), percentage of crop treated and quantity (kg) of active substances for all crops

Growth regulators	Winter barley		Spring barley		Winter wheat		Spring wheat		Winter oats		Spring oats		All cereals (1)	All cereals (1)
	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	**(ha)**	(kg)
2-Chloroethylphosphonic Acid	24,609	47	14,377	6	32,752	32	83	1	0	0	0	0	**72,557**	11,854
Chlormequat	43,332	70	16,700	7	145,098	91	1,388	18	7,376	86	11,990	49	**231,087**	174,118
Chlormequat chloride	1,959	4	461	<0.5	5,412	5	0	0	0	0	0	0	**7,833**	3,772
Imazaquin	0	0	0	0	17,959	14	0	0	0	0	0	0	**17,959**	17
Mepiquat	4,633	6	32	<0.5	952	1	0	0	0	0	0	0	**5,617**	1,595
Mepiquat chloride	13,219	24	8,913	4	18,037	16	0	0	1,412	17	3,821	17	**45,402**	6,718
Prohexadione-calcium	13,219	24	9,702	4	15,414	14	0	0	1,412	17	3,821	17	**43,569**	955
Trinexapac-ethyl	34,078	54	13,992	6	94,727	71	856	12	6,254	59	4,644	20	**158,294**	5,023
All growth regulators	**135,050**	**92**	**64,178**	**18**	**330,351**	**98**	**2,326**	**18**	**16,453**	**92**	**24,276**	**68**	**582,317**	**204,053**
Area grown	48,030		238,901		102,753		6,843		8,091		23,119		**432,077**	

(1) Includes winter rye and triticale

Table 22 Winter oilseed rape seed treatment active substances - 2016

Area treated (ha), percentage of crop treated and quantity (kg) of active substances

Seed treatments	Winter oilseed rape		Winter oilseed rape
	(ha)	(%)	(kg)
Prochloraz	25,368	84	90
Thiram	26,389	88	208
Unspecified seed treatment(1)	400	1	N/A
All seed treatments	**52,157**	**89**	**298**
No information seed treatment(1)	759	3	
No seed treatment	2,594	9	
Area grown	30,142		

(1) Refer to Appendix 3 for definitions
N/A = not applicable

Table 23 Winter oilseed rape insecticide and molluscicide active substances - 2016

Area treated (ha), percentage of crop treated and quantity (kg) of active substances

Insecticides	Winter oilseed rape		Winter oilseed rape
	(ha)	(%)	(kg)
Acetamiprid	168	1	7
Alpha-cypermethrin	1,399	5	17
Cypermethrin	985	3	22
Deltamethrin	326	1	2
Indoxacarb	589	2	12
Lambda-cyhalothrin	22,438	43	132
Tau-fluvalinate	11,035	32	437
Thiacloprid	1,856	6	128
Zeta-cypermethrin	4,986	17	49
All insecticides	**43,782**	**79**	**805**
Molluscicides			
Ferric phosphate	1,187	4	138
Metaldehyde	14,353	39	1,647
Methiocarb	694	2	61
All molluscicides	**16,234**	**43**	**1,846**
Area grown	30,142		

Table 24 Winter oilseed rape fungicide and sulphur active substances - 2016

Area treated (ha), percentage of crop treated and quantity (kg) of active substances

Fungicides	**Winter oilseed rape**		**Winter oilseed rape**
	(ha)	(%)	(kg)
Azoxystrobin	6,137	17	824
Bixafen	3,193	11	226
Boscalid	14,055	46	2,423
Copper oxychloride	514	1	100
Cyproconazole	860	3	63
Difenoconazole	209	1	9
Dimoxystrobin	1,251	4	125
Fenpropimorph	609	2	46
Fluopyram	8,203	27	825
Iprodione	1,062	4	398
Isopyrazam	700	2	66
Metconazole	4,873	16	270
Penthiopyrad	4,569	14	369
Picoxystrobin	9,949	22	1,202
Prochloraz	10,062	29	2,473
Propiconazole	1,448	5	153
Prothioconazole	45,571	89	4,889
Tebuconazole	38,484	64	3,988
Thiophanate-methyl	3,226	11	915
All fungicides	**154,974**	**99**	**19,361**
Sulphur	**2,973**	**5**	**12,995**
Area grown	30,142		

Table 25 Winter oilseed rape herbicide and growth regulator active substances - 2016

Area treated (ha), percentage of crop treated and quantity (kg) of active substances

Herbicides	**Winter oilseed rape**		**Winter oilseed rape**
	(ha)	(%)	(kg)
Aminopyralid	1,528	5	11
Carbetamide	573	2	1,032
Clomazone	9,913	33	579
Clopyralid	2,098	7	186
Dimethachlor	412	1	418
Dimethenamid-P	3,646	12	1,480
Diquat	1,021	3	613
Fluazifop-P-butyl	4,135	14	374
Glyphosate	23,010	76	30,707
Metazachlor	23,922	79	15,388
Picloram	2,075	7	46
Propaquizafop	12,589	41	613
Propyzamide	5,125	17	3,527
Quinmerac	7,514	25	1,579
Quizalofop-P-ethyl	3,475	12	110
Quizalofop-P-tefuryl	3,490	12	105
All herbicides	**104,526**	**98**	**56,768**
Growth regulators			
Mepiquat chloride	5,965	20	961
Metconazole	5,965	20	137
All growth regulators	**11,931**	**20**	**1,098**
Area grown	30,142		

Table 26 Potato seed treatment active substances - 2016

Area treated (ha), percentage of crop treated and quantity (kg) of active substances for all crops

Seed treatments	Seed potatoes		Ware potatoes		All potatoes	All potatoes
	(ha)	(%)	(ha)	(%)	**(ha)**	(kg)
Fludioxonil	930	7	95	1	**1,025**	99
Flutolanil	1,762	14	2,526	17	**4,288**	1,455
Imazalil	1,294	10	3,335	23	**4,629**	193
Pencycuron	7,097	56	8,071	55	**15,168**	8,996
Thiabendazole	1,043	8	1,651	11	**2,694**	270
Unspecified seed treatment(1)	169	1	0	0	**169**	N/A
All seed treatments	**12,295**	**85**	**15,678**	**88**	**27,973**	**11,014**
No information seed treatment(1)	582	5	288	2	**869**	
No seed treatment	1,309	10	1,526	10	**2,835**	
Area grown	12,760		14,766		**27,526**	

(1) Refer to Appendix 3 for definitions
N/A = not applicable

Table 27 Potato insecticide and molluscicide active substances - 2016

Area treated (ha), percentage of crop treated and quantity (kg) of active substances for all crops

Insecticides/nematicides	**Seed potatoes**		**Ware potatoes**		**All potatoes**	**All potatoes**
	(ha)	(%)	(ha)	(%)	**(ha)**	(kg)
Acetamiprid	1,890	13	105	1	**1,996**	97
Cypermethrin	239	2	0	0	**239**	6
Esfenvalerate	20,882	69	5,585	25	**26,467**	126
Flonicamid	2,190	17	1,662	6	**3,852**	306
Fosthiazate	127	1	2,288	15	**2,415**	5,370
Lambda-cyhalothrin	26,378	71	1,351	7	**27,729**	189
Oxamyl	0	0	761	5	**761**	2,478
Pymetrozine	6,060	40	975	5	**7,035**	976
Thiacloprid	6,681	40	92	1	**6,773**	591
Thiamethoxam	1,101	7	0	0	**1,101**	22
Zeta-cypermethrin	351	2	0	0	**351**	4
All insecticides	**65,899**	**79**	**12,820**	**51**	**78,719**	**10,166**
Molluscicides						
Ferric phosphate	1,699	13	4,369	12	**6,068**	653
Metaldehyde	10,548	34	16,816	52	**27,364**	2,854
All mollusicides	**12,247**	**34**	**21,185**	**55**	**33,432**	**3,506**
Area grown	12,760		14,766		**27,526**	

Table 28 Potato fungicide and sulphur active substances - 2016

Area treated (ha), percentage of crop treated and quantity (kg) of active substances for all crops

Fungicides	**Seed potatoes**		**Ware potatoes**		**All potatoes**	**All potatoes**
	(ha)	(%)	(ha)	(%)	**(ha)**	(kg)
Ametoctradin	7,018	36	8,281	42	**15,299**	3,659
Amisulbrom	6,398	21	11,684	42	**18,082**	1,787
Azoxystrobin	1,182	9	2,916	20	**4,098**	2,531
Benthiavalicarb isopropyl	5,849	21	3,190	16	**9,039**	252
Chlorothalonil	152	1	147	0	**299**	224
Copper oxychloride	1,690	4	0	0	**1,690**	845
Cyazofamid	25,695	88	36,409	77	**62,104**	4,958
Cymoxanil	55,289	87	81,347	95	**136,637**	12,313
Difenoconazole	0	0	2,331	8	**2,331**	350
Dimethomorph	13,332	52	19,047	58	**32,379**	5,626
Famoxadone	1,645	10	2,247	14	**3,891**	441
Fenamidone	3,610	19	1,632	8	**5,242**	775
Fluazinam	17,861	76	33,082	91	**50,943**	9,096
Fluopicolide	4,772	30	6,946	26	**11,718**	1,124
Mancozeb	34,026	77	46,426	85	**80,452**	101,795
Mandipropamid	18,277	75	21,719	66	**39,997**	5,837

Cont…

Table 28 Potato fungicide and sulphur active substances -2016 continued

Area treated (ha), percentage of crop treated and quantity (kg) of active substances for all crops

Fungicides	**Seed potatoes**		**Ware potatoes**		**All potatoes**	**All potatoes**
	(ha)	(%)	(ha)	(%)	**(ha)**	(kg)
Metalaxyl-M	0	0	74	0.5	**74**	5
Propamocarb hydrochloride	9,718	53	15,368	40	**25,086**	22,725
Zoxamide	3,215	19	3,432	17	**6,647**	875
All fungicides	**209,729**	**100**	**296,278**	**98**	**506,007**	**175,215**
Sulphur	**0**	**0**	**265**	**2**	**265**	**424**
Area grown	12,760		14,766		**27,526**	

Table 29 Potato herbicide and growth regulator active substances - 2016

Area treated (ha), percentage of crop treated and quantity (kg) of active substances for all crops

Herbicides	**Seed potatoes**		**Ware potatoes**		**All potatoes**	**All potatoes**
	(ha)	(%)	(ha)	(%)	**(ha)**	(kg)
Carfentrazone-ethyl	10,952	73	7,950	52	**18,902**	946
Clomazone	94	1	1,908	13	**2,002**	159
Cycloxydim	383	3	1,566	11	**1,950**	422
Diquat	26,004	93	30,200	92	**56,204**	21,598
Flufenacet	1,792	14	1,380	9	**3,172**	1,724
Glyphosate	138	1	68	<0.5	**206**	173
Linuron	7,234	57	9,095	62	**16,329**	9,147
Metobromuron	0	0	525	4	**525**	525
Metribuzin	10,251	80	11,685	79	**21,936**	10,152
Pendimethalin	0	0	947	6	**947**	809
Propaquizafop	0	0	284	2	**284**	43
Prosulfocarb	788	6	352	2	**1,140**	3,649
Pyraflufen-ethyl	127	1	722	5	**850**	18
Rimsulfuron	0	0	505	3	**505**	5
All herbicides	**57,764**	**95**	**67,189**	**98**	**124,952**	**49,369**
Growth regulators						
Maleic hydrazide	0	0	2,515	17	**2,515**	7,338
All growth regulators	**0**	**0**	**2,515**	**17**	**2,515**	**7,338**
Area grown	12,760		14,766		**27,526**	

Table 30 Legume seed treatment active substances - 2016

Area treated (ha), percentage of crop treated and quantity (kg) of active substances for all crops

Seed treatments	**Legumes**		**Legumes**
	(ha)	(%)	(kg)
Thiram	164	4	25
All seed treatments	**164**	**4**	**25**
No information seed treatment(1)	387	10	
No seed treatment	3,226	85	
Area grown	3,777		

(1) Refer to Appendix 3 for definition

Table 31 Legume insecticide and molluscicide active substances - 2016

Area treated (ha), percentage of crop treated and quantity (kg) of active substances for all crops

Insecticides	**Legumes**		**Legumes**
	(ha)	(%)	(kg)
Esfenvalerate	78	2	<0.5
Lambda-cyhalothrin	472	12	3
Zeta-cypermethrin	439	6	6
All insecticides	**989**	**20**	**10**
Molluscicides			
Metaldehyde	458	12	55
All molluscicides	**458**	**12**	**55**
Area grown	3,777		

Table 32 Legume fungicide and sulphur active substances - 2016

Area treated (ha), percentage of crop treated and quantity (kg) of active substances for all crops

Fungicides	**Legumes**		**Legumes**
	(ha)	(%)	(kg)
Azoxystrobin	1,047	20	119
Boscalid	629	17	112
Chlorothalonil	3,723	67	1,968
Cyproconazole	3,503	67	193
Metalaxyl-M	179	5	13
Pyraclostrobin	629	17	28
Tebuconazole	465	12	92
All fungicides	**10,175**	**85**	**2,525**
Sulphur	**230**	**6**	**1,068**
Area grown	3,777		

Table 33 Legume herbicide active substances - 2016

Area treated (ha), percentage of crop treated and quantity (kg) of active substances for all crops

Herbicides	**Legumes**		**Legumes**
	(ha)	(%)	(kg)
Carbetamide	458	12	825
Clomazone	1,291	34	85
Diquat	651	17	368
Fluazifop-P-butyl	65	2	6
Glyphosate	1,908	49	1,860
Imazamox	1,148	30	67
Linuron	990	26	485
Pendimethalin	2,312	61	2,389
Propaquizafop	326	9	23
All herbicides	**9,150**	**84**	**6,107**
Area grown	3,777		

Table 34 Mode of action/chemical group of insecticide/nematicide active substances on all arable crops - 2016

Area (ha) and quantity (kg) of active substances for all crops

Mode of Action	Active Substance	Chemical Group	IRAC Group	All arable	All arable
				(ha)	(kg)
Acetylcholinesterase (AChE) inhibitor	Oxamyl	Carbamate	1A	761	2,478
	Chlorpyrifos	Organophosphate	1B	1,674	1,046
	Fosthiazate	Organophosphate	1B	2,415	5,370
All acetylcholinesterase (AChE) inhibitors				**4,849**	**8,894**
Sodium channel modulators	Alpha-cypermethrin	Pyrethroid	3A	1,679	20
	Cypermethrin	Pyrethroid	3A	4,233	100
	Deltamethrin	Pyrethroid	3A	1,975	12
	Esfenvalerate	Pyrethroid	3A	30,855	138
	Lambda-cyhalothrin	Pyrethroid	3A	113,402	605
	Tau-Fluvalinate	Pyrethroid	3A	11,035	437
	Zeta-cypermethrin	Pyrethroid	3A	7,567	82
All sodium channel modulators				**170,746**	**1,394**
Nicotinic acetylcholine receptor (nAChR) competitive modulators	Acetamiprid	Neonicotinoid	4A	2,163	104
	Thiacloprid	Neonicotinoid	4A	8,629	720
	Thiamethoxam	Neonicotinoid	4A	1,101	22
All nAChR competitive modulators				**11,893**	**846**

Cont…

Table 34 Mode of action/chemical group of insecticide/nematicide active substances on all arable crops - 2016 continued

Area (ha) and quantity (kg) of active substances for all crops

Mode of Action	Active Substance	Chemical Group	IRAC Group	All arable	All arable
				(ha)	(kg)
Other					
Chordontonal organ TRPV channel modulators	Pymetrozine	Pyridine azomethine derivative	9B	7,035	976
Unclassified	Flonicamid	Pyridine compound	9C	3,852	306
Voltage-dependent sodium channel blocker	Indoxacarb	Oxadiazines	22A	589	12
All others				**11,475**	**1,295**
All insecticides				**198,964**	**12,428**
Area grown				494,167	

Note: Active substances have been grouped by their mode of action. Full details on mode of action classification can be found on the Insecticide Resistance Action Committee (IRAC) webpage[(9)].

