Scottish Government
Riaghaltas na h-Alba

Pesticide Usage in Scotland

A National Statistics Publication for Scotland

# Grassland and Fodder Crops 2021

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## Executive summary

This report presents information from a survey of pesticide use on grassland and fodder crops in Scotland in 2021. The crops surveyed included direct sown grass, undersown grass, grass one to four years old, grass over five years old, rough grazing, arable silage, fodder beet, fodder rape, kale and cabbage, maize, stubble turnips, turnips and swedes and other minor fodder crops. Information about the uptake of integrated pest management measures by Scottish growers (including non-chemical methods of control) was collected alongside the pesticide usage survey.

The estimated area of grassland and rough grazing grown in Scotland in 2021 was approximately 4,403,000 hectares, similar to that grown in 2017. Rough grazing accounted for 70 per cent of the total area grown, grass over five years 26 per cent, and grass under five years four per cent.

The fodder crop area was approximately 17,200 hectares, a six per cent increase from the previous survey in 2017. Other stock-feeding crops accounted for 38 per cent of fodder crops grown, of which 84 per cent was arable silage. Turnips and swedes accounted for 20 per cent, fodder rape 13 per cent, kale and cabbage 12 per cent, maize seven per cent, fodder beet seven per cent and stubble turnips three per cent.

Data were collected from 182 holdings with both fodder crops and grassland, and an additional 438 holdings with grassland only. This sample represented 16 per cent of total fodder crops grown in Scotland, six per cent of grassland area and two per cent of rough grazing. Ratio raising was used to produce estimates of national pesticide use from the sampled data.

The estimated total area of grassland and rough grazing treated with a pesticide formulation was ca. 81,000 ha (± 11 per cent Relative Standard Error, RSE), with a combined weight of 67 tonnes (± 11 per cent RSE). Overall, these pesticides, almost exclusively herbicides, were applied to four per cent of grassland and less than 0.5 per cent of the rough grazing area. Taking into account changes in crop area, the 2021 total pesticide treated area on grassland and rough grazing was nine per cent lower than that reported in 2017 and seven per cent lower than in 2013. The weight of pesticide applied was 21 per cent lower than in 2017 and 22 per cent lower than 2013. The decrease in overall pesticide use in 2021 from 2017 and 2013 may have been influenced by a number of factors. A cold, dry spring in 2021 may have reduced pest pressure and thus the need for pesticide use. The estimated reduction in herbicide use was also influenced by the infrequency of aerial spraying encountered in the 2021 sample. Additionally, the continued reduction in pesticide options may also have influenced use figures, with several of the key active substances used during 2013 and 2017 now being withdrawn and were unavailable in 2021.

The estimated total area of fodder crops treated with a pesticide formulation was ca. 25,100 ha (± eight per cent RSE), with a combined weight of ca. 10 tonnes (± 12 per cent RSE). Pesticides, primarily herbicides, were applied to 38 per cent of fodder crops. When changes in crop area is accounted for,

there was a decrease of two per cent in total area treated with pesticide formulations from 2017 to 2021 and a 32 per cent decrease from 2013. Weight of pesticide applied showed a 20 per cent increase from 2017 and a 21 per cent decrease from 2013. The application of insecticides, fungicides and herbicides increased in terms of weight applied (230, 142, and 13 per cent respectively), whilst the application of seed treatments and molluscicides decreased (42 and 44 per cent respectively).

The decrease in area treated but the increase in weight applied between 2017 and 2021 may have been influenced by the loss of seed treatment active substances (thiram and thiamethoxam) and the subsequent increase in foliar fungicides and insecticides. In addition, pesticide usage was low in 2017, influenced by the particularly dry spring, drier than 2021, so pest pressure was particularly low.

In terms of area treated, the most commonly used herbicide on grassland and fodder crops was fluroxypyr and the most used foliar fungicide and seed treatment was prothioconazole. The pyrethroid deltamethrin was the most commonly used insecticide. The herbicides halauxifen-methyl, mesosulfuron-methyl and napropamide, the fungicides benzovindiflupyr and mefentrifluconazole, the seed treatments sedaxane and ziram, and the insecticide flonicamid were recorded for the first time in this survey.

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, pest monitoring and pest control. This dataset is the second in this series of surveys of IPM measures on grassland and fodder crops, allowing the adoption of IPM techniques to be monitored. There was very strong evidence for an increase in the use of IPM plans from the 2017 survey (24 per cent in 2021 compared to five per cent in 2017).

## 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 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 and soft fruit 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, or visit the Fera pesticide usage survey webpage.

The Scottish Pesticide Usage reports have been designated as Official Statistics since August 2012 and as National Statistics since October 2014. The interim Chief Statistician (Ally McAlpine) 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 SASA privacy policies and SASA revision policies, a pesticide usage report feedback survey and detailed background information on the survey methodology used and uses of the PSU pesticide usage dataset.

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

### 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 2021 pesticide usage section summarises usage on all grassland and fodder crops in 2021. Appendix 1 presents all estimated pesticide usage in three formats, area and weight of formulations by crop and area and weight of active substances grouped by their mode of action. The area and weight of active substances by crop data, which were previously published in this report, are now published as supplementary data in Excel format. 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.

## General trends

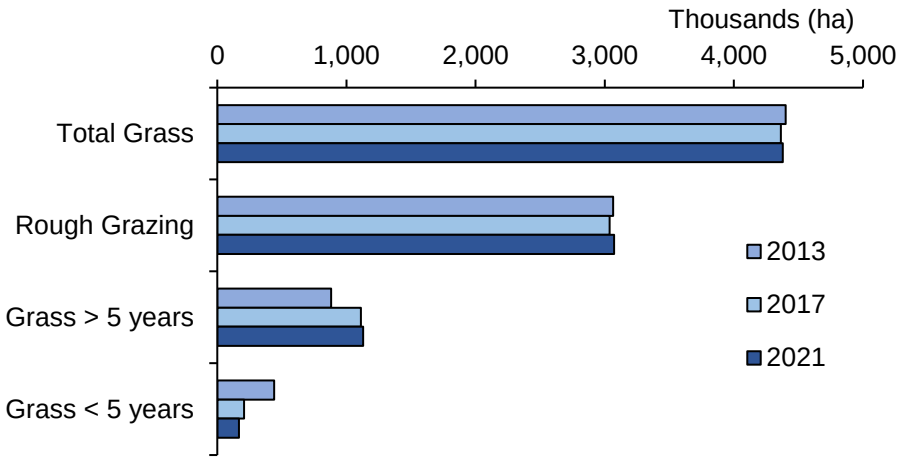
### Crop area – grassland and rough grazing

The estimated area of grassland and rough grazing in 2021 was 4,378,628 hectares (Table 16). This is very similar to the area recorded in 2017[(3)] and in 2013[(4)]. Since the last survey, the area of rough grazing has remained almost the same, grass over five years old has increased by two per cent and grass under five years old has decreased by 19 per cent (Figure 1). Undersown grass (not illustrated in Figure 1) has increased by 22 per cent since the last survey in 2017 but has fallen by 41 per cent when compared to 2013. However, it should be noted that there was a change in census definition of temporary and permanent grass between 2013 and 2017. This change may have influenced the reported crop areas, and the subsequent estimates of pesticide use made using these census areas (refer to Appendix 4).