Table 35 Mode of action/chemical group of fungicide active substances on all arable crops - 2016

Area (ha) and quantity (kg) of active substances for all crops

Mode of action	Active Substance	Group Name	Chemical Group	FRAC Group	All arable	All arable
					(ha)	(kg)
A: Nucleic acid synthesis	Metalaxyl-M	Phenylamide	Acylalanine	4	252	19
B: Cytoskeleton and motor proteins	Thiophanate-Methyl	Methyl benzimidazole carbamate	Thiophanate	1	3,226	915
	Zoxamide	Benzamide	Toluamides	22	6,647	875
	Fluopicolide	Benzamide	Pyridinylmethyl-benzamide	43	11,718	1,124
All cytoskeleton and motor proteins					**21,591**	**2,913**
C: Respiration	Bixafen	SDHI	Pyrazole-4-carboxamides	7	91,517	4,716
	Boscalid	SDHI	Pyridine-carboxamides	7	61,815	12,059
	Fluopyram	SDHI	Pyridinyl-ethyl-benzamides	7	8,203	825
	Fluxapyroxad	SDHI	Pyrazole-4-carboxamides	7	138,596	7,415
	Isopyrazam	SDHI	Pyrazole-4-carboxamides	7	41,975	2,576
	Penthiopyrad	SDHI	Pyrazole-4-carboxamides	7	38,281	3,867

Cont…

Table 35 Mode of action/chemical group of fungicide active substances on all arable crops - 2016 continued

Area (ha) and quantity (kg) of active substances for all crops

Mode of action	Active Substance	Group Name	Chemical Group	FRAC Group	All arable	All arable
					(ha)	(kg)
C: Respiration	Azoxystrobin	Qo inhibitors	Strobilurin	11	33,851	5,357
	Dimoxystrobin	Qo inhibitors	Strobilurin	11	2,224	192
	Fluoxastrobin	Qo inhibitors	Strobilurin	11	95,183	3,484
	Kresoxim-Methyl	Qo inhibitors	Strobilurin	11	8,699	464
	Picoxystrobin	Qo inhibitors	Strobilurin	11	53,488	4,321
	Pyraclostrobin	Qo inhibitors	Strobilurin	11	82,032	5,954
	Trifloxystrobin	Qo inhibitors	Strobilurin	11	138,065	5,458
	Famoxadone	Qo inhibitor	Oxazole	11	3,891	441
	Fenamidone	Qo inhibitor	Imidazolinones	11	5,242	775
	Cyazofamid	Qi inhibitor	Cyano-imidazole	21	62,104	4,958
	Amisulbrom	Qi inhibitor	Sulfamoyl-triazole	21	18,082	1,787
	Fluazinam	Phenylpyridinamine	2,6-dinitro-anilines	29	50,943	9,096
	Ametoctradin	Qo inhibitor, stigmatellin binding type	Triazolo-pyrimidine	45	15,299	3,659
All respiration					**949,488**	**77,404**

Cont…

Table 35 Mode of action/chemical group of fungicide active substances on all arable crops – 2016 continued

Area (ha) and quantity (kg) of active substances for all crops

Mode of action	Active Substance	Group Name	Chemical Group	FRAC Group	All arable	All arable
					(ha)	(kg)
D: Amino acids and protein synthesis	Cyprodinil	Anilino - pyrimidine	Anilino - pyrimidine	9	50,891	9,950
E: Signal transduction	Iprodione	Dicarboximide	Dicarboximide	2	1,062	398
	Proquinazid	Aza-naphthalenes	Quinazolinone	13	73,422	1,634
All signal transduction					**74,485**	**2,032**
F: Lipid synthesis and membrane integrity	Propamocarb Hydrochloride	Carbamate	Carbamate	28	25,086	22,725
G: Sterol biosynthesis in membranes	Cyproconazole	Demethylation inhibitor	Triazoles	3	29,968	1,425
	Difenoconazole	Demethylation inhibitor	Triazoles	3	2,540	359
	Epoxiconazole	Demethylation inhibitor	Triazoles	3	255,961	15,926
	Metconazole	Demethylation inhibitor	Triazoles	3	29,274	1,047
	Prochloraz	Demethylation inhibitor	Imidazoles	3	69,833	13,063
	Propiconazole	Demethylation inhibitor	Triazoles	3	12,567	861

Cont…

Table 35 Mode of action/chemical group of fungicide active substances on all arable crops – 2016 continued

Area (ha) and quantity (kg) of active substances for all crops

Mode of action	Active Substance	Group Name	Chemical Group	FRAC Group	All arable	All arable
					(ha)	(kg)
G: Sterol biosynthesis in membranes	Prothioconazole	Demethylation inhibitor	Triazolinthiones	3	572,997	48,454
	Tebuconazole	Demethylation inhibitor	Triazoles	3	259,166	23,347
	Spiroxamine	Morpholine	Spiroketal-amines	5	164,003	27,001
	Fenpropimorph	Morpholine	Morpholines	5	102,236	21,612
All sterol biosynthesis in membranes					**1,498,544**	**153,095**
H: Cell wall biosynthesis	Dimethomorph	Carboxylic acid amide	Morpholine/ cinomic acid amide	40	32,379	5,626
	Mandipropamid	Carboxylic acid amide	Mandelic acid amides	40	39,997	5,837
	Benthiavalicarb Isopropyl	Carboxylic acid amide	Valinamide carbamate	40	9,039	252
All cell wall biosynthesis					**81,414**	**11,714**
U: Unknown mode of action	Cymoxanil	Cyanoacetamide oxime	Cyanoacetamide oxime	27	136,637	12,313
	Cyflufenamid	Phenyl-acetamide	Phenyl-acetamide	U 06	16,606	127

Cont…

Table 35 Mode of action/chemical group of fungicide active substances on all arable crops -2016 continued

Area (ha) and quantity (kg) of active substances for all crops

Mode of action	Active Substance	Group Name	Chemical Group	FRAC Group	All arable	All arable
					(ha)	(kg)
U: Unknown mode of action	Metrafenone	Aryl-phenyl-ketone	Benzophenone	U 08	23,935	1,413
All unknown mode of action					**177,178**	**13,853**
M: Chemicals with multi-site activity	Copper Oxychloride	Inorganic	Inorganic	M 01	3,838	1,658
	Mancozeb	Dithio-carbamate	Dithio-carbamate	M 03	82,095	103,191
	Folpet	Phthalimide	Phthalimide	M 04	53,862	22,599
	Chlorothalonil	Chloronitrile	Chloronitrile	M 05	531,659	239,656
All chemicals with multi-site activity					**671,454**	**367,105**
All fungicides					**3,550,384**	**660,809**
Sulphur					**11,879**	**37,467**
Area grown					494,167	

Note: Active substances have been grouped by their mode of action. Full details on mode of action classification can be found on the Fungicide Resistance Action Committee (FRAC) webpage[10].

Table 36 Mode of action/chemical group of herbicide active substances on all arable crops - 2016

Area (ha) and quantity (kg) of active substances for all crops

Mode of Action	Active Substance	Chemical Group	HRAC Group	All arable	All arable
				(ha)	(kg)
Inhibition of acetyl CoA carboxylase	Clodinafop-propargyl	Aryloxyphenoxy-propionate 'FOPS'	A	9,695	274
	Fenoxaprop-P-ethyl	Aryloxyphenoxy-propionate 'FOPS'	A	5,542	300
	Fluazifop-P-butyl	Aryloxyphenoxy-propionate 'FOPS'	A	4,200	380
	Propaquizafop	Aryloxyphenoxy-propionate 'FOPS'	A	13,198	678
	Quizalofop-P-ethyl	Aryloxyphenoxy-propionate 'FOPS'	A	3,475	110
	Quizalofop-P-tefuryl	Aryloxyphenoxy-propionate 'FOPS'	A	3,490	105
	Cycloxydim	Cyclohexanedione 'DIMS'	A	1,950	422
	Pinoxaden	Phenylpyrazoline	A	45,012	1,156
All Inhibition of acetyl CoA carboxylase				**86,562**	**3,425**
Inhibition of acetolactate synthase ALS	Amidosulfuron	Sulfonylurea	B	1,663	38
	Flupyrsulfuron-methyl	Sulfonylurea	B	28,149	189

Cont…

Table 36 Mode of action/chemical group of herbicide active substances on all arable crops -2016 continued

Area (ha) and quantity (kg) of active substances for all crops

Mode of Action	Active Substance	Chemical Group	HRAC Group	All arable	All arable
				(ha)	(kg)
Inhibition of acetolactate synthase ALS	Iodosulfuron-methyl-sodium	Sulfonylurea	B	16,309	34
	Mesosulfuron-methyl	Sulfonylurea	B	14,903	105
	Metsulfuron-methyl	Sulfonylurea	B	172,852	597
	Rimsulfuron	Sulfonylurea	B	505	5
	Sulfosulfuron	Sulfonylurea	B	132	3
	Thifensulfuron-methyl	Sulfonylurea	B	155,161	3,559
	Tribenuron-methyl	Sulfonylurea	B	123,338	1,009
	Imazamox	Imidazolinone	B	1,148	67
	Florasulam	Triazolopyrimidine	B	69,976	181
	Pyroxsulam	Triazolopyrimidine	B	3,108	58
All inhibition of acetolactate synthase ALS				**587,245**	**5,845**
Inhibition of photosynthesis at photosystem II	Metribuzin	Triazinone	C1	21,936	10,152
	Chlorotoluron	Urea	C2	8,037	3,654
	Linuron	Urea	C2	17,319	9,632
	Metobromuron	Urea	C2	525	525
	Bromoxynil	Nitrile	C3	1,533	186

Cont…

Table 36 Mode of action/chemical group of herbicide active substances on all arable crops -2016 continued

Area (ha) and quantity (kg) of active substances for all crops

Mode of Action	Active Substance	Chemical Group	HRAC Group	All arable	All arable
				(ha)	(kg)
	Ioxynil	Nitrile	C3	1,153	81
All inhibition of photosynthesis at photosystem II				**50,504**	**24,230**
Photosystem-I-electron diversion	Diquat	Bipyridylium	D	57,951	22,608
Inhibition of protoporphyrinogen oxidase	Carfentrazone-ethyl	Triazolone	E	19,369	953
	Pyraflufen-ethyl	Phenylpyrazole	E	850	18
All inhibition of protoporphyrinogen oxidase				**20,218**	**971**
Bleaching: Inhibition of carotenoid biosynthesis	Diflufenican	Pyridinecarboxamide	F1	157,797	8,095
	Flurtamone	Other	F1	19,557	1,200
	Picolinafen	Pyridinecarboxamide	F1	74,601	2,186
All bleaching: inhibition of carotenoid biosynthesis				**251,956**	**11,481**
Bleaching: DOXP inhibitors	Clomazone	Isoxazolidinone	F4	13,206	822
Inhibition of EPSP synthase	Glyphosate	Glycine	G	196,243	168,709
Microtubule assembly inhibition	Pendimethalin	Dinitroaniline	K1	127,238	99,187
	Propyzamide	Benzamide	K1	5,125	3,527
All microtubule assembly inhibition				**132,363**	**102,715**

Cont…

Table 36 Mode of action/chemical group of herbicide active substances on all arable crops – 2016 continued

Area (ha) and quantity (kg) of active substances for all crops

Mode of Action	Active Substance	Chemical Group	HRAC Group	All arable	All arable
				(ha)	(kg)
Inhibition of mitosis / microtubule organisation	Carbetamide	Carbamate	K2	1,032	1,857
Inhibition of VLCFAs	Dimethenamid-P	Chloroacetamide	K3	3,646	1,480
	Metazachlor	Chloroacetamide	K3	23,922	15,388
	Dimethachlor	Chloroacetamide	K3	412	418
	Flufenacet	Oxyacetamide	K3	86,704	12,849
All inhibition of VLCFAs				**114,684**	**30,135**
Inhibition of lipid synthesis	Prosulfocarb	Thiocarbamate	N	3,388	7,245
Action like indole acetic acid	2,4-D	Phenoxy-carboxylic acid	O	3,495	2,873
	2,4-DB	Phenoxy-carboxylic acid	O	6,215	5,322
	Dichlorprop-P	Phenoxy-carboxylic acid	O	7,049	3,217
	MCPA	Phenoxy-carboxylic acid	O	16,761	7,557
	Mecoprop-P	Phenoxy-carboxylic acid	O	191,282	110,755
	Dicamba	Benzoic acid	O	68,884	4,321

Cont…

Table 36 Mode of action/chemical group of herbicide active substances on all arable crops -2016 continued

Area (ha) and quantity (kg) of active substances for all crops

Mode of Action	Active Substance	Chemical Group	HRAC Group	All arable	All arable
				(ha)	(kg)
Action like indole acetic acid	Aminopyralid	Pyridine carboxylic acid	O	1,528	11
	Clopyralid	Pyridine carboxylic acid	O	33,678	2,260
	Fluroxypyr	Pyridine carboxylic acid	O	142,425	15,743
	Picloram	Pyridine carboxylic acid	O	2,075	46
	Quinmerac	Quinoline carboxylic acid	O	7,514	1,579
	Halauxifen-methyl	Arylpicolinate	O	259	1
All action like indole acetic acid				**481,162**	**153,684**
All herbicides				**1,996,514**	**533,728**
Area grown				494,167	

Note: Active substances have been grouped by their mode of action. Full details on mode of action classification can be found on the Herbicide Resistance Action Committee (HRAC) webpage[(11)].

Table 37 Principal active substances by area treated - 2016

Area treated (1000 ha) with the 50 most used active substances, including seed treatments, on all crops surveyed

No.	Active substance	Type[(1)]	2016	2014	% change
1	Prothioconazole	F/S	719	718	<0.5
2	Chlorothalonil	F	532	422	26
3	Tebuconazole	F/S	383	353	8
4	Prochloraz	F/S	258	287	-10
5	Epoxiconazole	F	256	293	-13
6	Chlormequat	G	231	224	3
7	Glyphosate	H	196	161	22
8	Mecoprop-P	H	191	217	-12
9	Metsulfuron-methyl	H	173	183	-6
10	Spiroxamine	F	164	176	-7
11	Trinexapac-ethyl	G	158	168	-6
12	Diflufenican	H	158	153	3
13	Thifensulfuron-methyl	H	155	176	-12
14	Triticonazole	S	144	180	-20
15	Fluroxypyr	H	142	124	15
16	Fluxapyroxad	F	139	79	75
17	Trifloxystrobin	F	138	117	18
18	Cymoxanil	F	137	144	-5
19	Pendimethalin	H	127	95	34
20	Tribenuron-methyl	H	123	138	-10
21	Fluopyram	F/S	119	101	17
22	Lambda-cyhalothrin	I	113	134	-15
23	Fenpropimorph	F	102	157	-35
24	Fluoxastrobin	F	95	100	-5
25	Bixafen	F	92	103	-11
26	Flufenacet	H	87	68	27
27	Mancozeb	F	82	96	-15
28	Pyraclostrobin	F	82	80	2
29	Picolinafen	H	75	39	90
30	Proquinazid	F	73	82	-11
31	2-Chloroethylphosphonic Acid	G	73	99	-26
32	Florasulam	H	70	62	12
33	Dicamba	H	69	69	-1
34	Cyazofamid	F	62	62	0
35	Boscalid	F	62	68	-9
36	Diquat	H	58	57	3
37	Metaldehyde	M	58	30	96
38	Folpet	F	54	101	-47
39	Picoxystrobin	F	53	61	-12
40	Mepiquat chloride	G	51	61	-16
41	Fluazinam	F	51	55	-7
42	Cyprodinil	F	51	79	-36
43	Pinoxaden	H	45	82	-45
44	Prohexadione-calcium	G	44	54	-19
45	Isopyrazam	F	42	48	-13
46	Mandipropamid	F	40	45	-11
47	Penthiopyrad	F	38	45	-15
48	Imazalil	S	36	17	110
49	Metconazole	F/G	35	78	-55
50	Fludioxonil	S	35	53	-34

(1) Pesticide type = F: Fungicide, G: Growth regulator, H: Herbicide, I: Insecticide, M: Molluscicide, S: Seed treatment.

Table 38 Principal active substances by weight - 2016

Quantity (tonnes) of the 50 most used active substances, including seed treatments, on all crops surveyed

No.	Active substance	Type[(1)]	2016	2014	% change
1	Chlorothalonil	F	240	179	34
2	Chlormequat	G	174	170	3
3	Glyphosate	H	169	134	26
4	Mecoprop-P	H	111	108	2
5	Mancozeb	F	103	101	2
6	Pendimethalin	H	99	71	39
7	Prothioconazole	F/S	50	54	-7
8	Sulphur	F	37	24	54
9	Spiroxamine	F	27	28	-5
10	Tebuconazole	F/S	24	24	-2
11	Propamocarb hydrochloride	F	23	26	-12
12	Diquat	H	23	21	7
13	Folpet	F	23	40	-43
14	Fenpropimorph	F	22	30	-28
15	Prochloraz	F/S	17	20	-13
16	Epoxiconazole	F	16	17	-8
17	Fluroxypyr	H	16	13	22
18	Metazachlor	H	15	21	-27
19	Flufenacet	H	13	9	36
20	Cymoxanil	F	12	12	4
21	Boscalid	F	12	14	-11
22	2-Chloroethylphosphonic Acid	G	12	17	-29
23	Metribuzin	H	10	10	4
24	Cyprodinil	F	10	16	-39
25	Linuron	H	10	8	28
26	Fluazinam	F	9	12	-24
27	Pencycuron	S	9	10	-14
28	Diflufenican	H	8	7	10
29	Mepiquat chloride	G	8	9	-13
30	MCPA	H	8	35	-79
31	Fluxapyroxad	F	7	4	85
32	Maleic hydrazide	G	7	5	58
33	Prosulfocarb	H	7	16	-56
34	Metaldehyde	M	7	3	112
35	Pyraclostrobin	F	6	6	5
36	Mandipropamid	F	6	7	-12
37	Dimethomorph	F	6	5	12
38	Trifloxystrobin	F	5	4	21
39	Fosthiazate	I	5	0	N/A
40	Azoxystrobin	F	5	7	-21
41	2,4-DB	H	5	6	-13
42	Trinexapac-ethyl	G	5	5	-6
43	Cyazofamid	F	5	5	2
44	Bixafen	F	5	5	-9
45	Picoxystrobin	F	4	6	-26
46	Dicamba	H	4	4	5
47	Penthiopyrad	F	4	5	-19
48	Chlormequat chloride	G	4	1	457
49	Ametoctradin	F	4	5	-20
50	Chlorotoluron	H	4	53	-93

(1) Pesticide type = F: Fungicide, G: Growth regulator, H: Herbicide, I: Insecticide/nematicide, M: Molluscicide, S: Seed treatment.

Table 39 Compounds encountered in the arable survey for the first time in 2016

Active substance	Type[(1)]	Area treated (ha)	Amount used (kg)
Halauxifen-methyl	H	259	1
Metobromuron	H	525	525
Pyraflufen-ethyl	H	850	18

Table 40 Total arable crop, comparison with previous years

Pesticide usage in 2012, 2014 and 2016, area treated with formulations (Forms), active substances (a.s.) and quantity applied (kg)

	2012			2014			2016		
	Forms (ha)	**a.s. (ha)**	**kg**	**Forms (ha)**	**a.s. (ha)**	**kg**	**Forms (ha)**	**a.s. (ha)**	**kg**
Insecticides & nematicides	227,938	227,763	25,605	293,363	293,363	29,389	198,964	198,964	12,428
Molluscicides	96,187	96,187	10,299	54,171	54,171	5,333	68,645	68,645	7,843
Physical control	1,083	1,083	271	0	0	0	0	0	0
Fungicides	2,394,861	3,666,147	610,946	2,445,034	3,852,458	660,121	2,239,796	3,550,384	660,809
Sulphur	7,140	7,140	21,237	11,468	11,468	24,353	11,879	11,879	37,467
Herbicides/desiccants	1,404,697	2,031,752	551,313	1,416,298	2,060,274	553,963	1,383,643	1,997,906	533,728
Growth regulators	449,357	527,598	184,073	530,753	644,131	209,708	497,456	596,763	212,489
Seed treatments	504,481	890,577	29,792	496,527	996,382	26,838	451,389	926,172	25,150
All pesticides	**5,085,653**	**7,448,247**	**1,433,537**	**5,247,614**	**7,912,247**	**1,509,705**	**4,851,771**	**7,350,712**	**1,489,914**
Total area grown (ha)	528,467			531,269			494,167		

Note: Unspecified treatments have been included in the formulation and active substance areas, however as their weights are unknown they cannot be included in the quantities applied. Total arable includes cereals, oilseeds, potatoes and legumes. It should be noted that there may be minor differences in the range of crops surveyed between years.