In 2021, as in 2017, rough grazing accounted for 70 per cent of Scottish grassland area. Grass over five years old accounted for 26 per cent and grass under 5 years old four per cent. Undersown grass remained unchanged at less than 0.5 per cent of the crop area (Figure 2). The majority

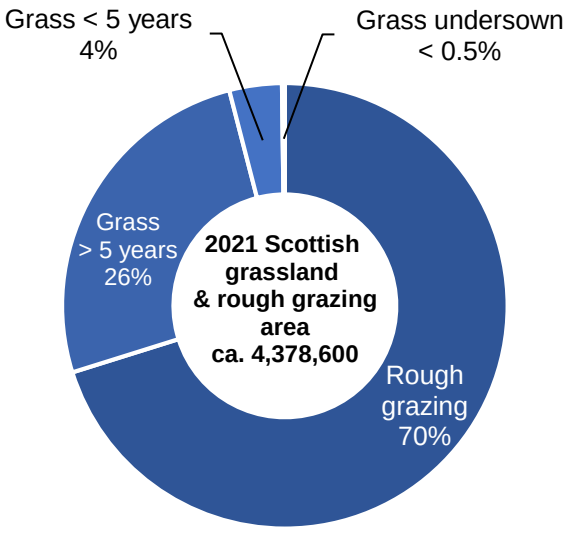
of grassland and rough grazing in Scotland is in the Highlands and Islands region (Figure 3).

**Figure 1 Area of grassland and rough grazing in Scotland 2013-2021**

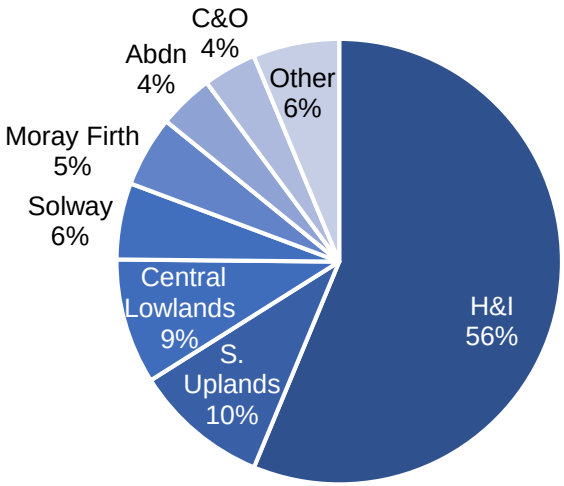



Note: undersown grass has been excluded as the area grown is < 20,000 hectares. There was a change in census definition of temporary and permanent grass between 2013 and 2017. Therefore, reported crop changes may not wholly reflect changes in land use (Appendix 4).

**Figure 2 Grassland and rough grazing census areas in Scotland 2021 (percentage of total area)**



## Figure 3 Regional distribution of grassland and rough grazing in Scotland 2021 (percentage of total area)



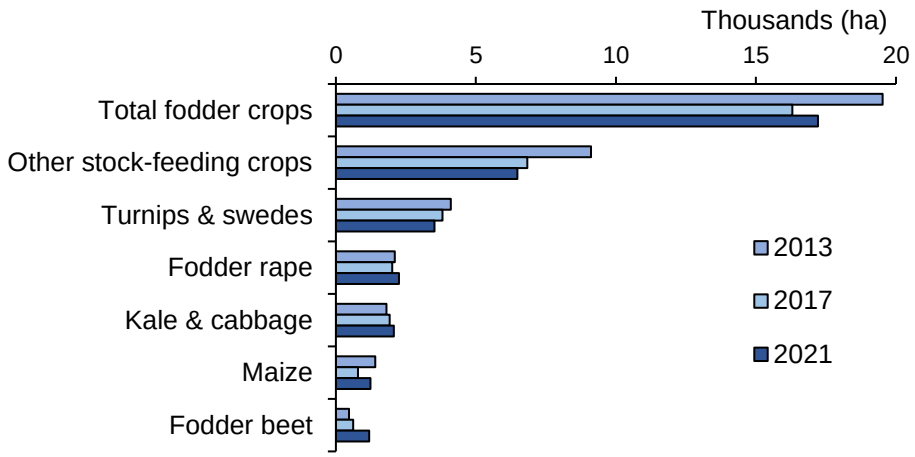

Note: H&I = Highlands and Islands, S. Uplands = Southern Uplands, C&O = Caithness and Orkney, Abdn = Aberdeen, Other = Angus, East Fife, Lothian and Tweed Valley.

### Crop area – fodder crops

The estimated area of fodder crops grown in 2021 was 17,214 hectares (Table 15). This represents a six per cent increase from 2017 and a 12 per cent decrease from 2013. Since the previous survey, the area grown with turnips & swedes and other stock-feeding crops have decreased (eight & five per cent respectively). Conversely, the area grown with fodder beet, maize, fodder rape, kale & cabbage have increased (95, 55, 12 and eight per cent respectively, Figure 4).

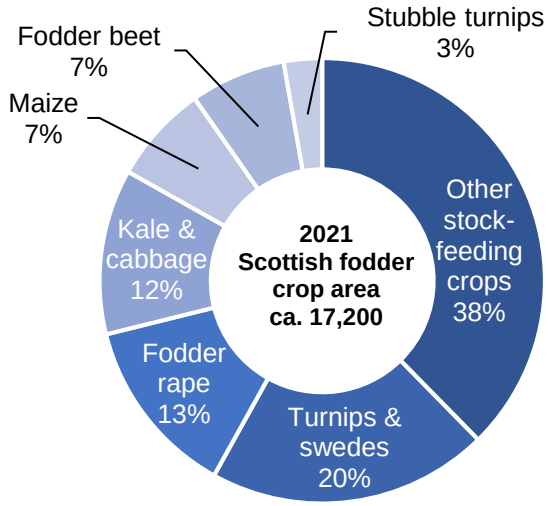
In 2021, 38 per cent of fodder crops were found in the 'other stock-feeding' category of the census (Figure 5). Arable silage accounted for 84 per cent of this category. Turnips & swedes (20 per cent), fodder rape (13 per cent) and kale & cabbage (12 per cent) were also widely grown. Maize and fodder beet accounted for seven per cent each. The distribution of fodder crops within Scotland is broadly similar to the pattern seen in 2017 and 2013, with the largest proportion, 17 per cent, grown in the Aberdeen region (Figure 6).

## Figure 4 Area of fodder crops in Scotland 2013-2021



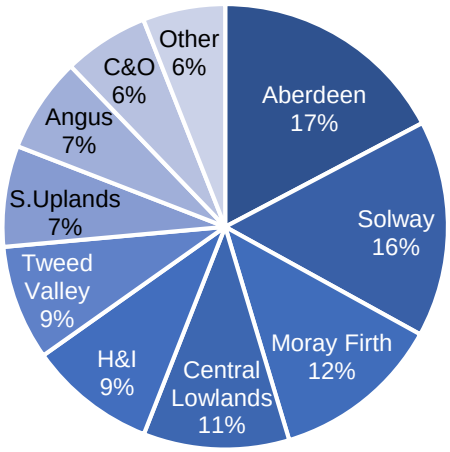

Note: 'other stock-feeding crops' include arable silage, fodder rape, kale, stubble turnips and fodder crop mixes.

## Figure 5 Fodder crop census areas Scotland 2021 (percentage of total area)




Note: 'other stock-feeding crops' include arable silage, red clover, swedes, kale, stubble turnips and fodder crop mixes.

## Figure 6 Regional distribution of fodder crops in Scotland 2021 (percentage of total area)



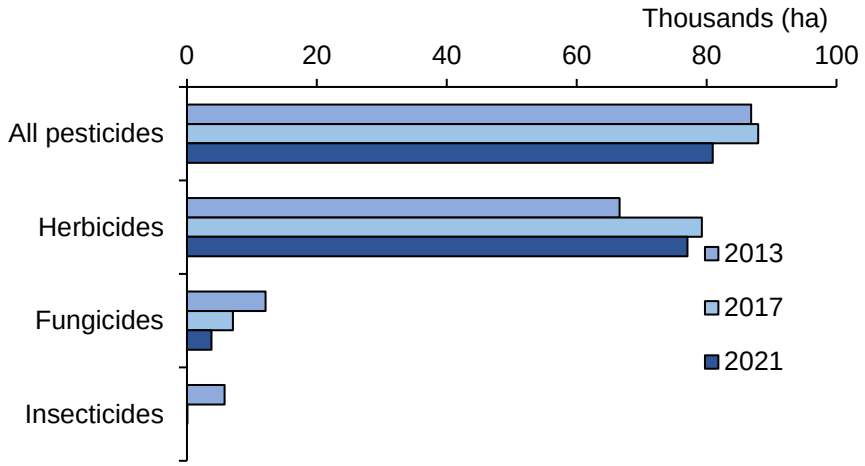

Note: H&I = Highlands and Islands, C&O = Caithness and Orkney, S. Uplands = Southern Uplands, Other = Lothian and East Fife.

### Pesticide usage – grassland and rough grazing

As in previous surveys, the proportion of grassland and rough grazing treated with a pesticide was very low. As in 2017, only four per cent of grassland and less than 0.5 per cent of rough grazing was treated with a pesticide. These areas received 1.1 and 1.0 sprays respectively, on average, during 2021 (Table 1).

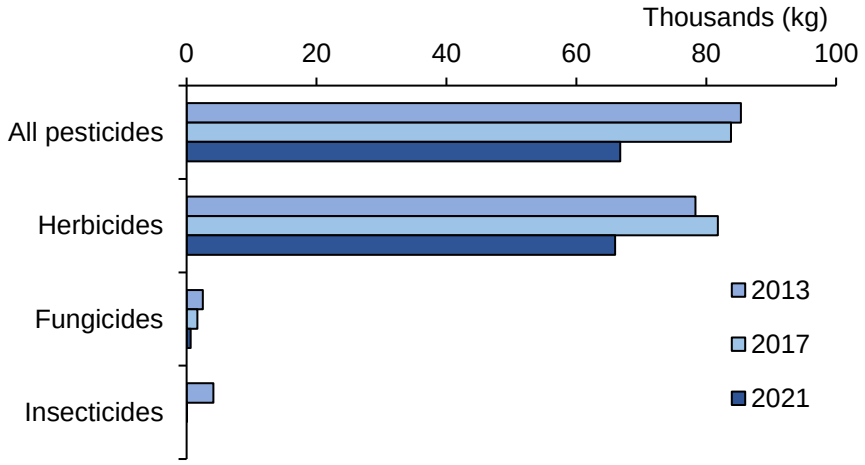
It is estimated that the area of grassland and rough grazing treated with a pesticide formulation in 2021 was ca. 81,000 hectares (Table 14 & Figure 7). This represents a decrease of eight per cent since 2017 and seven per cent since 2013. In relation to the weight of pesticide applied, ca. 66.7 tonnes was applied in 2021, a decrease of 20 per cent from 2017 and 22 per cent from 2013 (Figure 8).

## Figure 7 Area of grassland and rough grazing treated with the major pesticide groups in Scotland in 2013-2021




Note: seed treatments, growth regulators, molluscicides and sulphur have been excluded as they represent < 1,000 hectares. No seed treatment, growth regulator, molluscicide or insecticide use was recorded in 2021.

## Figure 8 Weight of major pesticide groups applied to grass crops in Scotland 2013-2021

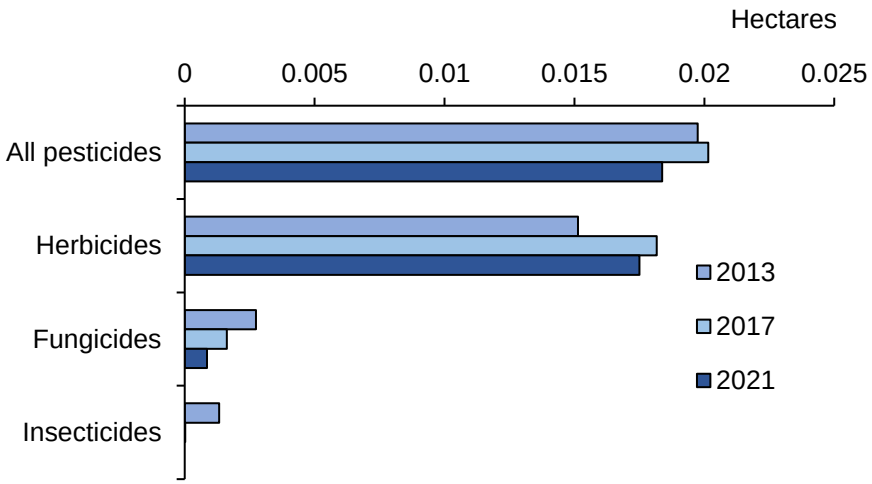



Note: seed treatments, growth regulators, molluscicides and sulphur have been excluded as they represent < 1,000 kg. No seed treatment, growth regulator, molluscicide or insecticide use was recorded in 2021.