Table 41 Cereals, comparison with previous years

Pesticide usage in 2012, 2014 and 2016, area treated with formulations (Forms), active substances (a.s.) and quantity applied (kg)

	2012			2014			2016		
	Forms (ha)	**a.s. (ha)**	**kg**	**Forms (ha)**	**a.s. (ha)**	**kg**	**Forms (ha)**	**a.s. (ha)**	**kg**
Insecticides	91,537	91,537	4,522	141,647	141,647	17,127	75,473	75,473	1,447
Molluscicides	27,645	27,645	2,746	11,155	11,155	1,184	18,520	18,520	2,436
Fungicides	1,797,200	2,898,385	421,962	1,877,867	3,069,096	454,831	1,762,377	2,879,227	463,707
Sulphur	5,296	5,296	13,091	9,482	9,482	19,050	8,412	8,412	22,980
Herbicides	1,175,700	1,785,036	429,288	1,187,398	1,811,144	435,914	1,163,254	1,759,278	421,484
Growth regulators	449,274	527,515	183,823	525,448	635,135	204,358	488,976	582,317	204,053
Seed treatments	416,294	740,907	15,299	415,382	854,612	14,291	399,608	845,878	13,815
All pesticides	**3,963,937**	**6,077,403**	**1,071,004**	**4,168,379**	**6,532,270**	**1,146,754**	**3,916,621**	**6,169,106**	**1,129,922**
Area grown (ha)	456,895			461,474			432,077		

Note: Unspecified treatments have been included in the formulation and active substance areas, however as their weights are unknown they cannot be included in the quantities applied.

Table 42 Potatoes, comparison with previous years

Pesticide usage in 2012, 2014 and 2016, area treated with formulations (Forms), active substances (a.s.) and quantity applied (kg)

	2012			2014			2016		
	Forms (ha)	**a.s. (ha)**	**kg**	**Forms (ha)**	**a.s. (ha)**	**kg**	**Forms (ha)**	**a.s. (ha)**	**kg**
Insecticides & nematicides	85,246	85,246	20,085	102,147	102,147	11,361	78,719	78,719	10,166
Molluscicides	51,567	51,567	5,439	24,918	24,918	2,445	33,432	33,432	3,506
Fungicides	451,729	571,088	159,735	402,924	539,323	176,009	370,696	506,007	175,215
Sulphur	863	863	4,833	0	0	0	265	265	424
Herbicides/desiccants	126,444	130,181	54,561	115,397	116,130	47,548	121,927	124,952	49,369
Growth regulators	83	83	250	1,613	1,613	4,648	2,515	2,515	7,338
Seed treatments	31,427	37,722	13,741	29,663	35,752	11,911	24,828	27,973	11,014
All pesticides	**747,359**	**876,750**	**258,644**	**676,664**	**819,884**	**253,922**	**632,381**	**773,863**	**257,032**
Area grown (ha)	29,536			28,511			27,526		

Note: Unspecified treatments have been included in the formulation and active substance areas, however as their weights are unknown they cannot be included in the quantities applied.

Table 43 Winter oilseed rape, comparison with previous years

Pesticide usage in 2012, 2014 and 2016, area treated with formulations (Forms), active substances (a.s.) and quantity applied (kg)

	2012			2014			2016		
	Forms (ha)	**a.s. (ha)**	**kg**	**Forms (ha)**	**a.s. (ha)**	**kg**	**Forms (ha)**	**a.s. (ha)**	**kg**
Insecticides	49,302	49,128	944	47,987	47,987	886	43,782	43,782	805
Molluscicides	16,976	16,976	2,113	18,098	18,098	1,705	16,234	16,234	1,846
Fungicides	139,915	186,129	26,938	160,020	237,183	27,642	100,681	154,974	19,361
Sulphur	981	981	3,313	1,072	1,072	3,426	2,973	2,973	12,995
Herbicides/desiccants	90,691	102,739	58,280	105,740	123,196	64,310	90,409	104,526	56,768
Growth regulators	0	0	0	3,692	7,383	702	5,965	11,931	1,098
Seed treatments	55,746	109,898	690	50,288	104,457	534	26,789	52,157	298
All pesticides	**353,610**	**465,851**	**92,279**	**386,898**	**539,378**	**99,205**	**286,833**	**386,577**	**93,171**
Area grown (ha)	35,541			36,419				30,142	

Note: Unspecified treatments have been included in the formulation and active substance areas, however as their weights are unknown they cannot be included in the quantities applied.

Appendix 2 – Survey statistics

Census and sample information

Table 44 Regional distribution of arable crops in 2016

Census area (ha) of arable crops grown in Scotland

	H&I [1]	C&O [1]	Moray Firth	Abdn [1]	Angus	East Fife	Lothian	C. Low-lands [1]	Tweed Valley	S. Uplands [1]	Solway	Scotland 2016	Scotland 2014	% change
Winter Barley	103	236	2,013	14,797	7,195	4,128	3,951	4,971	7,194	878	2,564	**48,031**	52,507	-9
Spring Barley	4,300	7,302	34,535	71,873	46,391	12,136	11,395	26,129	13,238	3,421	8,180	**238,899**	274,377	-13
Total Wheat	141	*	5,505	8,751	23,205	15,223	18,550	11,183	22,445	1,184	3,373	**109,594**	109,023	1
Winter Oats	24	*	125	237	846	1,978	532	917	2,876	279	278	**8,091**	7,998	1
Spring Oats	687	1,519	2,081	4,713	3,419	2,689	905	4,319	1,939	194	656	**23,119**	17,052	36
Winter Rye[3]	*	0	670	334	648	426	765	244	583	0	*	**3,725**	0[3]	N/A
Triticale	*	*	72	*	*	*	*	163	142	*	94	**614**	519	18
Winter Oilseed Rape	*	0	2,493	6,952	6,603	1,989	4,143	1,388	6,260	*	*	**30,141**	36,420	-17
Spring Oilseed Rape[2]	*	*	*	118	106	*	140	*	*	0	*	**590**	720	-18
Seed Potatoes	177	*	1,872	1,861	6,269	498	124	1,320	530	*	*	**12,760**	13,300	-4

Cont…

Table 44 Regional distribution of arable crops in 2016 continued

Census area (ha) of arable crops grown in Scotland

	H&I (1)	C&O (1)	Moray Firth	Abdn (1)	Angus	East Fife	Lothian	C. Low-lands (1)	Tweed Valley	S. Uplands (1)	Solway	Scotland 2016	Scotland 2014	% change
Ware Potatoes	106	37	812	867	6,707	1,971	1,304	1,325	1,423	18	196	**14,766**	15,211	-3
Combine Peas	*	*	45	122	*	143	167	117	96	*	*	**776**	616	26
Field Beans	*	0	147	0	414	360	413	446	1,026	*	159	**3,002**	2,765	9
Lupins	*	0	*	*	*	*	*	*	*	0	0	**42.54**	114	-63
Mixed Grains	12.93	*	*	*	0	0	0	*	0	*	0	**17.8**	646	-97
Totals	**5,635**	**9,245**	**50,447**	**110,640**	**101,890**	**41,616**	**42,402**	**52,565**	**57,762**	**6,267**	**15,699**	**494,167**	**531,269**	**-7**

* To prevent disclosure of information about individual holdings, entries relating to fewer than five holdings are not reported
(1) H&I = Highlands & Islands, C&O = Caithness & Orkney, Abdn = Aberdeen, C.Lowlands = Central Lowlands, S.Uplands = Southern Uplands
(2) Includes linseed.
(3) Winter rye area published for the first time in 2016

Table 45 Distribution of arable sample - 2016

Number of holdings surveyed in each region and size group

Size (ha)	H & I[(1)] C & O[(1)]	Moray Firth	Abdn[(1)] & Angus	East Fife	Lothian	Central Lowlands	Tweed Valley	S. Uplands[(1)] & Solway	Total
0.1-19.99	7	2	7	0	1	2	1	1	**21**
20-49.9	3	5	19	2	1	7	1	3	**41**
50-99.9	3	6	33	3	4	9	5	4	**67**
100-149.9	1	6	25	5	5	4	8	2	**56**
150+	0	13	42	7	13	11	16	1	**103**
All sizes	14	32	126	17	24	33	31	11	**288**

(1) H&I = Highlands & Islands, C&O = Caithness & Orkney, Abdn = Aberdeen, S. Uplands = Southern Uplands

Table 46 Sampled area - 2016

Area (ha) of arable crops grown in sample

Size (ha)	H & I[(1)] C & O[(1)]	Moray Firth	Abdn[(1)] & Angus	East Fife	Lothian	Central Lowlands	Tweed Valley	S. Uplands[(1)] & Solway	Total
0.1-19.99	52	19	87	0	18	20	15	10	**221**
20-49.9	83	174	663	78	45	226	29	88	**1,386**
50-99.9	192	418	2,316	221	246	628	379	310	**4,710**
100-149.9	144	616	3,030	623	609	495	958	240	**6,715**
150+	0	3,669	9,241	1,810	2,488	2,144	3,599	211	**23,163**
All sizes	471	4,896	15,336	2,732	3,406	3,514	4,980	859	**36,195**

(1) H&I = Highlands & Islands, C&O = Caithness & Orkney, Abdn = Aberdeen, S. Uplands = Southern Uplands

Table 47 Census area - 2016

Area (ha) of arable crops grown in Scotland

Size (ha)	H & I[(1)] C & O[(1)]	Moray Firth	Abdn[(1)] & Angus	East Fife	Lothian	Central Lowlands	Tweed Valley	S. Uplands[(1)] & Solway	Scotland
0.1-19.99	5,447	2,957	10,810	982	826	5,391	1,215	4,015	**31,643**
20-49.9	3,854	7,964	30,290	3,863	2,640	10,823	3,429	6,010	**68,872**
50-99.9	3,554	11,058	52,866	10,046	7,324	14,008	7,078	5,824	**111,759**
100-149.9	1,624	9,456	39,967	8,785	9,101	7,725	12,118	2,316	**91,092**
150+	401	19,012	78,596	17,940	22,511	14,618	33,923	3,800	**190,802**
All sizes	**14,880**	**50,447**	**212,530**	**41,616**	**42,402**	**52,565**	**57,762**	**21,965**	**494,167**

(1) H&I = Highlands & Islands, C&O = Caithness & Orkney, Abdn = Aberdeen, S. Uplands = Southern Uplands

Table 48 Raising factors - 2016

Size (ha)	H & I[(1)] C & O[(1)]	Moray Firth	Abdn[(1)] & Angus	East Fife	Lothian	Central Lowlands	Tweed Valley	S. Uplands[(1)] & Solway
0.1-19.99	103.8801	152.9028	124.9365	N/A	46.1480	275.7422	79.7623	403.8843
20-49.9	46.6879	45.7287	45.6914	49.4714	58.9065	47.8123	117.9807	68.0842
50-99.9	18.5118	26.4744	22.8285	45.4812	29.7394	22.2893	18.6771	18.7705
100-149.9	11.2567	15.3625	13.1908	14.0982	14.9442	15.6090	12.6521	9.6341
150+	N/A	5.1814	8.5051	9.9098	9.0465	6.8167	9.4263	18.0451

(1) H&I = Highlands & Islands, C&O = Caithness & Orkney, Abdn = Aberdeen, S. Uplands = Southern Uplands
N/A = not applicable

Table 49 First and second adjustment factors - 2016

	Adj 1 H & I[(1)] C & O[(1)]	Adj 1 Moray Firth	Adj 1 Abdn[(1)] & Angus	Adj 1 East Fife	Adj 1 Lothian	Adj 1 Central Lowlands	Adj 1 Tweed Valley	Adj 1 S. Uplands[(1)] & Solway	Adj 2
Winter barley	N/A	0.9161	1.2004	1.3110	1.6886	1.5332	1.1762	1.5456	1.0071
Spring barley	0.8796	0.9987	0.9341	0.7970	1.3588	0.9300	1.1381	1.0060	1.0000
Total wheat	N/A	0.8848	1.0304	1.1626	0.8213	1.0085	0.8976	0.7172	1.0016
Winter oats	N/A	0.4774	1.6112	1.3179	0.9556	0.6977	0.5657	N/A	1.0774
Spring oats	1.7297	1.0363	0.7168	1.0874	0.4814	0.9250	1.1312	0.7705	1.0000
Winter rye	N/A	0.8924	4.1921	N/A	1.4888	N/A	N/A	N/A	1.5404
Triticale	N/A	0.4754	0.3087	N/A	0.0662	N/A	0.3905	N/A	2.3304
Winter oilseed rape	N/A	0.9211	1.3140	1.2155	1.1788	0.7052	1.0997	N/A	1.0105
Seed potatoes	N/A	1.6450	1.0445	0.3176	2.9178	1.1831	1.5664	N/A	1.0229
Ware potatoes	9.9680	1.8842	1.4369	1.3532	0.6490	1.9309	1.1747	0.8792	1.0000
Dry harvest peas	N/A	N/A	0.3880	N/A	0.9005	N/A	N/A	N/A	2.3145
Field beans	N/A	N/A	1.0570	0.6809	1.5354	1.1587	1.6913	0.3330	1.0615

(1) H&I = Highlands & Islands, C&O = Caithness & Orkney, Abdn = Aberdeen, S. Uplands = Southern Uplands
N/A = not applicable

Response rates

The table below summarises the number of holdings who were contacted during the survey.

Table 50 Response rate - 2016

	2016	% total
Target sample arable	350	100
Total achieved arable	**288**	**82**
Total number of refusals/non-contact	163	36
Total number of farms approached	**451**	

Financial burden to farmers

In order to minimise the burden on farmers, the survey team used non-visit methods of collection such as email, post or telephone call, where possible.

To determine the total burden that the 2016 Arable Crop Survey and the Integrated Pest Management Survey placed on those providing the information, the surveyors recorded the time that 235 respondents spent providing the data during the surveys. This sample represents 82 per cent of growers surveyed. Information was recorded from all strata of the sample to ensure that the overall estimate of burden was representative. The median time taken to provide the information was 30 minutes.

The following formula was used to estimate the total cost of participating:

Burden (£) = No. surveyed x median time taken (hours) x typical hourly rate* (* using median "Full Time Gross" hourly pay for Scotland of £13.48)[12]

The total financial burden to all growers resulting from participation in the 2016 Arable Crop Survey and the Integrated Pest Management Survey was calculated to be £1941.

Appendix 3 - Definitions and notes

1) '**Pesticide**' is used throughout this report to include commercial formulations containing active substances (a.s.) used as herbicides, fungicides, insecticides, molluscicides, biological control agents, biopesticides, growth regulators, seed treatments and physical control. A pesticide product consists of one or more active substances co-formulated with other materials.

2) An **active substance** (or active ingredient) is any substance or micro-organism which has a general or specific action: against harmful organisms; or on plants, parts of plants or plant products.

3) In this report the term '**formulation**(s)' is used to describe the pesticide active substance or mixture of active substances in a product(s). It does not refer to any of the solvents, pH modifiers or adjuvants also contained within a product that contribute to its efficacy.

4) A **fungicide** is a pesticide used to control fungal diseases in plants.

5) A **herbicide** is a pesticide used to control unwanted vegetation (weed killer).

6) A **growth regulator** is a pesticide used to regulate the growth of the plant, for example to prevent the crop from growing too tall.

7) An **insecticide** is a pesticide used to control unwanted insects. A **nematicide** is a pesticide used to control unwanted nematodes.

8) A **molluscicide** is a pesticide used to control unwanted slugs and snails.

9) A **seed treatment** is a pesticide applied to seed before planting to protect that plant against diseases and pests from the earliest stage of development. The pesticide can be a fungicide, an insecticide or a biological control agent.

10) **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.

11) **Area 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. For example, if a field of five hectares gets sprayed with the same fungicide twice, the basic area is five hectares, and the treated area is 10 hectares.

12) Farmers/growers can apply pesticides to crops by a number of different methods. Multiple pesticides can be applied to a crop in a single tank mix. For example a crop could be sprayed with two different fungicides and an insecticide at the same time.

13) In this report each pesticide is reported in three formats. The area of each pesticide is reported as both a formulation (mixture of active substances in a product) and as individual active substances. Quantities of active substance are also reported (Tables 2 to 17 for formulation data and Tables 18 to 33 for active substance and quantity data). All three different formats are provided to satisfy the needs of all data users and allow them to assess pesticide use trends. Some users may be interested in use of pesticide products which contain a number of active substances, thus formulation data would be required. Other users are interested in particular active substances which may be formulated on their own or in combination with other active substances. Therefore active substance data would be required. In addition, both quantity and area of pesticide applications are important indicators of changes in use over time. Different pesticides are applied at different dose rates and only by comparing both area and quantity can trends in use be elucidated.

14) It should be noted that some herbicides may not have been applied directly to the crop itself but either as land preparation treatments prior to sowing/planting the crop, or to control weeds at the field margins.

15) The **June Agricultural Census**(13) is conducted annually by the Scottish Government's Rural and Environmental Science Analytical Services (RESAS). The June Agricultural Census collects data on land use, crop areas, livestock and the number of people working on agricultural holdings. For this report the June Agricultural Census was used to draw a sample of growers growing the relevant crops to participate in the survey

16) Throughout this report the term '**census area**' refers to the total area for a particular crop or group of crops recorded within the June Agricultural Census. These are the areas which the sampled areas are raised to. Please see Appendix 4 – survey methodology for details. The June Agricultural Census Form is divided up into different categories which relates to a particular crop or group of crops. These are referred to as '**census categories**' throughout this report.

17) Where quoted in the text or within figures, reasons for application are the grower's stated reasons for use of that particular pesticide on that crop and may not always seem appropriate. It should be noted that growers do not always provide reasons; therefore those presented in the figures only reflect those specified and may not reflect overall reasons for use.

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

19) Data from the 2014**(3)** and 2012**(4)** surveys are provided for comparison purposes in some of the tables, although it should be noted that there may be minor differences in the range of crops surveyed, together with changes in areas of each of the crops grown. Changes from previous surveys are described in Appendix 4. When comparisons are made between surveys it is important to take into account that there may be changes in the area of crop grown. In order to take this into account, comparisons have been made on a

per hectare grown basis, i.e. the number of hectares that have been sprayed (treated hectares) has been divided by the area of crop grown for each survey, and the weight (kilograms) applied has also been divided by the area of crop grown. This is to enable like for like comparisons between surveys, so that changes in pesticide use patterns are not masked by changes in crop area.