In order to make accurate comparisons between surveys, temporal differences in crop area must be taken into account. Therefore, the number of pesticide treated hectares and total weight of pesticide used per hectare of crop grown were calculated. When crop area is taken into account, there was

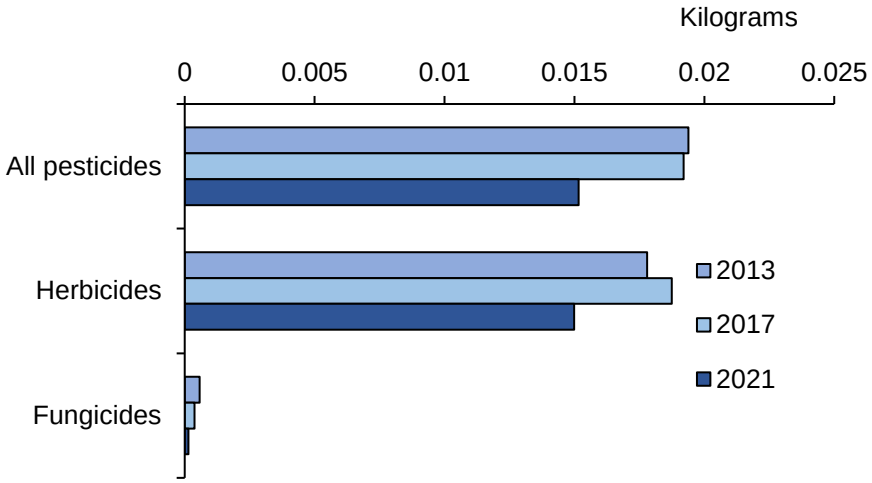
a nine per cent decrease from 2017 to 2021 and a seven per cent decrease from 2013 to 2021 in terms of the total pesticide treated area of crop grown (Figure 9). Similarly, in terms of quantity of pesticides used per hectare of crop grown, there was a decrease of 21 per cent from 2017 to 2021 and a decrease of 22 per cent from 2013 to 2021 (Figure 10).

**Figure 9 Number of pesticide treated hectares (formulations) per hectare of grass crop grown – 2021**




Note: seed treatments, growth regulators, molluscicides and sulphur have been excluded as they represent < 1,000 hectares. No seed treatment, growth regulator, molluscicide or insecticide use was recorded in 2021.

**Figure 10 Weight of pesticides applied per hectare of grass crop grown – 2021**

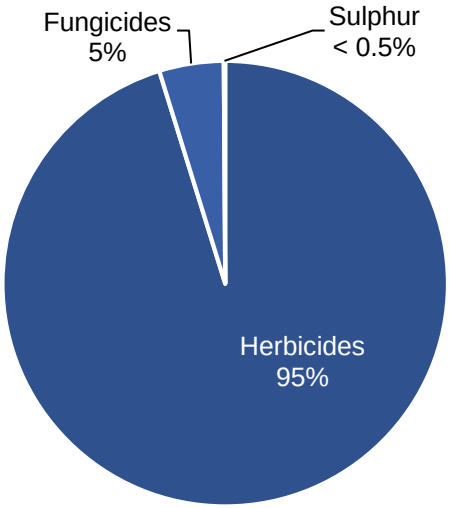



Note: insecticides, seed treatments, growth regulators, molluscicides and sulphur have been excluded as they represent < 0.0005 kg. No seed treatment, growth regulator, molluscicide or insecticide use was recorded in 2021.

As noted in the General trends, Crop area section of the report, the census grass area and, as a result, subsequent estimates of pesticide use, may have been influenced by changes in census definitions of temporary and permanent grass implemented between the 2013 and 2017 surveys, rather than wholly reflecting changes in land use (refer to Appendix 4), but have no impact on comparisons between the 2017 and 2021 surveys.

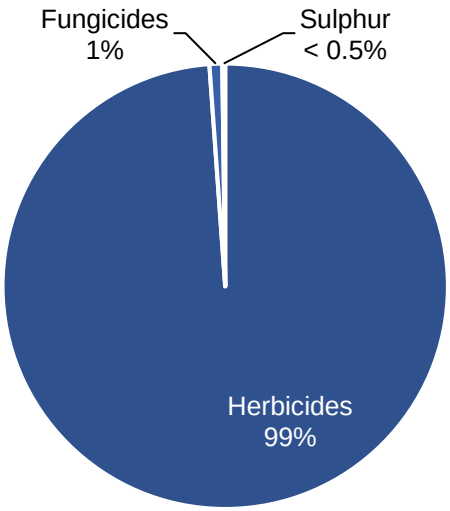
Herbicides were again the most commonly used pesticides on grassland and rough grazing in 2021, accounting for 95 per cent of the treated area and 99 per cent of total pesticide use by weight (Figures 11 & 12). The majority of herbicide use was on undersown and direct sown grass (34 per cent and 23 per cent of crop area treated respectively). Herbicides were the only type of pesticide applied to one to four year old grass, grass over five years old and rough grazing (Table 1). When changes in crop area are considered, there was a four per cent decrease in the area treated with herbicides from 2017 to 2021 and a 16 per cent increase in area treated from 2013 to 2021 (Figure 9). Accounting for changes in crop area, the weight of herbicide applied per hectare decreased by 20 per cent from 2017 and by 16 per cent from 2013 (Figure 10). The decrease in overall herbicide use between 2017 and 2021 may have been influenced by the 2021 sample. During the 2021 survey, only one holding applying asulam to a small area was encountered, therefore the asulam treated area and weight applied will be underestimated. This was a ground-based application and no aerial application was encountered. In the 2017 report it was estimated that 24,817 kg was applied to 6,028 ha. In comparison, in 2021 only 187 kg was estimated to have been applied to 42 ha. This is clearly an underestimate as the majority of asulam used in Scotland is applied by helicopter. Fera Science Ltd reported that 3,128 ha of bracken were treated with a total of 13,763 kg of asulam via aerial application in Scotland in 2021 (D. Garthwaite, FERA, pers. comm. Sep 2022), very similar to the 3,459 ha treated in 2017[5].