20) During the survey, the wheat crop is differentiated as either winter wheat or spring wheat. In the census, wheat is not subdivided. Any data from the census refers to the wheat crop as 'total wheat', but the survey data refers to winter and spring wheat.

21) There were a limited number of holdings with winter rye and triticale sampled. Therefore, no details of pesticide use on these crops are reported separately. However pesticide use on winter rye and triticale are included in the totals for 'all cereals' in the pesticide usage tables.

22) The **average number of applications** indicated in the text for each crop is based on the occurrence of a chemical group on at least ten per cent of the area grown. The average number of applications is calculated only on the areas using each pesticide group and therefore the minimum number of applications is always going to be one. Several pesticides may be applied as a tank mix as part of the same spray event; therefore the average number of pesticide sprays reported is less than the sum of sprays of each chemical group.

23) In the pesticide tables, some pesticide treatments are reported as '**unspecified**'. This description was used for occasions where the use of a particular treatment was reported by the grower, but they were unable to provide details of the product used. For these treatments, we are able to provide an area treated but no quantity of pesticide used since the exact pesticide is unknown.

24) Some seed treatments were recorded as '**no information seed treatment**'. This description was used for occasions where the grower was unable to confirm whether the seed had received a treatment.

25) **Integrated pest management.** The sustainable use directive[14] defines IPM as follows; "'integrated pest management' means careful consideration of all available plant protection methods and subsequent integration of appropriate measures that discourage the development of populations of harmful organisms and keep the use of plant protection products and other forms of intervention to levels that are economically and ecologically justified and reduce or minimise risks to human health and the environment. 'Integrated pest management' emphasises the growth of a healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms."

Appendix 4 – Survey methodology

Sampling and data collection

Using the June 2016 Agricultural Census [13], a sample was drawn representing arable cultivation in Scotland. The country was divided into 11 land-use regions (Figure 56). Each sample was stratified by these land-use regions and according to holding size. The sampling fractions used within both regions and size groups were based on the areas of relevant crops grown rather than number of holdings, so that smaller holdings would not dominate the sample.

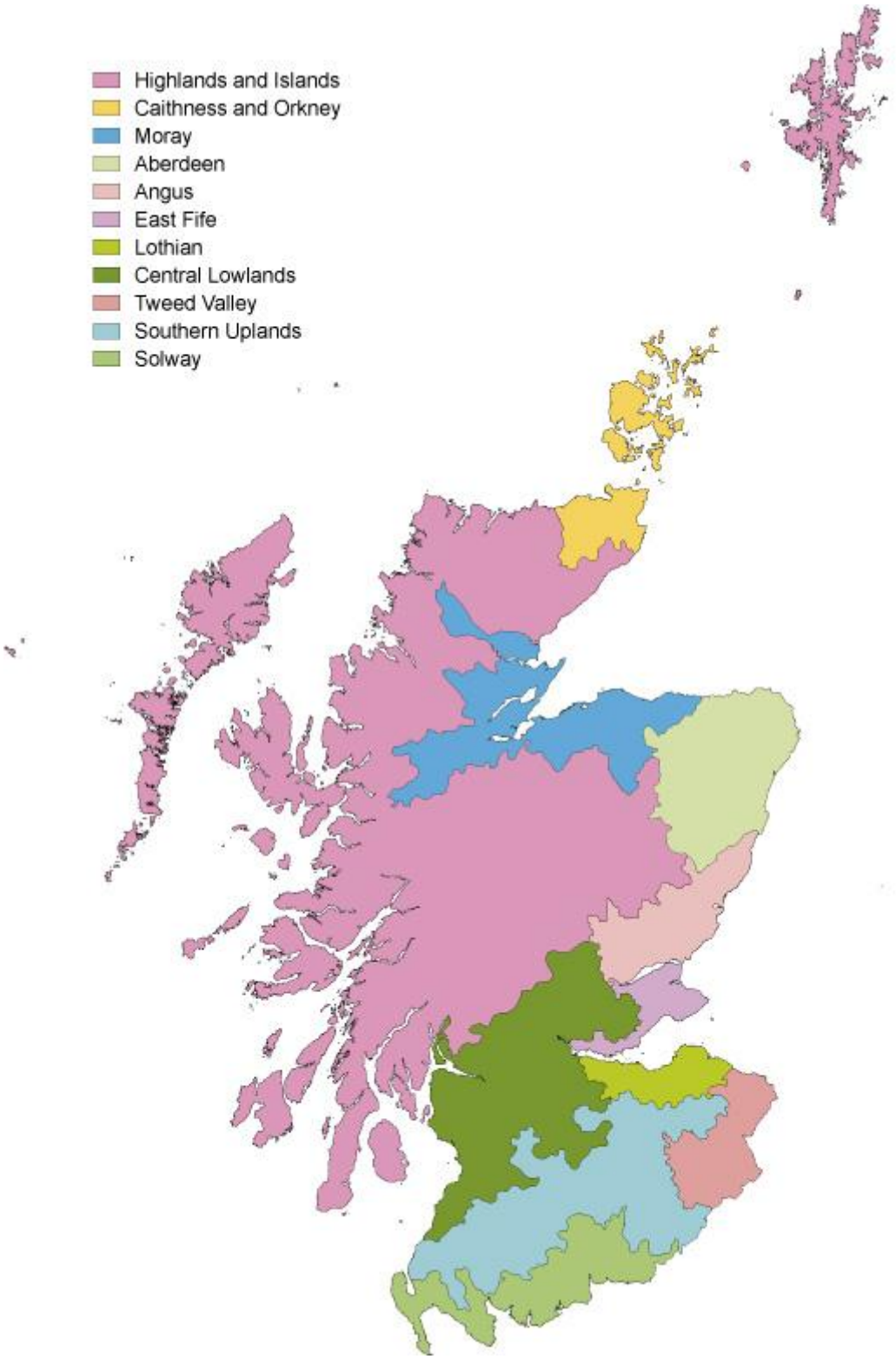
The survey covered pesticide applications to arable crops where all or the majority of the growing season was in 2016. As well as recording treatments applied directly to the crop, data was also collected on land preparation treatments prior to sowing or planting the crop.

Following an introductory letter and phone call, data were collected by either personal interview during a visit to the holding or during a phone interview or by email. Where necessary, information was also collected from agronomists and contractors. In total, information was collected from 288 holdings growing arable crops (Table 44). These holdings collectively represent seven per cent of the total Scottish arable crop area grown.

Raising factors

National pesticide use was estimated by ratio raising. This is a standard statistical technique for producing estimates from a sample. It is the same methodology used by the other UK survey teams and has been used for all historical datasets produced by the Pesticide Survey Unit, allowing comparability over time. The sample data were multiplied by raising factors (Table 47). These factors were calculated by comparing the sampled area to the areas recorded in the Agricultural Census within each region and size group. An adjustment (Table 48) was made for each crop within each region by applying the raising factors to the sample area of each crop grown and comparing this with the census area. This adjustment modifies the estimate to take into account differences in composition of crops encountered in the sample and those present in the population. A second adjustment was necessary for some crops which were present in the population, but were not encountered in the sample in some strata.

Figure 56 Land use regions of Scotland[15]



Changes from previous years

Winter rye is included in the 2016 report for the first time. The area grown in Scotland has significantly increased to 3,725 hectares in 2016. It was previously recorded in the 'Other crop' category of the June Agricultural Census but will be recorded in a separate census category from 2017.

The 2016 report contains a number of new details to help improve data quality for users. Data relating to the average number of applications for each crop and type of pesticide have been included in Table 1 and Figures 13 and 14. Details relating to pesticide application timings for each crop have been included in the pesticide usage section. Fungicides, herbicides and insecticides have been classified into groups according to their mode of action and chemical group in Tables 34-36. Data on Integrated Pest Management activities (i.e. non-chemical methods to control pests, weeds and diseases) has been collected from farmers and is reported in Appendix 6.

The total number of refusals to participate in this voluntary survey (36 per cent) has increased from 23 per cent in 2014 and 12 per cent in 2012. This has resulted in a 2016 sample size 18 per cent lower than the target. It is possible that this decrease in sample size may influence the estimates made in this report, although the very similar relative standard errors reported between the last two surveys provides some reassurance that the statistical robustness of the data has not been compromised.

Data quality assurance

The dataset undergoes several validation processes as follows; (i) checking for any obvious errors upon data receipt (ii) checking and identifying inconsistencies with use and pesticide approval conditions once entered into the database (iii) 100 per cent checking of data held in the database against the raw data. Where inconsistencies are found these are checked against the records and with the grower if necessary. Additional quality assurance is provided by sending reports for review to members of the Working Party on Pesticide Usage Surveys and other agricultural experts. In addition, the Scottish pesticide survey unit is accredited to ISO 9001:2015. All survey related processes are documented in Standard Operating Procedures (SOPs) and our output is audited against these SOPs by internal auditors annually and by external auditors every three years.

Main sources of bias

The use of a random stratified sample is an appropriate survey methodology. A stratified random sample, grouped by farm size and region, is used to select holdings used in this survey. Sampling within size groups is based on area rather than numbers of holdings, so that smaller size groups are not over-represented in the sample. The pesticide survey may be subject to measurement bias as it is reliant on farmers/growers recording data accurately. As this survey is not compulsory it may also subject to non-response bias, as growers on certain farm/holding types may be more likely to respond to the survey than others. Reserve lists of holdings are held for each stratum to allow non-responding holdings to be replaced with similar holdings.

Experience indicates that stratified random sampling, including reserves, coupled with personal interview technique, delivers the highest quality data and minimises non-response bias.

Appendix 5 – Standard errors

The figures presented in this report are produced from surveying a sample of holdings rather than a census of all the holdings in Scotland. Therefore the figures are estimates of the total pesticide use for Scotland and should not be interpreted as exact. To give an idea of the precision of estimates, the report includes relative standard errors (RSE) (Table 50). Standard errors are produced using the raising factors. An overall variance is calculated by summing the variance estimates for individual strata (region and size group) multiplied by the square of their raising factors. These variance estimates include a finite population correction. The overall standard error is calculated from the overall variance by taking its square root. This method of standard error estimation was implemented as it is both relatively straightforward and has advantages over ratio estimator methods when within-strata sample sizes are small.

Standard errors are expressed as percentage relative standard errors (Table 50) for both total pesticide use by area treated and for weight applied. Larger relative standard errors mean that the estimates are less precise. A relative standard error of 0 per cent would be achieved by a census. A relative standard error of 100 per cent indicates that the error in the survey is of the same order as the measurement. Relative standard errors may be reduced with larger sample sizes. However, larger relative standard errors can also result from greater variability in pesticides among holdings.

The RSE for estimates of total pesticide use on arable crops was three per cent for area and four per cent for quantity (Table 50). For constituent crop groups, the RSE varied from three to 20 per cent for area and four to 36 per cent for weight, varying with sample size and uniformity of pesticide regime encountered. For triticale and dry harvest peas, a standard error could not be calculated due to too few active substances being recorded; therefore pesticide estimates for these crops should be treated with caution.

Table 51 Relative standard errors - 2016

Relative standard errors (RSE) for the area treated (ha) with pesticide and for weight of active substance (kg) applied

Crops	Area SE (%)	Weight SE (%)
Winter barley	9	10
Spring barley	3	5
Wheat (winter and spring)(1)	5	6
Winter oats(1)	20	15
Spring oats	12	13
Winter rye(1)	13	0
Triticale	NC	NC
Winter oilseed rape	8	13
Seed potatoes(1)	10	10
Ware potatoes(1)	20	36
Dry harvest peas	NC	NC
Field beans(1)	20	20
All arable crops	3	4

(1) For these crops standard errors could not be calculated for all strata due to insufficient data in the sample, as these strata have not been used in the aggregate totals for the region and the overall RSE values should be treated with caution

(2) Standard errors could not be calculated (NC) for triticale and dry harvest peas because there were too few active substances recorded. Therefore estimates for these crops should be treated with caution

Appendix 6 – Integrated pest management

It is a requirement of the EU Sustainable use of Pesticides Directive (2009/128/EC)[14] that member states should promote low pesticide input pest management, in particular Integrated Pest Management (IPM).

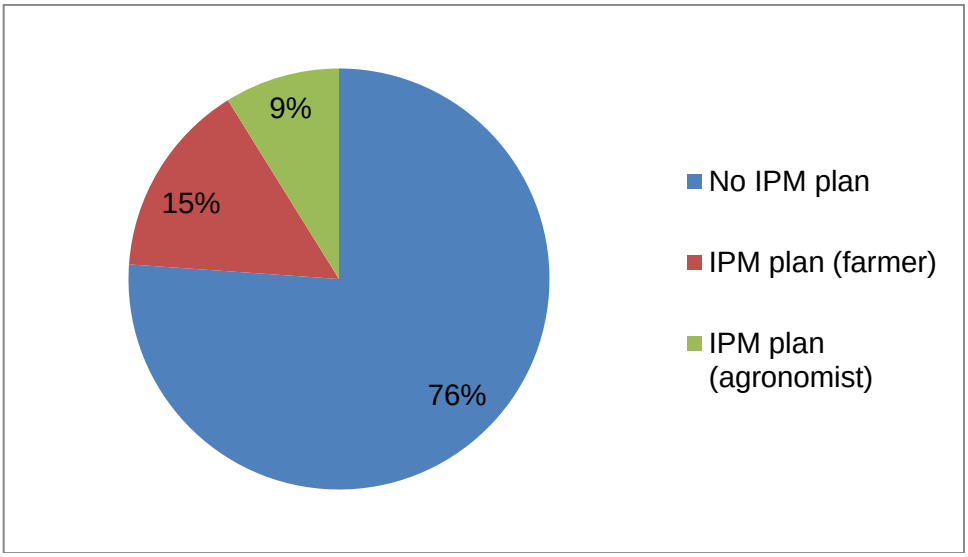
The Directive defines IPM as follows "'integrated pest management' means careful consideration of all available plant protection methods and subsequent integration of appropriate measures that discourage the development of populations of harmful organisms and keep the use of plant protection products and other forms of intervention to levels that are economically and ecologically justified and reduce or minimise risks to human health and the environment. 'Integrated pest management' emphasises the growth of a healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms."

As part of this survey, additional data collection was conducted in relation to grower adoption of Integrated Pest Management (IPM) measures. The term 'pest' is used to denote diseases, weeds and pests. This data collection was designed to inform the Scottish Government about the current adoption of IPM in the main crop sectors.

All growers were asked a series of questions about the IPM activities that they were implementing for their arable crop production. Unlike the other statistics in this report, the figures reported in this section are not raised (i.e. are not national estimates) but represent only the responses of those surveyed.

In total IPM data was collected from 113 farmers, representing 123 holdings and 52 per cent of the sampled arable crop area (four per cent of census area). Of these farmers, 76 per cent did not have an IPM plan, 15 per cent of farmers completed their own IPM plan and nine per cent had a plan completed by their agronomist (Figure 57). Completing an IPM plan is voluntary for Scottish farmers, but this helps meet their legal obligation to take reasonable precautions to protect human health and the environment when using pesticides. Completing an IPM plan will help the landowner/contractor to make the best possible and most sustainable use of all available methods for controlling pests, weeds and diseases.

Figure 57 Percentage of respondents with an IPM plan



Farmers were asked about their IPM activities in relation to three categories; risk management, pest monitoring and pest control. Information was collected about all activities growers conducted in relation to each category. Despite the fact that the majority of growers did not complete an IPM plan, uptake of a wide range of IPM activities was encountered.

Risk management

IPM programs aim to prevent or reduce the risk of pests becoming a threat by minimising the risk of damage occurring that will require subsequent control. Table 52 presents an overview of the risk management measures adopted by the growers surveyed. All the growers sampled used one or more risk management activity.

Eighty eight per cent of the farmers reported that they used crop rotation to manage the risk of pest damage. Rotation is a basic principle of farming, breaking the link between pathogen and host and reducing pest population build-up. It can also improve soil fertility and structure, consequently increasing the vigour of subsequent crops.

Nearly all of the farmers (96 per cent) stated that they tested their soil in order to tailor inputs to improve crop performance. Ninety two per cent tested soil nutrient levels with lower proportions testing for nematodes (including free living nematodes and potato cyst nematodes), disease (including powdery scab and clubroot), leatherjackets and wheat bulb fly (Figure 58). By testing for nutritional and pest status, farmers' can make informed decisions about inputs required and optimal crop choice for that field.

Ninety three per cent of farmers reported that they managed their seed bed agronomy to reduce risk. Sixty per cent increased soil organic matter to improve soil quality, 44 per cent used rotational ploughing, 41 per cent used non-inversion tillage including minimum tillage or strip tillage and 15 per cent used direct drilling (Figure 59). The majority of non-inversion tillage and direct drilling was conducted in winter oilseed rape crops.

Forty four per cent of farmers stated that they amended cultivation methods at sowing to try to increase crop success. Twenty one per cent varied the sowing rate, 14 per cent used under-sowing, 13 per cent varied the date of sowing and 12 per cent varied the sowing density to mitigate for potential pest damage (Figure 60).

Ninety three per cent of the farmers sampled also reported that they considered risk management when selecting seeds and/or varieties. Eighty six per cent of farmers used seed treatments to protect seedlings at crop emergence. Fifty two per cent of farmers selected pest resistant varieties, where available, to reduce damage. Forty three per cent used certified seed and 39 per cent tested home saved seed. Some growers (17 per cent) also reported that they chose to adopt varietal diversification (using a range of different varieties) to increase overall resistance to pests and environmental stresses (Figure 61).

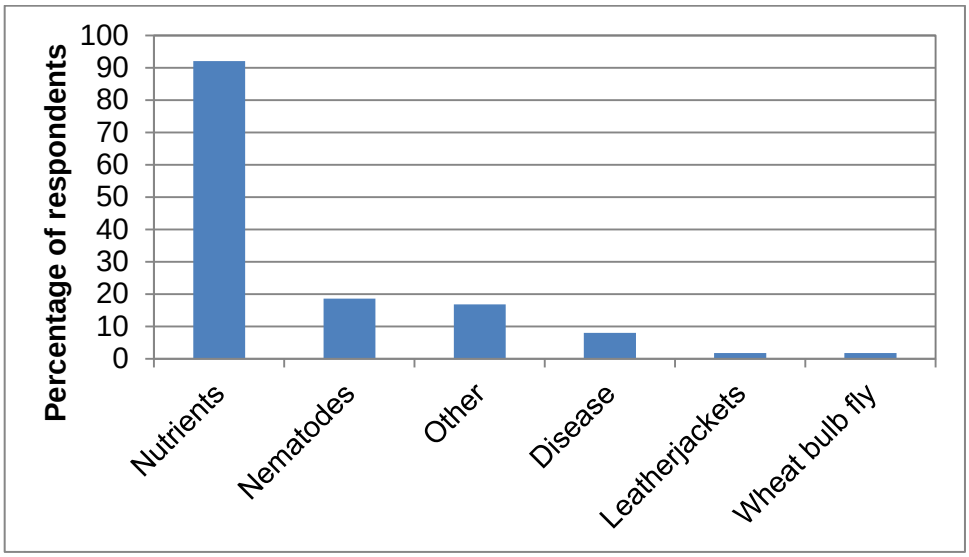
Twenty seven per cent of respondents sowed catch or cover crops as part of their crop production cycle. These crops were cultivated to improve soil quality (19 per cent), to control weeds (4 per cent), to manage soil pests (4 per cent) and also to comply with for Ecological Focus Area (EFA) rules, as a companion crop and to reduce run-off from the soil (Figure 62). When farmers were asked details of the types of catch or cover crops grown, 50 per cent of crops reported were mixes and 50 per cent were straight crops. The most commonly reported mix used was a vetch mix and the most commonly reported straight crop was clover.

Finally, 88 per cent of farmers sampled stated that they adopted techniques to protect or enhance populations of beneficial organisms. Sixty eight per cent of farmers left uncultivated areas including fallow, 12 per cent had grass margins, 10 per cent planted wild flower strips and 10 per cent took part in agri-environment schemes. Others (25 per cent) established beetle banks, hedges, ponds and wetland (Figure 63).

Table 52 Summary of responses to risk management questions - 2016

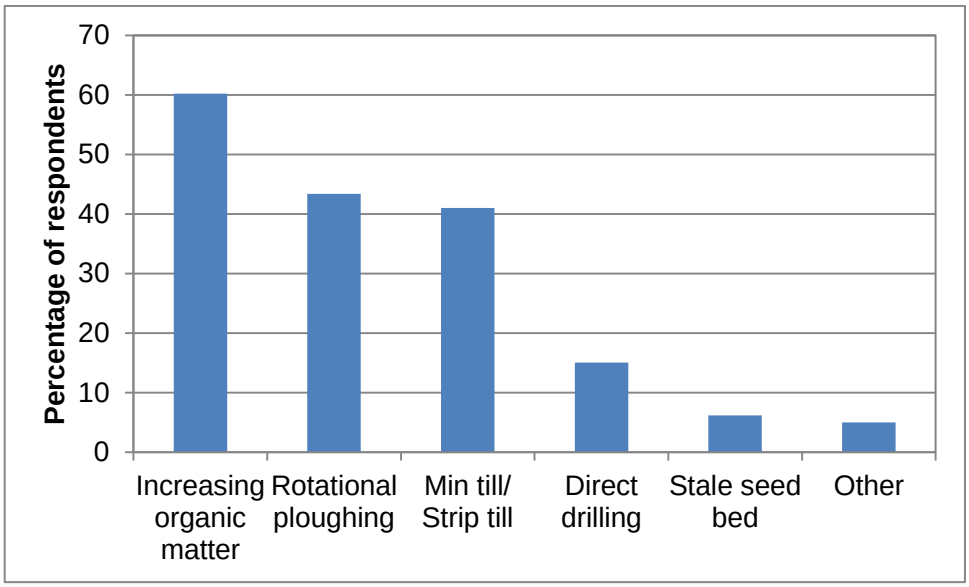
Risk management activity	**Percentage yes response**
Crop rotation	88
Soil testing	96
Cultivation of seed bed	93
Cultivations at sowing	44
Varietal or seed choice	93
Catch and cover cropping	27
Protection or enhancement of beneficial organism populations	88
Any risk management activity	**100**

Figure 58 Types of soil testing recorded (percentage of respondents) - 2016



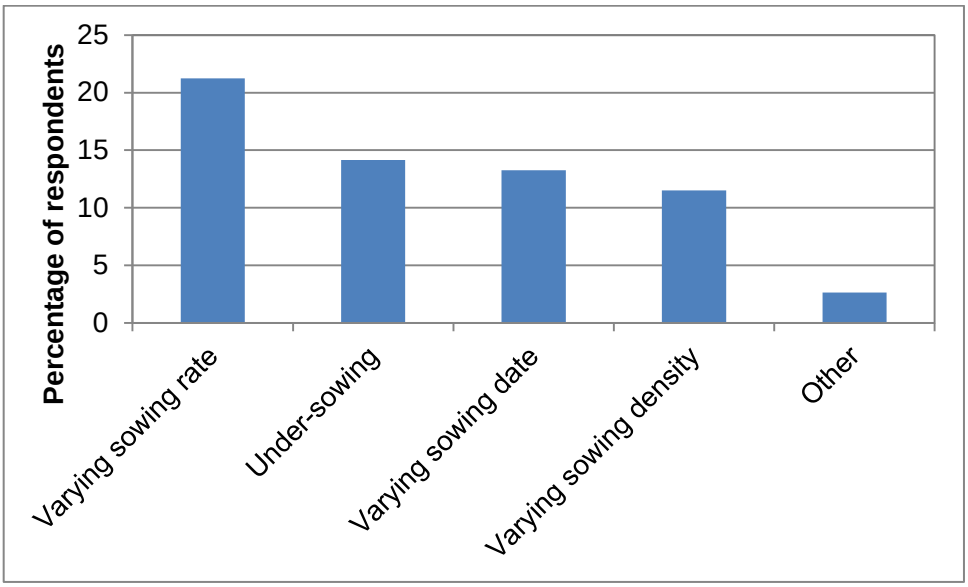
Note: 'other' includes pH, sulphur and eelworm

Figure 59 Methods of cultivating seed bed to reduce pest risk (percentage of respondents) - 2016



Note: 'other' includes considering pest management when planning irrigation, using a straw rake and shallow cultivations or rolling to control slugs

Figure 60 Methods of cultivating at sowing to reduce pest risk (percentage of respondents) - 2016



Note: 'other' includes drilling headlands after crop to reduce slugs, considering pest management when planning nutrition and sowing deeper when crows are a problem

Figure 61 Variety and seed choice to reduce pest risk (percentage of respondents) - 2016

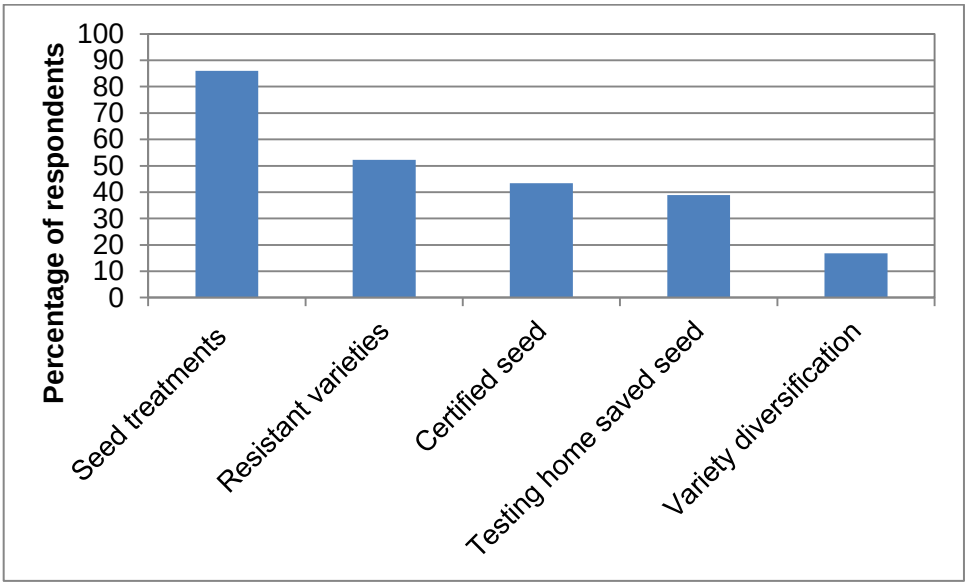
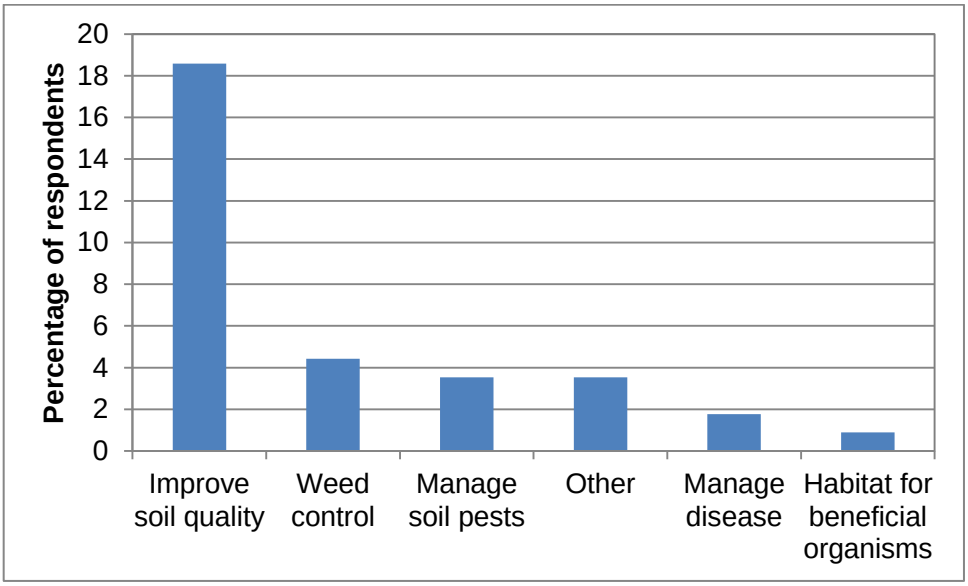
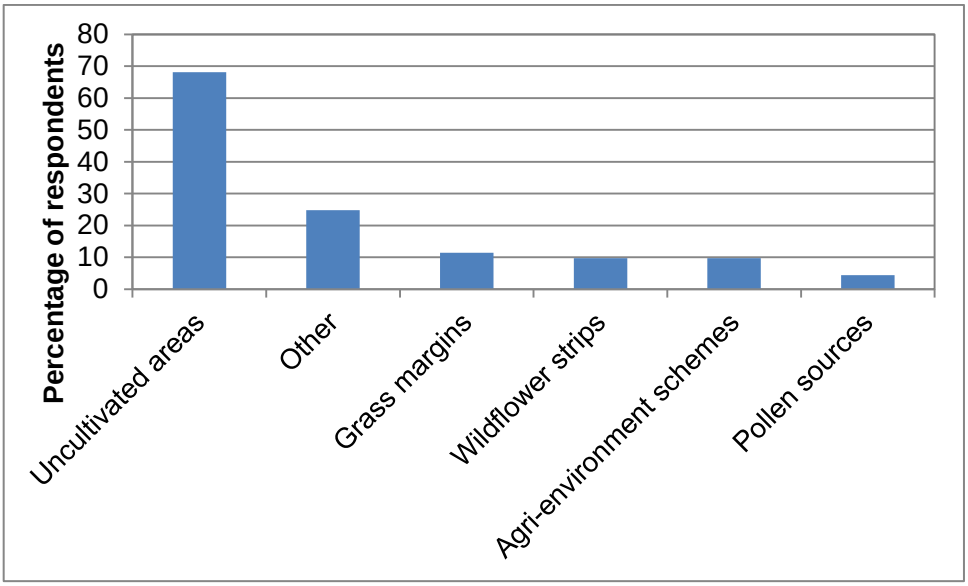


Figure 62 Reasons for use of catch and cover crops (percentage of respondents) - 2016



Note: 'other includes EFA catch crop, companion crop and stopping runoff from soil

Figure 63 Methods for protecting and enhancing beneficial organism populations (percentage of respondents) - 2016



Note: 'other' includes beetle banks, hedging, ponds and wetland areas

Pest monitoring

In IPM, pests are monitored to determine whether control is economically justified and to effectively target control options. IPM programs aim to monitor and identify pests, so that appropriate control decisions can be made in conjunction with action thresholds. Table 53 presents an overview of the pest monitoring measures reportedly adopted by the growers surveyed. All of the growers sampled implemented one or more pest monitoring activity.

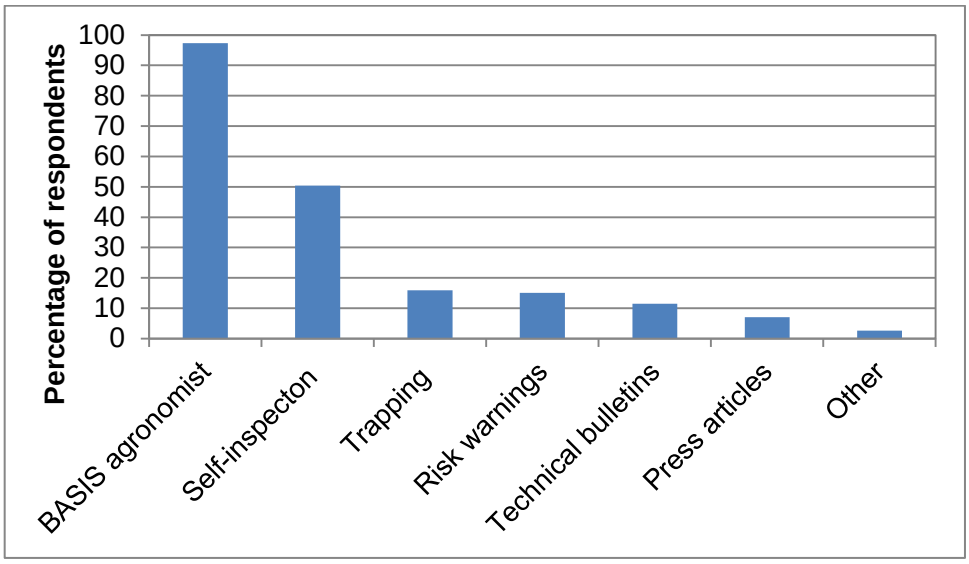
Ninety nine per cent of farmers stated that they regularly monitored crop growth stages and all growers monitored and identified pests on their crops. Most farmers (68 per cent) also used action thresholds when monitoring pest populations. Pest monitoring was conducted primarily by BASIS agronomist inspection (97 per cent) and self-inspection (50 per cent). In addition, some farmers used trapping, risk warnings, technical bulletins and press articles to assess pest pressure (Figure 64).

Fifty eight per cent of farmers also reported that they used specialist diagnostics when dealing with pests that were more problematic to identify or monitor. Around a third (35 per cent) used tissue testing to monitor nutritional deficiencies, 34 per cent used field or pest mapping and 11 per cent used clinic services to identify unknown pests (Figure 65).

Table 53 Summary of responses to pest monitoring questions - 2016

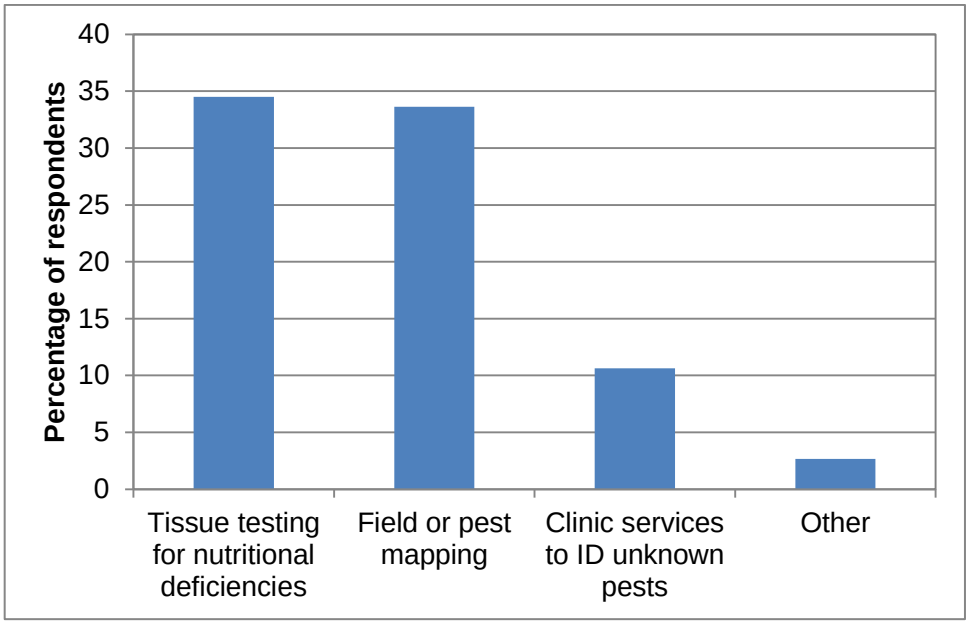
Pest monitoring activity	Percentage yes response
Setting action thresholds for crops	68
Monitor and identify pests	100
Use of specialist diagnostics	58
Regular monitoring of crop growth stage	99
Any pest monitoring activity	**100**

Figure 64 Methods of monitoring and identifying pests (percentage of respondents) - 2016



Note: 'other' includes information from local farmers and growers

Figure 65 Use of specialist diagnostics (percentage of respondents) - 2016



Note: 'other' includes using nitrogen sensor for variable rate application and using applications on phone

Pest control

If monitoring, identification, and action thresholds indicate that pest control is required, and preventive methods are no longer effective or available, IPM programs evaluate the best control method in relation to effectiveness and risk. Control programmes incorporate non-chemical methods alongside, or instead of, chemical control. Use of chemical pest control should be as targeted as possible and the risk of resistance development should be minimised. The effectiveness of the control programme should be reviewed regularly to gauge success and improve their regime as necessary. Table 54 presents an overview of the pest control measures reported by the farmers surveyed. All of the growers sampled adopted at least one IPM pest control activity.

Sixty eight per cent of farmers reported that they used non-chemical control in partnership or instead of chemical control. The majority of farmers used hand rogueing as part of their weed control measures (65 per cent). Of these farmers, 91 per cent were using hand rogueing to control wild oats. Some growers also used mechanical/manual weeding or pest trapping (Figure 66).