## Figure 11 Use of pesticides on grassland and rough grazing (percentage of total area treated with formulations) – 2021




Note: no insecticides, molluscicides, growth regulators or seed treatments were recorded on grassland in 2021.

## Figure 12 Use of pesticides on grassland and rough grazing (percentage of total weight of pesticides applied) – 2021




Note: no insecticides, molluscicides, growth regulators or seed treatments were recorded on grassland in 2021.

In 2021, fungicides accounted for just five per cent of the total pesticide treated area and one per cent of the total weight applied (Figures 11 & 12). Fungicides were only applied to undersown grass for the control or prevention of disease on the nurse crop. Thirty per cent of undersown grass was treated, with an average of 1.2 fungicide applications (Table 1). When changes in

crop area are taken into account, the fungicide treated area decreased by 47 per cent from 2017 to 2021 and by 69 per cent from 2013 to 2021 (Figure 9). Accounting for changes in crop area, the weight of fungicides applied decreased by 63 per cent from 2017 and 75 per cent from 2013 (Figure 10). There was a fairly dry, cold spring in 2021 which resulted in many of the undersown grass crops being late drilled and thus late to emerge[6]. These cold, dry conditions may have reduced disease pressure in the nurse crop and the requirement for fungicide sprays[7]. In addition, the continued reduction in pesticide options may also have influenced use figures[8]. Several of the key fungicide active substances used during 2013 and 2017 such as chlorothalonil, epoxiconazole and fenpropimorph have now been withdrawn and were unavailable in 2021.

No growth regulators were encountered during this survey. Growth regulators accounted for only one per cent of the total pesticide treated area and less than 0.5 per cent of the total weight of pesticides applied in 2017. Similarly, no pesticide seed treatments were encountered in 2021. In 2017 thiram was the only seed treatment active recorded, applied to five per cent of the direct sown grass area. Thiram was withdrawn in January 2020.

No insecticide use was recorded in 2021. This follows the substantial decrease in the use of insecticides on grass crops between 2013 and 2017 following the withdrawal of chlorpyrifos in 2016 (Figures 7 & 8). There are now no insecticides approved for leatherjacket control in grassland.

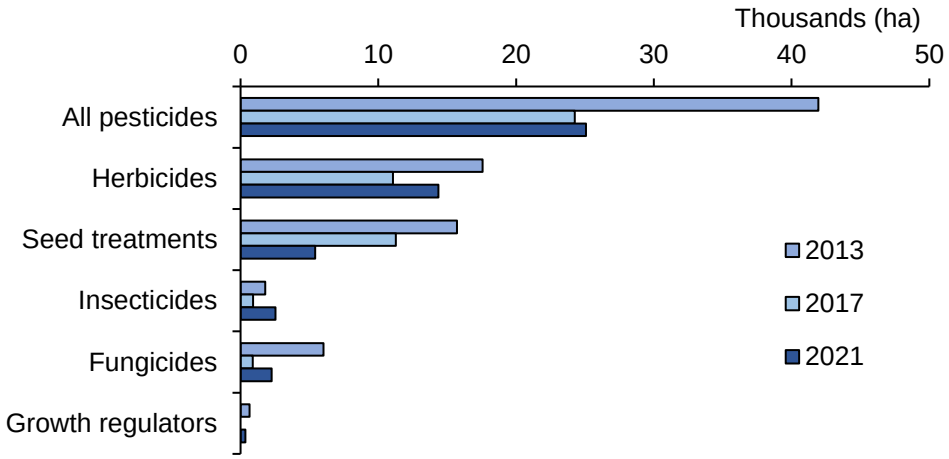
In 2021 no molluscicide use was recorded and sulphur accounted for less than 0.5 per cent of the total pesticide treated area (Figures 11 & 12). No molluscicides or sulphur were applied to grassland or rough grazing crops in 2017.

### Pesticide usage – fodder crops

In contrast to pesticide use on grassland, an estimated 38 per cent of the total fodder crop was treated with a pesticide (Table 1). During the 2021 survey the area of fodder crops treated with a pesticide formulation was estimated to be ca. 25,100 hectares (Table 15 & Figure 13) and the total weight of pesticide applied ca. 10 tonnes (Figure 14). When crop area is accounted for, there was a decrease of two per cent in total area treated with pesticide formulations from 2017 to 2021 and a 32 per cent decrease from 2013 to 2021 (Figure 15). Weight of pesticide applied showed a 20 per cent increase from 2017 to 2021 and a 21 per cent decrease from 2013 to 2021 (Figure 16). The decrease in area treated but the increase in weight applied between 2017 and 2021 may have been influenced by the loss of seed treatment active substances and the subsequent increase in foliar fungicides and insecticides. Substituting foliar applications for seed treatments has a lower impact on area treated but a large impact on weight applied as seed treatments make a small contribution to overall weight of pesticide applied in comparison to foliar applications. It is also worth noting pesticide usage was low in 2017, influenced by the particularly dry spring, drier than 2021, so pest pressure was particularly low.

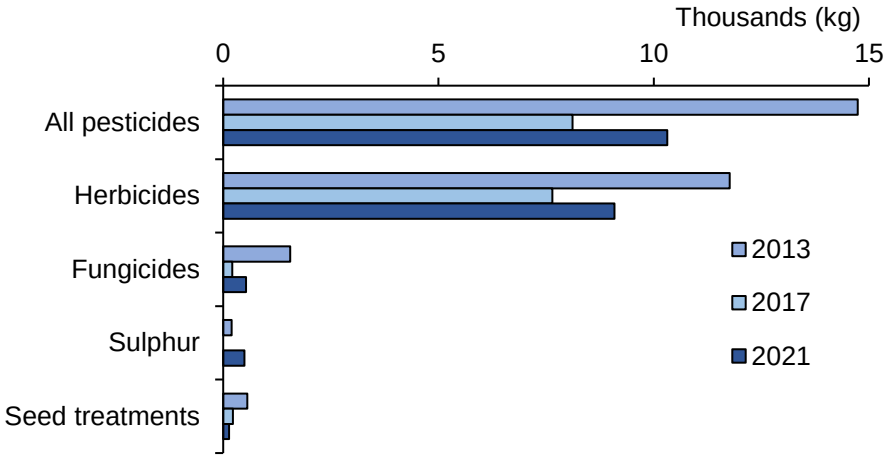
As in 2017, maize and fodder beet crops had the highest proportion of area treated with all crops encountered receiving at least one pesticide treatment (Table 1). The remaining fodder crops received a range of pesticide input, with 20 to 77 per cent of their crop area treated with pesticide, primarily herbicide.