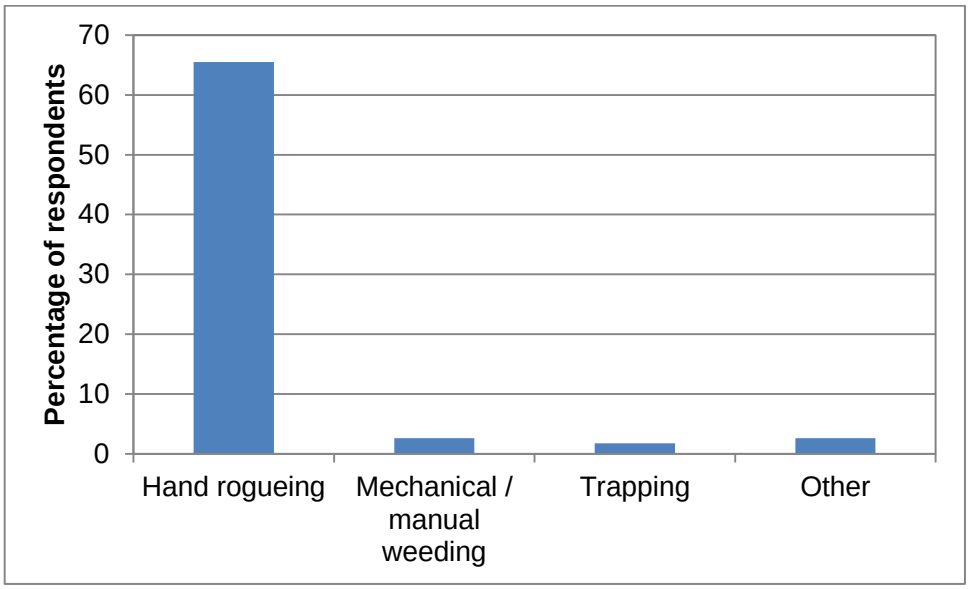
Seventy three per cent of farmers stated that they targeted their pesticide applications using monitoring data. The most common method reported was spot treatments, used by 48 per cent of farmers (Figure 67). Spot treatments were used to combat weeds including docks, wild oats and couch. Thirty per cent reduced their dosage or frequency of applications where possible and 25 per cent used drift reduction. In addition, 73 per cent of farmers stated that they followed anti-resistance strategies. These included 57 per cent minimising the number of applications, 34 per cent using pesticides with multiple modes of action and 27 per cent using pesticides with multi-site modes of action (Figure 68).

All respondents stated that they monitored the success of their crop protection measures. The measures used included 91 per cent having a regular review with their agronomist, 39 per cent investigating causes of poor efficacy, 35 per cent conducting regular self-inspection and 16 per cent having a seasonal review of practice (Figure 69).

Table 54 Summary of responses to pest control questions - 2016

Pest control activity	**Percentage yes response**
Non-chemical control used in partnership or instead of chemical control	68
Targeted pesticide application	73
Follow anti-resistance strategies	73
Monitor success of crop protection measures	100
Any pest control activity	**100**

Figure 66 Types of non-chemical control used (percentage of respondents) - 2016



Note: 'other' includes growing winter oilseed rape under nets and using a machine to remove slug eggs

Figure 67 Methods of targeting pesticide applications using monitoring data (percentage of respondents) - 2016

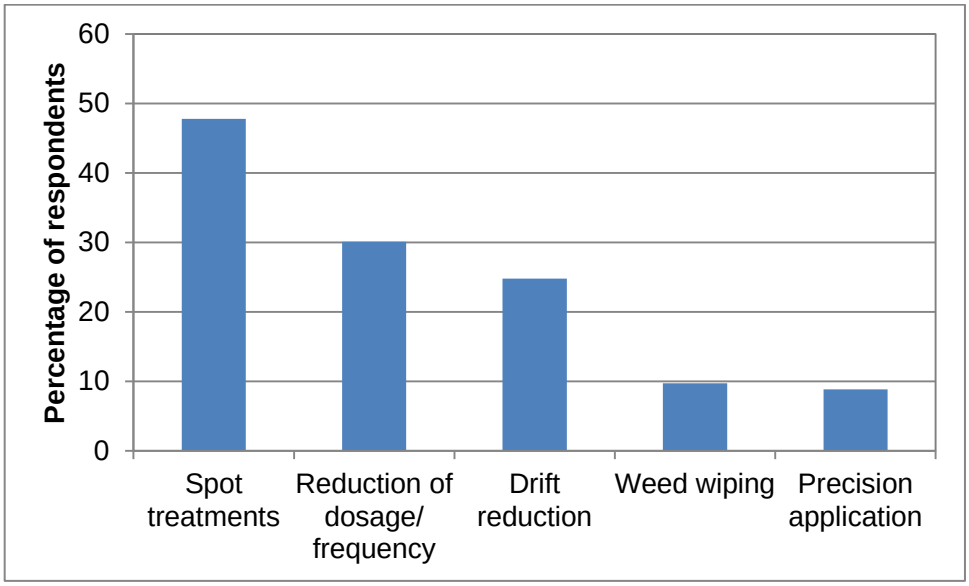
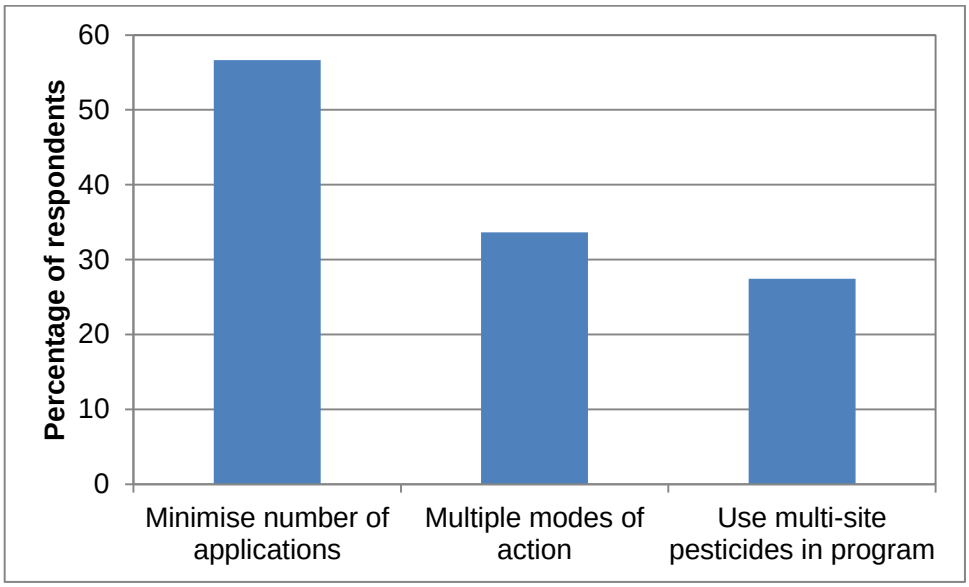
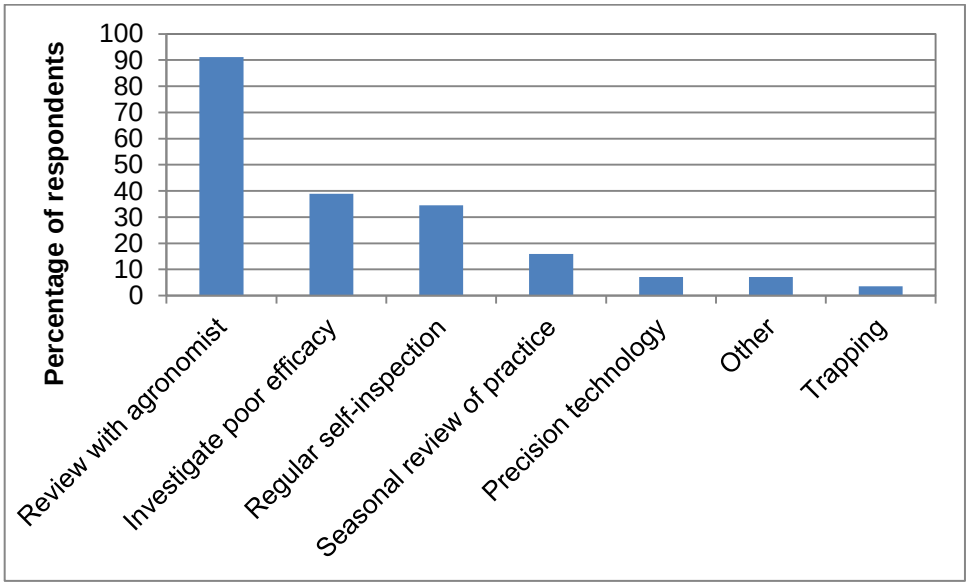


Figure 68 Types of anti-resistance strategies (percentage of respondents)



Note: multi-site pesticides each act on different metabolic sites within the target weed, fungus or insect pest, thus increasing their effectiveness

Figure 69 Methods for monitoring success of crop protection measures (percentage of respondents) - 2016



Note: 'other' includes measuring success by examining the results of harvest and comparing with historic yields and independent trials

Acknowledgements

Thanks are due to all the farmers who provided the information for this report. Thanks are also due to Jackie Hughes (SASA), Fiona Burnett, Stuart Wale, Innes Jessiman and Ruairidh Bain (SRUC), Yiqun Chen (HSE), Sarah Cook, Peter Gladders and Sacha White (ADAS) for editorial assistance. In addition, the authors are grateful for the support from Mr David Garthwaite and his colleagues at Fera Science Limited, Mr Paul Gavin at the Scottish Government's Agricultural Census Analysis Team and to Mr Adrian Roberts of Biomathematics & Statistics Scotland.

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Pesticide Usage in Scotland

Potato Stores 2016

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Executive summary

This report presents information from a survey of pesticide use in Scottish potato stores on tubers harvested in 2016. Data were collected from 65 growers, who collectively cultivated 25 per cent of the area of potatoes grown in Scotland. Pesticide use in potato stores was recorded for crops grown for seed production and for consumption (ware potatoes). Ratio raising was used to produce estimates of national pesticide usage from the sample data.

The overall estimated quantity of potatoes stored in 2016 was 1,140,286 tonnes, which was very similar to that reported in 2014. Both the 2016 and 2014 storage estimates were almost 20 per cent greater than 2012 which was a climatically difficult year for Scottish potato production.

Sixty one per cent of seed and 77 per cent of ware potatoes were stored in refrigerated stores in 2016. The majority of the remaining stores were ambient ventilated stores. Over 99 per cent of potatoes were stored in boxes.

The proportion of stored seed and ware potatoes receiving an in-store pesticide treatment in 2016 was 47 and 11 per cent respectively. These proportions are the same as reported in 2014.

As in 2014, the principal formulation used on seed potatoes in 2016 was the fungicide formulation imazalil/thiabendazole, which was applied to an estimated 27 per cent of the stored crop for control of a range of tuber diseases. The only other fungicide applied was imazalil, to 19 per cent. As in 2014, a small proportion of the seed crop was treated with ethylene (one per cent). Ethylene is approved as a commodity substance for plant growth regulation in post-harvest crops under the Control of Pesticides regulations (COPR).

As in the last survey, chlorpropham, a growth regulator used for sprout suppression, was the most commonly used formulation on ware potatoes, applied to seventeen per cent of tubers stored in 2016. Ethylene, the principal sprout suppressant formulation for ware potatoes prior to 2014, was applied to one per cent of the crop. The fungicidal formulations, imazalil and imazalil/thiabendazole were both applied to less than 0.5 per cent of the stored ware crop.

Introduction

The Scottish Government (SG) is required by legislation[1][2] to carry out post-approval surveillance of pesticide use. This is conducted by the Pesticide Survey Unit at Science and Advice for Scottish Agriculture (SASA), a division of the Scottish Government's Agriculture and Rural Economy Directorate.

This survey is part of a series of annual reports which are produced to detail pesticide usage in Scotland for arable, vegetable, soft fruit and protected edible crops on a biennial basis and for fodder and forage crops every four years. In addition to surveying pesticide use on field crops, pesticide usage in potato stores is also surveyed biennially alongside the arable survey. The Scottish survey data are incorporated with England, Wales and Northern Ireland data to provide estimates of annual UK-wide pesticide use. Information on all aspects of pesticide usage in the United Kingdom as a whole may be obtained from the Pesticide Usage Survey Team at FERA Science Ltd, Sand Hutton, York. Also available at:

https://secure.fera.defra.gov.uk/pusstats/surveys/index.cfm

The Scottish Pesticide Usage reports have been designated as Official Statistics since August 2012 and as National Statistics since October 2014. The Chief Statistician (Roger Halliday) acts as the statistics Head of Profession for the Scottish Government and has overall responsibility for the quality, format, content and timing of all Scottish Government national statistics publications, including the pesticide usage reports. As well as working closely with Scottish Government statisticians, SASA receive survey specific statistical support from Biomathematics and Statistics Scotland (BioSS).

All reports are produced according to a published timetable. For further information in relation to Pesticide Survey Unit publications and their compliance with the code of practice please refer to the pesticide usage survey section of the SASA website. The website also contains other useful documentation such as confidentiality and revision policies, user feedback and detailed background information on survey methodology.

Additional information regarding pesticide use can be supplied by the Pesticide Survey unit. Please email psu@sasa.gsi.gov.uk or visit the survey unit webpage:

http://www.sasa.gov.uk/pesticides/pesticide-usage

Structure of report and how to use these statistics

This report is intended to provide data in a useful format to a wide variety of data users. The general trends section provides commentary on recent changes in survey data and longer term trends. The 2016 pesticide usage section summarises pesticide use on stored potatoes in 2016. Appendix 1 presents estimated pesticide usage data. Appendix 2 summarises survey statistics including census and holding information, raising factors and the financial burden to farmers. Appendix 3 defines many of the terms used throughout the report. Appendix 4 describes the methods used during sampling, data collection and analysis. Any changes in method from previous survey years are also explained.

It is important to note that the figures presented in this report are produced from surveying a sample of holdings rather than a census of all the holdings in Scotland. Therefore the figures are estimates of the total pesticide use for Scotland and should not be interpreted as exact.

General trends

Scottish potato storage

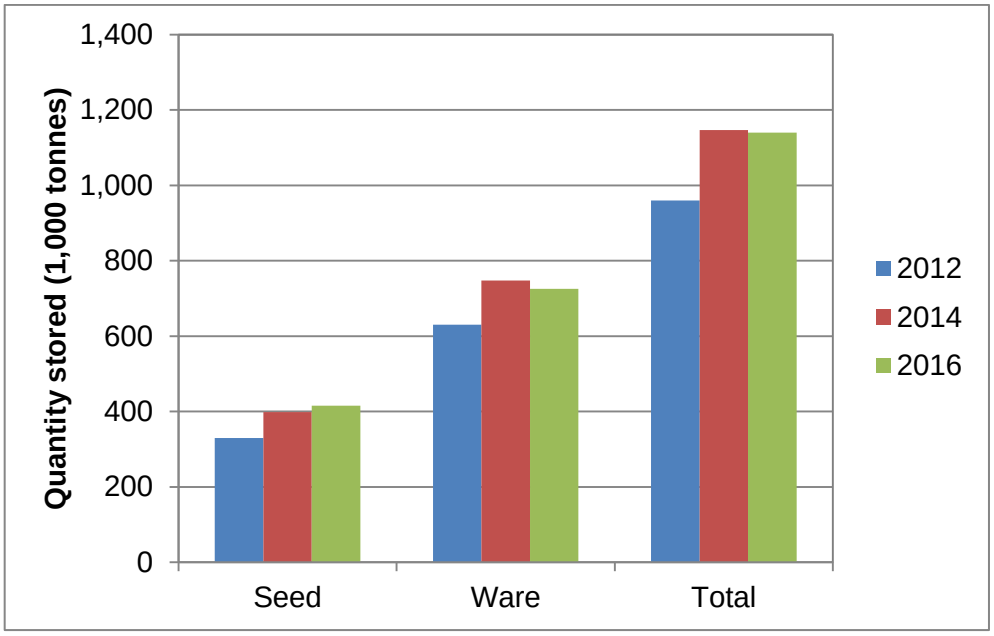
The total estimated quantity of potatoes stored in Scotland in 2016 (1,140,286 tonnes) was very similar to that reported in 2014 (1,146,682 tonnes). Both the 2016 and 2014 storage estimates were almost 20 per cent greater than 2012 (960,064 tonnes). The reduced storage in 2012 was a consequence of poor climatic conditions during the 2012 growing season[(3)], which resulted in yields 21 per cent below the 10 year average (2006 to 2016) for Scottish potato production[(4)].

The quantity of seed and ware potatoes stored was estimated to be 415,023 and 725,263 tonnes respectively (Table 1). This represents a four per cent increase in stored seed potatoes, and a three percent reduction in storage of ware potatoes, from the previous survey in 2014 (Figure 1).

In 2016, as in previous surveys, almost all potatoes surveyed were stored in boxes and very few bulk stores were encountered (<0.5 per cent of stored crops, Figures 5 & 7). Seed crops were mainly held in refrigerated stores (61 per cent) with the majority of the remainder in ambient ventilated stores (37 per cent) and a small proportion in unventilated stores (2 per cent) (Table 1). The majority of seed crops were also held in refrigerated stores in both 2014 and 2012 (69 and 71 per cent respectively).

Ware potato stores were also mostly refrigerated in 2016 (77 per cent) with 21 per cent stored in ambient ventilated stores and two per cent in unventilated stores (Table 1). Ware storage regimes in 2016 were also similar to those encountered in the previous two surveys; 66 and 78 per cent of ware tubers were held in refrigerated stores in 2014 and 2012 respectively.

Figure 1 Estimated total potato storage in Scotland 2012-2016

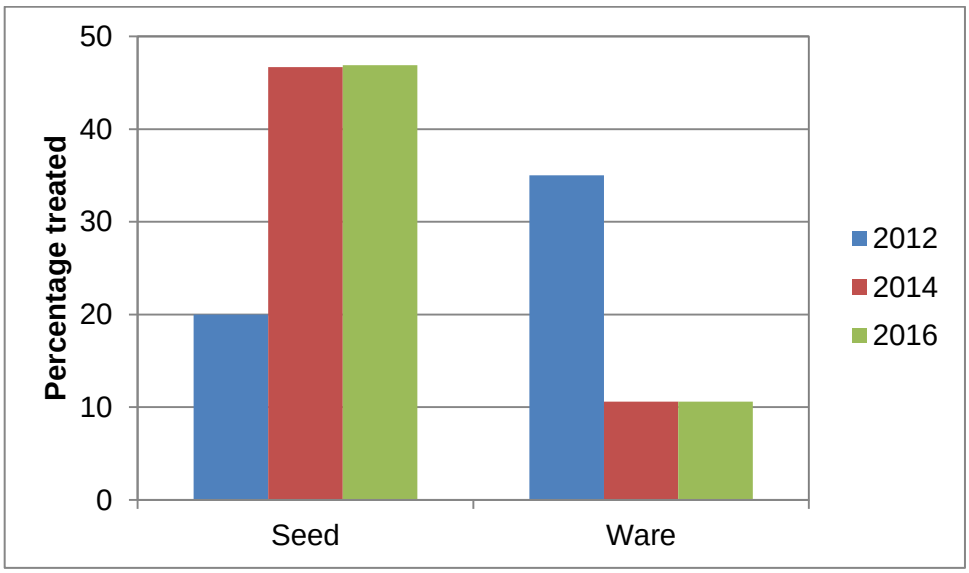


Pesticide usage

Seed potatoes

The proportion of stored seed potatoes treated with a pesticide in 2016 was the same as in 2014 (47 per cent) (Table 1, Figure 2). This was an increase from 2012, when 20 per cent of seed crops received a store treatment. In 2012, despite the difficult growing season, the quality of seed potatoes harvested in Scotland was good[5] and pesticide use was around half of that encountered in the previous decade of surveys[6]. With the exception of 2012, the proportion of seed potatoes receiving a pesticide treatment in the store has been fairly stable over the last decade (Figure 3).

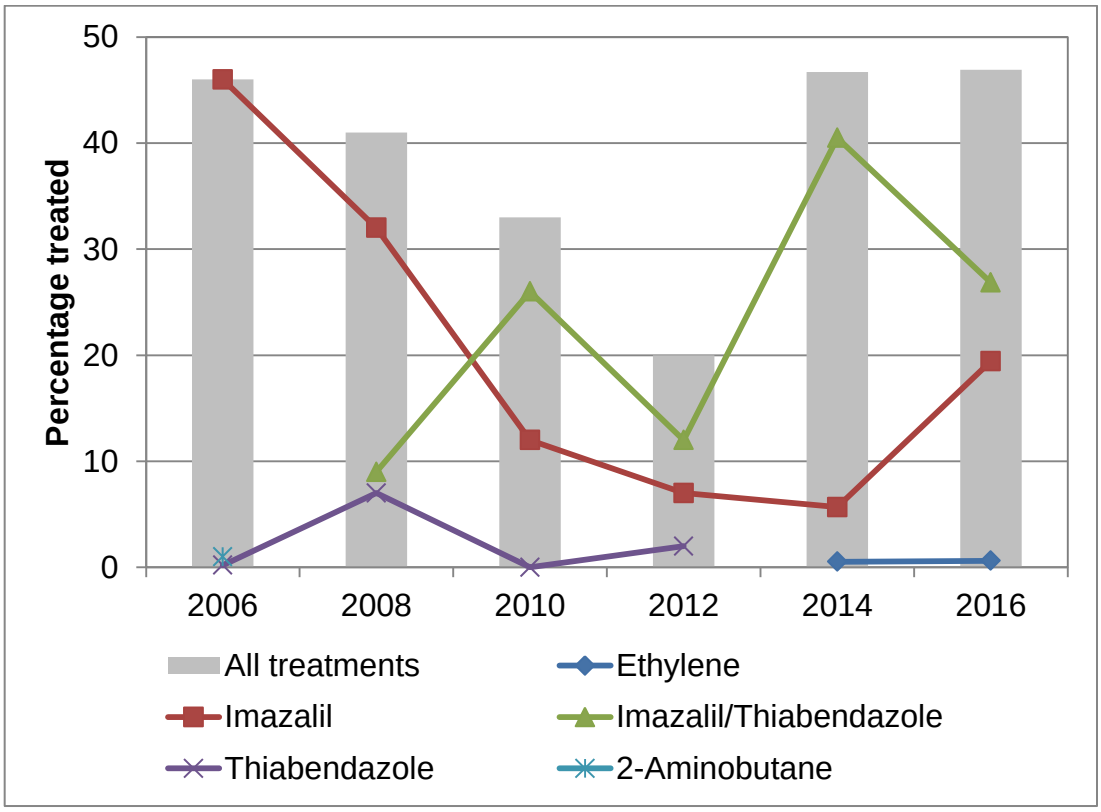
Figure 2 Percentage of stored potatoes treated with pesticides in Scotland 2012-2016



The majority (>99 per cent) of the pesticides used in seed potato stores were fungicides (Figure 3, Table 2). In 2016, the most commonly used fungicide was a formulation of imazalil/thiabendazole which was applied to 27 per cent of seed crops, whilst imazalil alone was applied to 19 per cent. In 2014, these compounds were applied to 40 and 6 per cent of the crop respectively. The reason for the reduction in imazalil/thiabendazole use, and resultant increase in imazalil, is due to changes in pesticide approval. Imazalil/thiabendazole lost approval in 2015, with a final marketing and sale date of 30th June 2016; which was prior to the 2016 potato store treatment period. However, the final use date of 30th June 2017 allowed some growers to use their remaining stocks on the tubers harvested in 2016.

As in 2014, a small proportion (1 per cent) of stored potatoes, were treated with ethylene. Ethylene, which is generated from ethanol, is not approved as a plant protection product for stored seed potatoes. However it is approved as a commodity substance for plant growth regulation for post-harvest crops under COPR(7).

Figure 3 Percentage of stored seed potatoes treated with a pesticide in Scotland 2006-2016

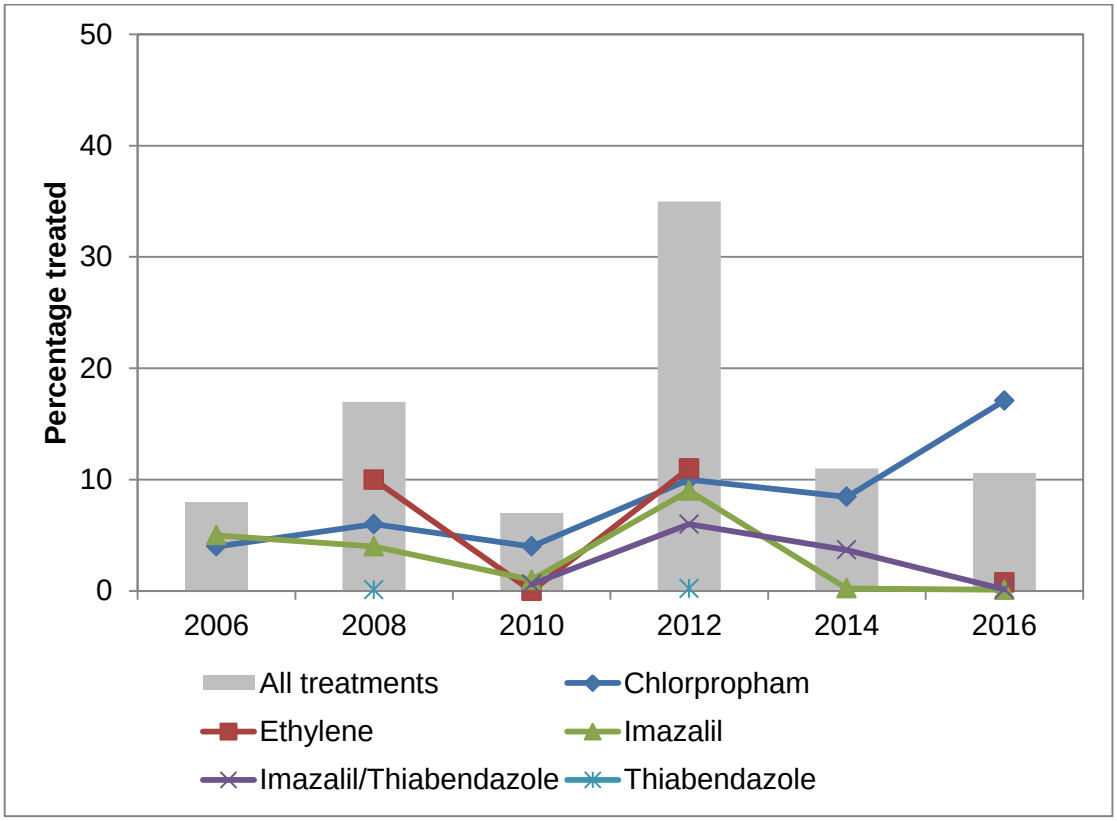


Ware potatoes

As with the seed crop, the overall proportion of ware potatoes treated with a pesticide in store in 2016 was the same as in the previous survey (11 per cent) (Table 2, Figure 4). Very few fungicide applications were encountered on ware potatoes (<1 per cent of stored crop). Historically, with the exception of 2012, which was an outlier, less than five per cent of stored ware potatoes have been treated with a fungicide over the last decade.

The majority of the pesticides used in ware stores were growth regulators, which are used for sprout suppression. The estimated percentage of the ware crop treated with a growth regulator in 2016 doubled from 2014, almost exclusively due to increased chlorpropham use (applied to 8 and 17 per cent of potatoes in 2014 and 2016 respectively. In recent surveys use of chlorpropham appears to be becoming more prevalent, with greater use recorded than ethylene, which was the principal sprout suppressant formulation prior to 2014. However, the use of growth regulators has shown variation over time, as have the compounds encountered (Figure 4) and it's difficult to interpret trends within this data series.

Figure 4 Percentage of stored ware potatoes treated with a pesticide in Scotland 2006-2016



2016 Potato storage and pesticide usage

Seed Potatoes

- An estimated 415,023 tonnes of seed potatoes were stored in Scotland in 2016. This represents a four per cent increase from the estimated 398,780 tonnes stored in 2014
- 61 per cent of seed potatoes were stored in refrigerated stores, 37 per cent in ambient ventilated stores and two per cent in unventilated stores (Figure 5)
- More than 99 per cent of seed potatoes were stored in boxes; the remainder (ca. 3 tonnes) were held in bulk stores
- Overall, 47 per cent of seed potatoes received a pesticide treatment in store
- The percentage of seed potatoes receiving an in-store pesticide treatment was 34, 69 and 45 per cent in refrigerated stores, ambient ventilated stores and unventilated stores respectively
- Two fungicidal formulations (imazalil and imazalil/thiabendazole) and one growth regulator (ethylene) were encountered in seed potato stores (summary below)
- Imazalil and imazalil/thiabendazole are applied as sprays to tubers. Ethylene is applied as a gas in the store
- Reasons for use were supplied for 77 per cent of the crop which was treated with fungicides (imazalil and imazalil/thiabendazole). The most commonly specified diseases targeted with these treatments were dry rot (*Fusarium* spp.) and silver scurf (*Helminthosporium solani*) (Figure 6)
- No reasons were supplied for use of ethylene. Ethylene has a growth regulatory function in seed potatoes. It is used, in conjunction with modified temperatures, to increase the number of sprouts and stems, resulting in increased tuber numbers

Summary of estimated pesticide use on seed potatoes in store

Pesticide formulation	Tonnes treated	% treated
Ethylene[(1)]	2,557	1
Imazalil	80,684	19
Imazalil/thiabendazole	111,401	27

(1) Ethylene is not approved as a pesticide for use in seed potato stores under PPP regulations. However it is approved as a commodity substance for plant growth regulation in post-harvest crops under COPR[(7)]

Figure 5 Seed potato storage by type - 2016

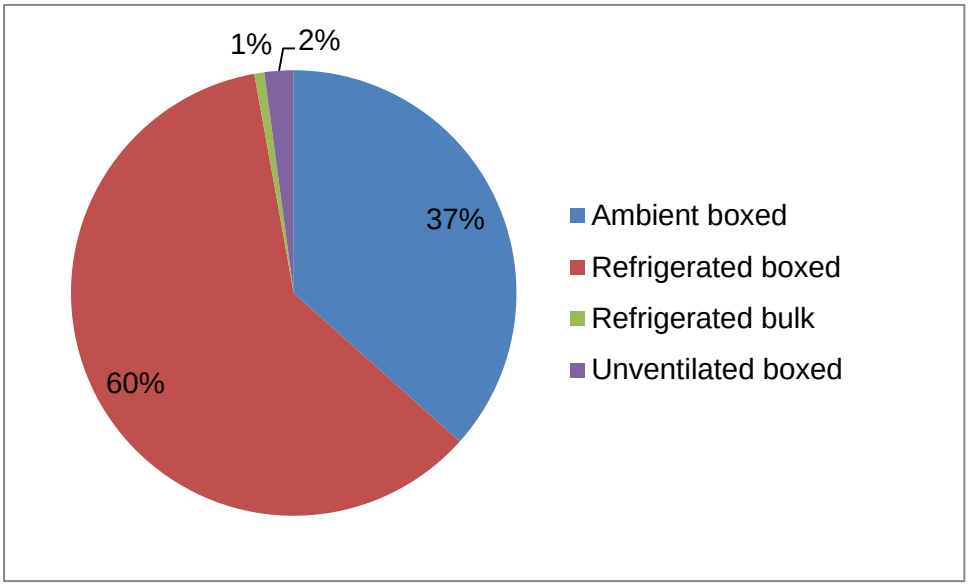
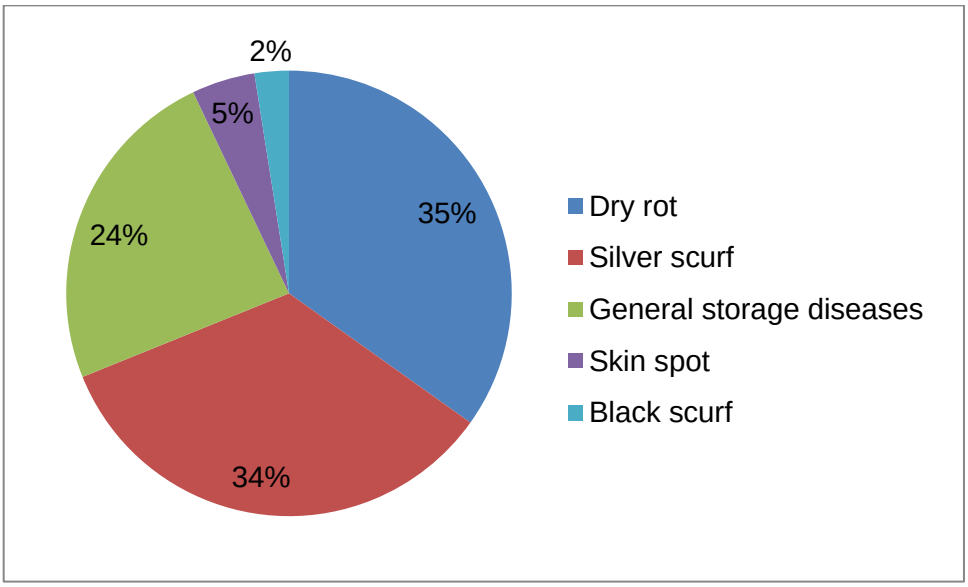


Figure 6 Reasons for use of fungicides on stored seed potatoes (where specified) - 2016



Ware Potatoes

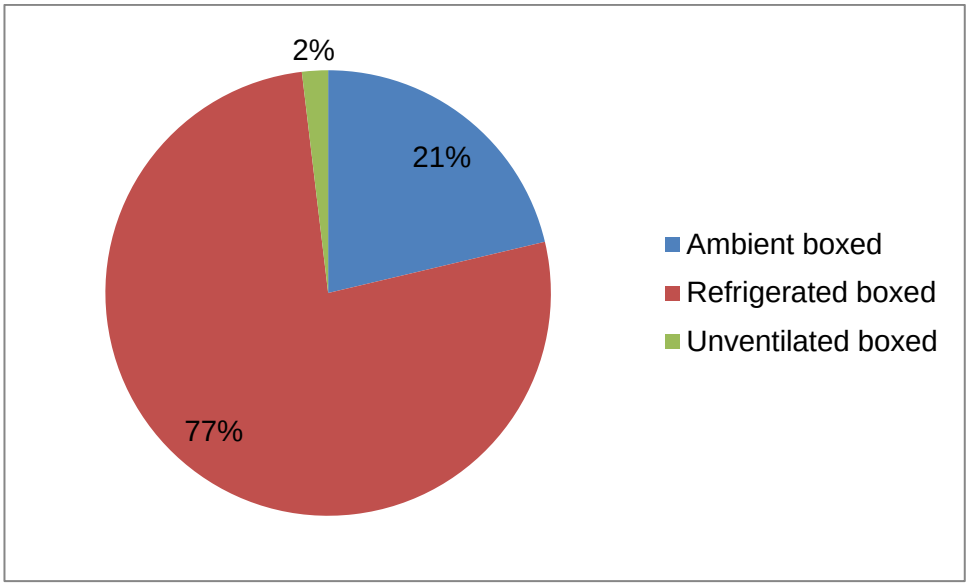
- An estimated 725,263 tonnes of ware potatoes were stored in Scotland in 2016. This is a three per cent decrease compared to the estimated 747,902 tonnes stored in 2014.
- 77 per cent of ware potatoes were stored in refrigerated stores, 21 per cent were stored in ambient ventilated stores and two per cent in unventilated stores (Figure 7)
- All of the ware potatoes sampled were stored in boxes
- 11 per cent of ware potatoes received a pesticide treatment in store
- The percentage of ware potatoes receiving an in-store pesticide treatment was 8 and 20 per cent in refrigerated stores and ambient ventilated stores respectively. No treatments were recorded in unventilated stores
- Two fungicidal formulations (imazalil and imazalil/thiabendazole) and two growth regulators (chlorpropham and ethylene) were encountered in ware potato stores (summary below)
- Imazalil and imazalil/thiabendazole are applied as sprays to tubers. Ethylene is applied as a gas, and chlorpropham as a fog, to stores
- Reasons for use were supplied for 86 per cent of the crop which was treated with fungicides (imazalil and imazalil/thiabendazole). The only specified reason for use of these formulations was general disease control
- Chlorpropham is a growth regulator and all use was reported to be for tuber sprout suppression. No reasons were supplied for use of ethylene, which is also a growth regulator used to suppress sprouting in ware potatoes

Summary of estimated pesticide use on ware potatoes in store

Pesticide formulation	Tonnes treated	% treated
Ethylene	5,461	1
Chlorpropham	123,985	17
Imazalil	740	<0.5
Imazalil/thiabendazole(1)	1,060	<0.5

(1) This formulation is not approved on ware potatoes. It was applied to seed crops which were later reclassified as ware.