## Figure 13 Area of fodder crops treated with the major pesticide groups in Scotland in 2013–2021



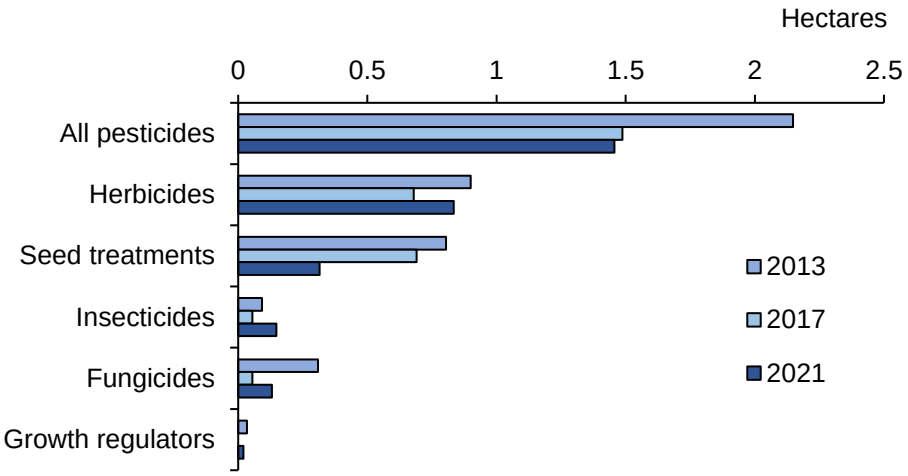

Note: molluscicides and sulphur have been excluded as they represent < 500 hectares.

## Figure 14 Weight of major pesticide groups applied to fodder crops in Scotland 2013-2021



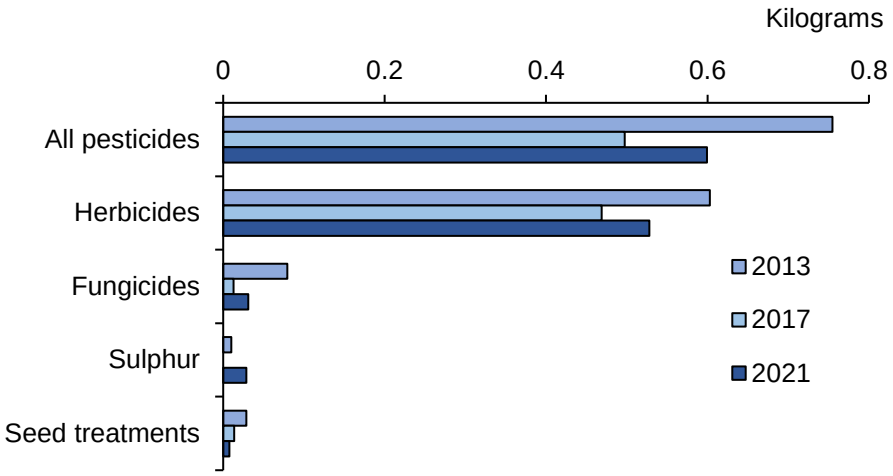

Note: insecticides, growth regulators and molluscicides have been excluded as they represent < 500kg.

## Figure 15 Number of pesticide treated hectares (formulations) per hectare of fodder crop grown - 2021




Note: molluscicides and sulphur have been excluded as they represent < 0.02 treated hectares per hectare grown.

## Figure 16 Weight of pesticides applied per hectare of fodder crop grown – 2021




Note: insecticides, growth regulators and molluscicides have been excluded as they represent < 500kg.

Herbicides were the most commonly used pesticide, accounting for 57 per cent of the area treated (Figure 17) and 88 per cent of the total weight of pesticides applied (Figure 18). When changes in crop area were taken into account, there was a 23 per cent increase in area treated with herbicides from 2017 to 2021 (Figure 15) and a 13 per cent increase in weight (Figure 16). However, use in 2021 is seven per cent lower than 2013 in terms of area treated and 12 per cent lower in terms of weight applied. As noted previously, pesticide usage was low in 2017, influenced by the particularly dry spring followed by a very wet summer resulting in low weed pressure and low herbicide use. Crop composition may influence overall herbicide use. For example, the area of fodder beet and maize grown in Scotland increased by 95 and 55 per cent respectively between 2017 and 2021 and as mentioned before these crops had the highest proportion of area treated with a herbicide. Although the area of maize grown in 2021 was higher than in 2017, it was lower than in 2013.

Seed treatments accounted for 22 per cent of the total area treated and one per cent of the total weight of pesticide applied (Figures 17 & 18). When changes in crop area were taken into account, the area treated decreased by 54 per cent from 2017 to 2021 (Figure 15) and weight decreased by 42 per cent (Figure 16). Since the 2017 survey there has been a further reduction in approved seed treatments available, with the two principal seed treatments in 2017 (thiram and thiamethoxam) now withdrawn. This particularly has impacted turnips and swedes where 80 per cent of the crop received a seed treatment in 2017 compared to none of the crop in 2021.