Figure 7 Ware potato storage by type - 2016



Appendix 1 – Estimated Application Tables

Table 1 Potatoes stored, and proportion treated, by storage type - 2016

	Store Type			Total
	Unventilated	**Ventilated**	**Refrigerated**	
Seed				
Tonnes stored	8,768	151,945	254,310	**415,023**
% storage type	2%	37%	61%	
Basic tonnes treated	3,973	105,149	85,522	**194,644**
% treated	45%	69%	34%	**47%**
Ware				
Tonnes stored	13,691	154,536	557,036	**725,263**
% storage type	2%	21%	77%	
Basic tonnes treated	0	31,529	45,433	**76,962**
% treated	N/A	20%	8%	**11%**
All stored potatoes				
Tonnes stored	22,459	306,481	811,346	**1,140,286**
% storage type	2%	27%	71%	
Basic tonnes treated	3,973	136,678	130,955	**271,606**
% treated	1%	50%	48%	**24%**

N/A = not applicable

Table 2 Potato storage treatment formulations by storage type - 2016

	Store Type			Total tonnes treated	% Treated
	Unventilated	Ventilated	Refrigerated		
Seed					
Ethylene[1]	0	0	2,557	**2,557**	1%
Imazalil	0	70,004	10,680	**80,684**	19%
Imazalil/thiabendazole	3,973	35,144	72,284	**111,401**	27%
Basic tonnes treated[3]	**3,973**	**105,149**	**85,522**	**194,644**	**47%**
Ware					
Ethylene	0	0	5,461	**5,461**	1%
Chlorpropham	0	85,270	38,715	**123,985**	17%
Imazalil	0	56	684	**740**	<0.5%
Imazalil/thiabendazole[2]	0	488	572	**1,060**	<0.5%
Basic tonnes treated[3]	**0**	**31,529**	**45,433**	**76,962**	**11%**

(1) Ethylene is not approved as a pesticide for use in seed potato stores under PPP regulations. However it is approved as a commodity substance for plant growth regulation in post-harvest crops under COPR[7]
(2) This formulation is not approved on ware potatoes. It was applied to seed crops, a proportion of which were later reclassified as ware
(3) This represents the total tonnage treated, not the column sum, as more than one formulation may be applied to potatoes in store

Table 3 Potato storage treatment active substances - 2016

	Tonnes treated	Kg
Seed Potatoes		
Ethylene[1]	2,557	N/A[2]
Imazalil	192,089	2,125
Thiabendazole	111,404	2,677
Ware Potatoes		
Ethylene	5,461	N/A[2]
Chlorpropham	123,986	1,689
Imazalil	1,802	19
Thiabendazole	1,060	23

N/A = not applicable

(1) Ethylene is not approved as a pesticide for use in seed potato stores under PPP regulations. However it is approved as a commodity substance for plant growth regulation in post-harvest crops under COPR[7]

(2) The mass of ethylene used cannot be estimated (refer to Appendix 3 – definitions and notes)

Table 4 Potato cultivation and storage, comparison with previous surveys - 2016

		2012	2014	2016
Area grown (ha)[1]	Seed	13,002	13,300	12,760
	Ware	16,534	15,211	14,766
Tonnes stored	Seed	329,427	398,780	415,023
	Ware	630,637	747,902	725,263

[1] This is the census area of the crops intended to be grown for seed and ware production. Some of the seed crop was reclassified as ware post-harvest

Table 5 Percentage of stored potatoes treated, comparison with previous surveys - 2016

		2012	2014	2016
Total tonnage treated (%)	Seed	20	47	47
	Ware	35	11	11

Appendix 2 – Survey statistics

Census and sample information

Table 6 Distribution of sampled potato stores - 2016

Number of potato growers sampled in each region

Region		No. of stores
North:	Highlands & Islands, Caithness & Orkney, Moray Firth, Aberdeen	15
Angus		31
Central:	East Fife, Central Lowlands and Lothian	13
South:	Tweed Valley, Southern Uplands and Solway	6
Scotland		**65**

Table 7 Distribution of stored potatoes in sample - 2016

Quantity (tonnes) of potatoes sampled in each region

Crop	North	Angus	Central	South	Scotland
Seed Potatoes	39,678	70,336	18,350	5,939	**134,303**
Ware Potatoes	14,945	79,156	48,660	32,912	**175,673**
Total	**54,623**	**149,492**	**67,010**	**38,851**	**309,976**

Table 8 Distribution of sampled areas - 2016

Areas (ha) of potato crops sampled

Crop	North	Angus	Central	South	Scotland
Seed Potatoes	1,119	1,754	652	199	**3,724**
Ware Potatoes	338	1,553	822	575	**3,288**
Total	**1,457**	**3,307**	**1,474**	**774**	**7,012**

Table 9 Distribution of census areas - 2016

Areas (ha) of potato crops grown in Scotland

Crop	North	Angus	Central	South	Scotland
Seed Potatoes	3,959	6,269	1,943	589	**12,760**
Ware Potatoes	1,822	6,707	4,600	1637	**14,766**
Total	**5,781**	**12,976**	**6,543**	**2,226**	**27,525**

Table 10 Raising factors - 2016

Region	Seed	Ware
North	3.5376	5.3883
Angus	3.5745	4.3187
Central	2.9784	5.5977
South	2.9621	2.8447

Note: Raising factors are calculated by comparing the sampled crop area to the census crop area. Please see Appendix 4 for an explanation of the estimation method.

Table 11 First adjustment factors for ware potatoes - 2016

Adjusts for potatoes which were grown as seed but later designated as ware

Region	Ware
North	0.9457
Angus	0.979
Central	0.9231
South	1.0004

Table 12 Second adjustment factors -2016

Adjusts survey data to estimates of Scottish seed and ware potato production provided by AHDB Potatoes

Crop	Adjustment Factor
Seed	0.8944
Ware	0.9595

Financial burden to farmers

In order to minimise the burden on farmers, the survey team used non-visit methods of collection such as email, post or telephone call, where possible.

To determine the total burden that the 2016 Potato Storage Survey placed on those providing the information, the surveyors recorded the time that 23 respondents spent providing the data during the survey. This sample represents 35 per cent of growers surveyed. The median time taken to provide the information was 10 minutes.

The following formula was used to estimate the total cost of participating:

Burden (£) = No. surveyed x median time taken (hours) x typical hourly rate* (* using median 2015 “Full Time Gross” hourly pay for Scotland of £13.48[8])

The total financial burden to all growers resulting from participation in the 2016 Potato Storage Survey was calculated to be £146.

Appendix 3 - Definitions and notes

1) Pesticide information recorded in this survey relates to **any pesticide usage during potato storage** and also to **post-harvest applications**, carried out in the field at lifting, prior to entry to the store. Pre-planting treatments with a fungicide intended to control disease post-planting e.g. black scurf, are not included, even if the fungicide had been applied in store. Use of pesticides in this situation is recorded in the seed treatment section of the preceding arable crop report.

2) '**Pesticide**' is used throughout this report to include commercial formulations containing active substances (a.s.) used as herbicides, fungicides, insecticides, molluscicides, biological control agents, growth regulators, seed treatments and physical control. A pesticide product consists of one or more active substances co-formulated with other materials. In this survey only fungicides and sprout suppressants (growth regulators) were encountered.

3) An **active substance** (or active ingredient) is any substance or micro-organism which has a general or specific action against harmful organisms or on plants, parts of plants or plant products.

4) In this report the term '**formulation**(s)' is used to describe the pesticide active substance or mixture of active substances in a product(s). It does not refer to any of the solvents, pH modifiers or adjuvants also contained within a product that contribute to its efficacy.

5) A **fungicide** is a pesticide used to control fungal diseases in plants or potato tubers.

6) A **growth regulator** is a pesticide used to regulate the growth of the plant, for example to suppress the growth of sprouts by potato tubers in store.

7) A **seed treatment** is a pesticide applied to seed or potato tuber before planting to protect that plant against diseases and pests from the earliest stage of development.

8) **Basic tonnage** is the quantity of potatoes treated with a pesticide, irrespective of the number of times they were treated or the number of pesticides used. This figure is used to calculate the percentage of potatoes treated with a given pesticide or pesticide group.

9) **Seed potatoes** are crops grown for marketing or planting as seed for next season's crop. A fraction of the crop intended for seed production may not meet the necessary requirements and may be reclassified as ware potatoes post-harvest.

10) **Ware potatoes** are those grown for the ware (consumption) market, including those processed by a manufacturer. Ware potatoes may include a portion of potatoes originally planned for seed production but later classified as ware.

11) **Unventilated stores** are defined as simple stores without fans that are naturally ventilated.

12) **Ventilated stores** can either be **adapted ambient** or **purpose built ambient ventilated stores**. These stores use forced air ventilation; they are not refrigerated.

13) **Adapted ambient ventilated stores** are basic stores with forced air ventilation. These stores commonly contain temporary fans and raised vents (normally wire hoops) on the floor of the store.

14) **Purpose built ambient ventilated stores** are purpose built stores with forced air ventilation including open walled letterbox systems or suction wall systems. The potatoes are often stored to a depth of 3-5 metres; the floor is concrete and contains ventilation ducts. Pesticides can be applied by means of fogs and gases dispersed through the ventilation system.

15) **Refrigerated Stores** are purpose built stores which may also have mechanically assisted ventilation. Potatoes are stored at low temperatures which can help reduce the use of pesticides. Pesticides can be applied through the ventilation system

16) Potatoes can be stored either in **bulk** (loose potatoes) or in **wooden boxes**. Potatoes stored in bags are excluded from this survey.

17) **Ethanol** is used as an **ethylene** generator to suppress tuber sprouting in stores. There is no standard recommended rate per tonne for the use of ethanol in potato stores and the quantity used varies according to store capacity, crop volume, type of store and duration of storage. In most cases the actual rate of application is not available and total quantity cannot be estimated. Therefore estimated use of this pesticide is presented only as tonnes of potatoes treated.

18) In this report each estimated use of each pesticide is reported in three formats; tonnes treated with pesticide formulations (mixture of active substances in a product) and of individual active substances and quantities of active substance applied (Table 2 formulation data, Table 3 for active substance treated tonnes and quantity data). All three different formats are provided to satisfy the needs of all data users and allow them to assess pesticide use trends. Some users may be interested in use of pesticide products which contain a number of active substances, thus formulation data would be required. Other users are interested in particular active substances which may be formulated on their own or in combination with other active substances. Therefore active substance data would be required. In addition, both quantity and tonnes treated with pesticides are important indicators of changes in use over time.

19) The **June Agricultural Census**[9] is conducted annually by the Scottish Government's Rural and Environmental Science Analytical Services (RESAS). The June Agricultural Census collects data on land use, crop areas, livestock and the number of people working on agricultural holdings. For this report the

June Agricultural Census was used to draw a sample of growers growing the relevant crops to participate in the survey

20) Throughout this report the term '**census area**' refers to the total area for a particular crop or group of crops recorded within the June Agricultural Census[9]. These are the areas which the sampled areas are raised to. Please see Appendix 4 for details. The June Agricultural Census Form is divided up into different categories which relates to a particular crop or group of crops. These are referred to as '**census categories**' throughout this report.

21) Where quoted in the text or within figures, reasons for application are the grower's stated reasons for use of that particular pesticide on that crop and may not always seem appropriate. It should be noted that growers do not always provide reasons; therefore those presented in the figures only reflect those specified and may not reflect overall reasons for use.

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

23) Data from the 2012[10] and 2014[3] surveys are provided for comparison purposes in some of the tables and figures. It should be noted that there may be changes in areas of seed and ware potatoes grown between survey years. Also when comparisons are made between surveys it is important to take into account that there may be changes in quantity of potatoes stored.

24) For notes on data uses, quality and sources of bias please refer to the notes and definitions section of the preceding arable report.

Appendix 4 – Survey methodology

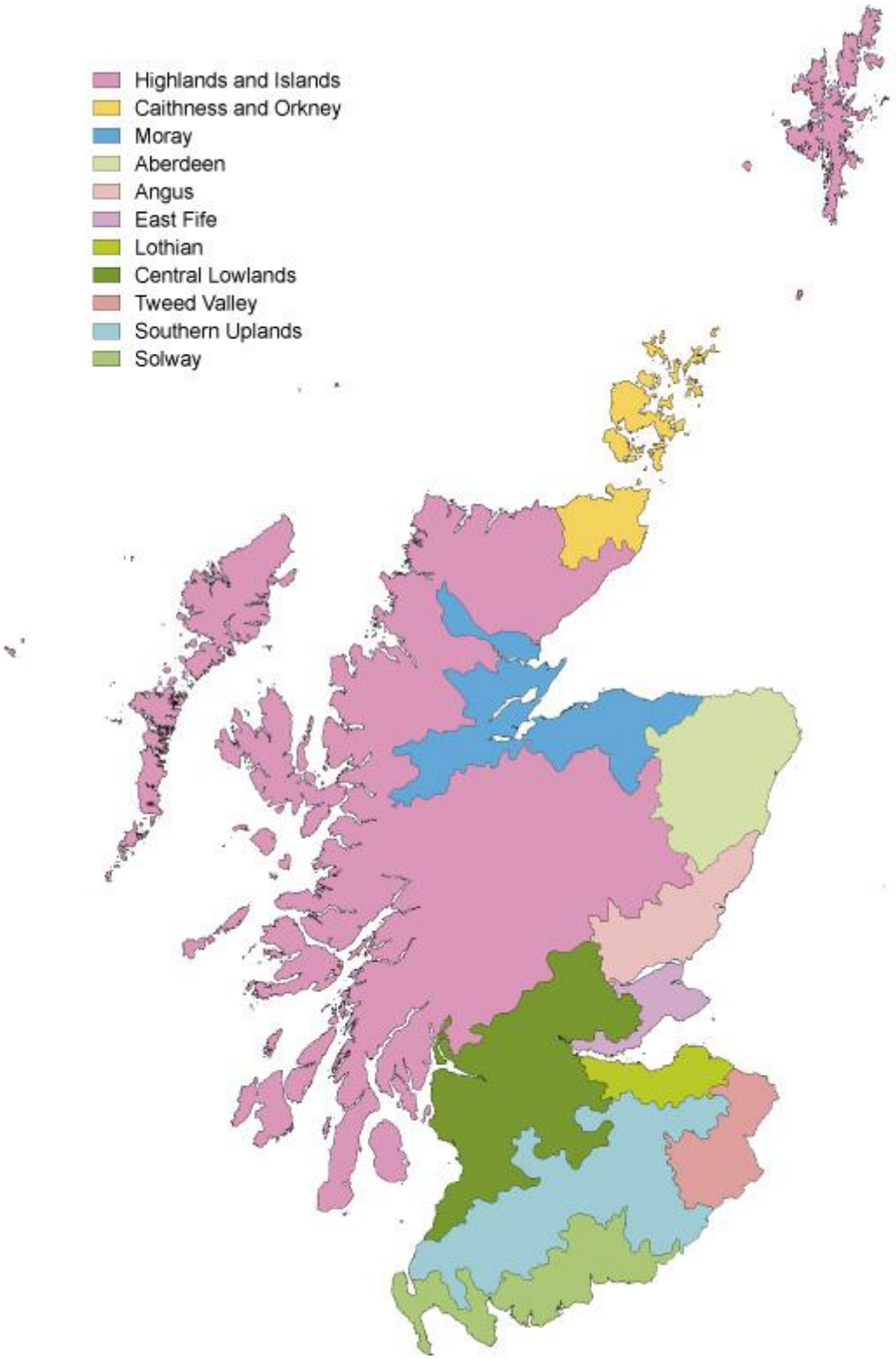
Sampling and data collection

The sample of farms used for this survey was the same as that for the Arable Crops 2016 survey. Using the June 2016 Agricultural Census[9], a sample was drawn representing arable cultivation in Scotland. The country was divided into 11 land-use regions (Figure 8). Each sample was stratified by these land-use regions and according to holding size. The holding size groups were based on the total area of arable crops grown. The sampling fractions used within both regions and size groups were based on the areas of relevant crops grown rather than number of holdings, so that smaller holdings would not dominate the sample.

Data relating to pesticide use in potato stores were collected from all potato growers encountered in the arable sample, either during an on-farm or telephone interview, or via e-mail or fax. In instances where the potato land was let, and storage was on a separate holding, the potato grower was contacted individually to obtain storage details. Data were collected for all potatoes stored by these growers, not just for those crops grown on the holdings sampled. Therefore the sample of stored potatoes relates to a greater area of potato cultivation than that for which field pesticide treatments were collected in the 2016 arable pesticide survey report. In total, data were collected from 65 growers. The crops grown by these growers represent 25 per cent of the total 2016 potato crop census area.

The data collected included the areas of seed and ware crops grown, quantities of potatoes sold and stored, storage type, storage method and post-harvest pesticide applications at crop lifting and during storage. Fungicidal seed treatments applied prior to planting are included in the arable crop report.

Figure 8 Land use regions of Scotland[11]



Raising factors

National pesticide use was estimated by ratio raising. This is a standard statistical technique for producing estimates from a sample. It is the same methodology used by the other UK survey teams and has been used for all historical datasets produced by the Pesticide Survey Unit, allowing comparability over time. The sample data were multiplied by raising factors (Table 10). These factors were calculated by comparing the sampled crop area to the areas recorded in the Agricultural Census within each region and size group. An adjustment (Table 11) was made to the ware fraction to correct for the potatoes grown as seed that were then designated as ware. A second adjustment (Table 12) was made to align the survey estimates of total tonnes stored with production estimates provided by AHDB Potatoes.

Due to the low numbers of potatoes grown and sampled in some geographic regions, stored data were amalgamated into four regions to allow more robust estimation of pesticide use: the North (Highlands & Islands, Caithness & Orkney, Moray Firth and Aberdeen), Angus (the main potato growing area in Scotland), Central (East Fife, Lothian and Central Lowlands) and the South (Tweed Valley, Southern Uplands and Solway).

Changes from previous years

There were no changes in methodology from the previous surveys presented as comparisons.

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