**Figure 17 Use of pesticides on fodder crops (percentage of total area treated with formulations) - 2021**

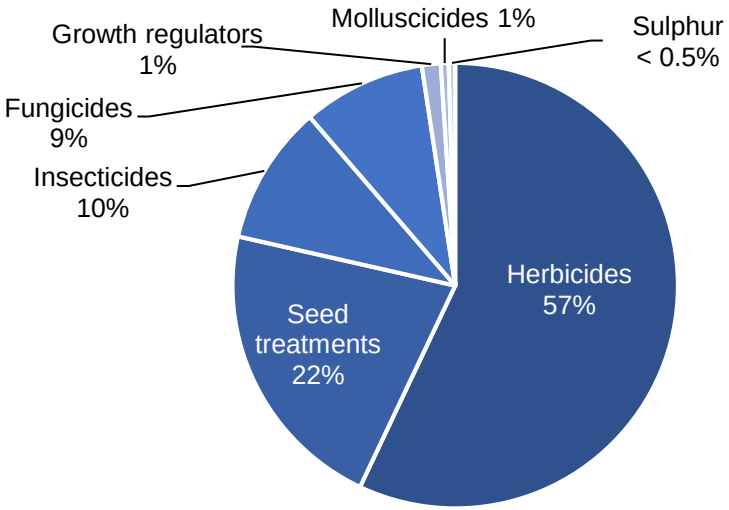
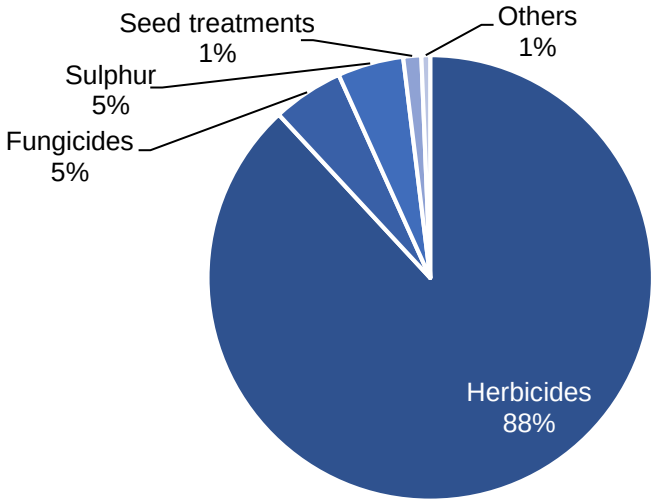



**Figure 18 Use of pesticides on fodder crops (percentage of total weight applied) – 2021**




Note: others include: insecticides, growth regulators and molluscicides.

Fungicide use remained low in fodder crops, accounting for nine per cent of the total treated area and five per cent of the total weight of pesticides applied (Figures 17 & 18). When changes in crop area are considered, there was a 140 per cent increase in area treated from 2017 to 2021 (Figure 15) and a similar 142 per cent increase in weight (Figure 16). However, fungicide usage in 2021 was much lower than in 2013 in terms of both area treated and weight applied (58 per cent and 61 per cent decrease respectively). Loss of fungicide seed treatments such as thiram from the market since the previous survey and a subsequent increase on foliar sprays on crops such as arable silage and turnips and swedes may partly explain the large increase in the use of fungicides in 2021 compared with 2017. As noted previously, 2017 had an unusually dry spring with low disease pressure and thus low fungicide use.

Insecticide use remained low, accounting for 10 per cent of the total treated area and less than 0.5 per cent of the total weight of pesticides applied (Figures 17 & 18). When changes in crop area are taken into account, there was a 169 per cent increase in area treated between 2017 and 2021 (Figure 15) and a 230 per cent increase in weight (Figure 16). Most insecticidal sprays were applied to turnips and swedes for the control of flea beetle. The increase in foliar insecticide sprays may be partly due to the removal of neonicotinoid seed treatments since 2017 which were used to control the pest. Ninety-five percent of all insecticides encountered in 2021 were pyrethroids, with flonicamid use on fodder beet the only non-pyrethroid recorded (Table 11).

Molluscicides accounted for less than one per cent of both pesticide treated area and weight (Figures 17 & 18). When changes in crop area are taken into account, there was a four per cent decrease in area treated from 2017 to 2021 (Figure 15) and a 44 per cent decrease in weight (Figure 16). Ferric phosphate was the only molluscicide recorded in 2021. Metaldehyde had been the only molluscicide recorded in 2017 and 2013 but sales of this active substance stopped from 31$^{st}$ of March 2021 prior to its final use date in March 2022.

Growth regulators accounted for one per cent of area treated and less than 0.5 per cent of weight applied in 2021 (Figure 17 &18). No growth regulators or sulphur were applied to fodder crops in 2017.

## General trends in active substances encountered – grass & fodder crops

The most commonly used pesticides in grass and fodder crops are herbicides. In terms of area treated, the same three herbicide active substances, fluroxypyr, triclopyr and MCPA, were the most used in 2021 and 2017 (Table 14), although use has increased by nine, 14 and six per cent respectively. These three active substances were also in the top five most commonly used herbicides in the 2013 survey. In relation to weight, the most used actives were the herbicides, MCPA, 2,4-D and glyphosate (Table 15). MCPA showed a decrease of 12 per cent in 2021, however 2,4-D and glyphosate use both increased since the previous survey (by 176 and 53 per cent respectively).

Other notable changes in herbicide active substance use since the previous survey include increases in the use of dicamba, metamitron, amidosulfuron and florasulam. These increased in terms of area treated by 105, 114, 104 and 148 per cent respectively (448, 91, 78, 149 per cent increase in weight applied respectively). In contrast the use of 2,4-DB decreased by 94 per cent in both area and weight. The use of asulam also significantly decreased (99 per cent decrease by area treated and weight applied). As discussed previously, this has been influenced by the infrequency of aerial spraying encountered in the 2021 sample.

As in both 2013 and 2017, the most used foliar fungicide active substance by area in this survey was prothioconazole. It is worth noting that the area of the multi-site fungicide folpet increased substantially between 2017 and 2021 (750 per cent increase by area treated and 937 per cent by weight) following the loss of the multi-site fungicide chlorothalonil in May 2020. The most used seed treatment active substance was prothioconazole. The most commonly used insecticide in terms of area treated in the 2021 survey was deltamethrin, in 2017 the most commonly used was lambda-cyhalothrin.

The herbicides halauxifen-methyl, mesosulfuron-methyl and napropamide, the fungicides benzovindiflupyr and mefentrifluconazole and the insecticide flonicamid were recorded for the first time in grass and fodder crops in 2021 (Table 10). Two seed treatments, sedaxane and ziram were recorded for the first time in this survey. It should be noted that ziram was present on imported maize. Although ziram has no authorisation in the UK, imported seed treated with a plant protection product authorised for that use in EU countries were allowed at the time of use[9].

## Integrated Pest Management

Information about the uptake of IPM measures by Scottish growers was collected alongside the 2021 grass and fodder crops pesticide usage survey. This 2021 IPM survey represents the second in the series of surveys of IPM measures on grass and fodder crops, allowing the adoption of IPM techniques to be monitored. 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 grass and fodder crop production. Unlike the other statistics in this report, the figures relating to IPM are not raised to produce national estimates but represent only the responses of those surveyed.

In total, IPM data was collected from 158 growers, collectively representing 163 holdings and 13 per cent of Scotland's 2021 grass and fodder crop area. Of these growers, 24 per cent had an IPM plan (13 per cent completed their own IPM plan and 11 per cent had a plan completed by their agronomist) (Figure 38). There was very strong evidence for an increase in the use of IPM plans from the 2017 survey where five per cent of growers had an IPM plan (p-value ≤ 0.001). Since 2017 there has been increased focus on the promotion of IPM and the introduction of mandatory completion of IPM plans within some key quality assurance schemes to help growers make the best possible and most sustainable use of all available methods of pest control. Growers were asked about their IPM activities is relation to three categories; risk management, pest monitoring and pest control.

In 2021, all growers sampled reported that they implemented at least one IPM risk management activity (Table 30). There was very strong evidence for an increase in the proportion of growers reporting the use of catch and cover cropping (p-value ≤ 0.001), and strong evidence for an increase in the proportion of growers reporting the use of varietal or seed choice to reduce pest risk (p-value ≤ 0.01) and through protection or enhancement of beneficial organism populations (p-value ≤ 0.01). There was some evidence for an increase in the proportion of growers implementing crop rotation (p-value ≤ 0.05).

In terms of the uptake of pest monitoring activities, there was strong evidence for an increase in the proportion of growers conducting pest monitoring activity (p-value ≤ 0.01) (Table 31), primarily due to strong evidence for an increase in the proportion of growers setting action thresholds for crops (p-value ≤ 0.01).

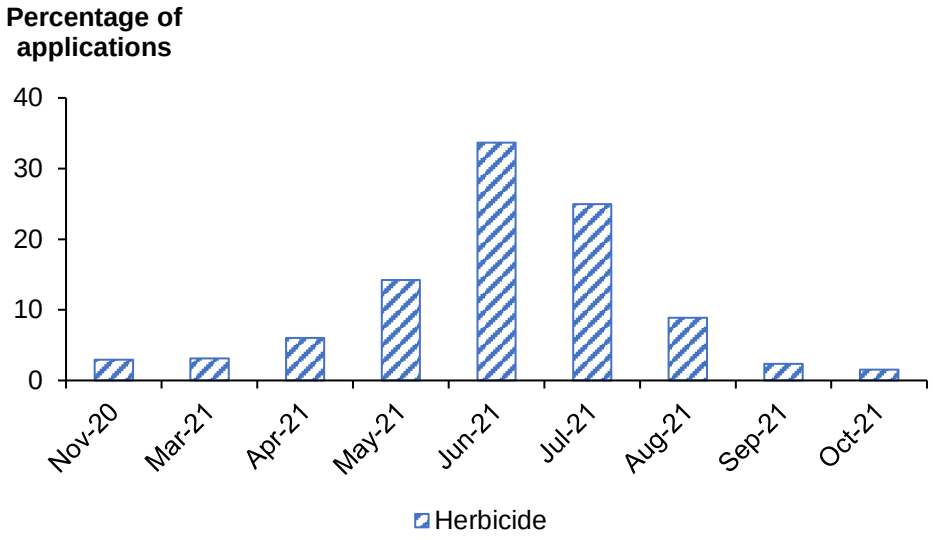
All growers responding in 2021 adopted as least one IPM pest control activity, a slight increase from 2017 (p-value > 0.05). There was very strong evidence for a decrease in the proportion of growers following anti-resistance strategies (p-value ≤ 0.001), and strong evidence for a decrease in the proportion of growers reporting targeted pesticide application (p-value ≤ 0.001) (Table 32). There was no evidence of a change in the portion of growers using non-chemical control in partnership or instead of chemical control or monitoring success of crop protection measures. Of the holdings sampled in 2021, eight per cent were organic, an increase from four per cent reported in 2017.

## 2021 Pesticide usage

### Direct sown grass

- An estimated 24,388 hectares of direct sown grass was grown in Scotland in 2021, an increase of 25 per cent since 2017
- 23 per cent of the crop was treated with a pesticide
- Pesticides were applied to 7,383 treated hectares and 7,103 kilograms of pesticide were applied in total
- 100 per cent of pesticides applied, by area, were herbicides
- Direct sown grass received on average one herbicide application (applied to 23 per cent of the crop area) (Table 1)
- Glyphosate (2,253 hectares) and florasulam/fluroxypyr (1,195 hectares) were the most used herbicide formulations
- Timing of herbicide applications are shown in Figure 19
- Reasons were given for 99 per cent of herbicide use: 27 per cent for grass weed control, 19 per cent for crop destruction/pasture kill, 16 per cent for docks, 12 per cent for thistles, 10 per cent for chickweed, three per cent for annual grass weeds and two percent for nettles. The remaining ten per cent was for control of other weeds including fat hen, rushes, buttercup, cow parsley, ragwort and to produce a stale seed bed

**Figure 19 Timing of herbicide applications on direct sown grass – 2021**




Note: there were small amounts (one per cent) of herbicides applied in in September 2020 and November 2021 which are not shown in this figure.

## Undersown grass

- An estimated 9,193 hectares of undersown grass was grown in Scotland in 2021, an increase of 22 per cent from 2017
- 40 per cent received a pesticide (see Figure 20 for types of pesticides used)
- 8,406 hectares of pesticide formulations were applied and 3,160 kilograms of pesticide were used in total on the crop (see summary table below)
- All fungicide use on undersown grass was for controlling disease in the nurse crop
- Undersown grass received on average 1.1 pesticide applications (applied to 40 per cent of the crop area) (Table 1). These applications included 1.2 fungicides (applied to 30 per cent of the crop area), one herbicide (applied to 34 per cent of the crop area) and one of sulphur (applied to one per cent of the crop area)
- Timing of pesticide applications are shown in Figure 21
- Reasons for fungicide applications were supplied for 50 per cent of total use; 49 per cent was for general disease control, one per cent for mildew
- Reasons for herbicide applications were supplied for 91 per cent of all use; 37 per cent for general weed control, 26 per cent for annual broad-leaved weeds, 12 per cent for day-nettle, nine per cent for chickweed, three per cent for buttercup and two per cent each for annual grass weeds and docks

Summary of pesticide use on undersown grass

| Pesticide group | Formulation area treated | Weight of pesticides applied | Percentage of crop treated | Most used formulations |
|---|---|---|---|---|
| | ha | kg | % | ha |
| Fungicides | 3,789 | 619 | 30 | Prothioconazole/tebuconazole (971), Cyprodinil (895) |
| Herbicides | 4,533 | 2,402 | 34 | MCPA (1,624), Amidosulfuron (896) |
| Sulphur | 84 | 139 | 1 | [z] |
| **All pesticides** | **8,406** | **3,160** | **40** | |

Note: some shorthand is used in this table: [z] = not applicable.

**Figure 20 Use of pesticides on undersown grass (percentage of total area treated with formulations) – 2021**

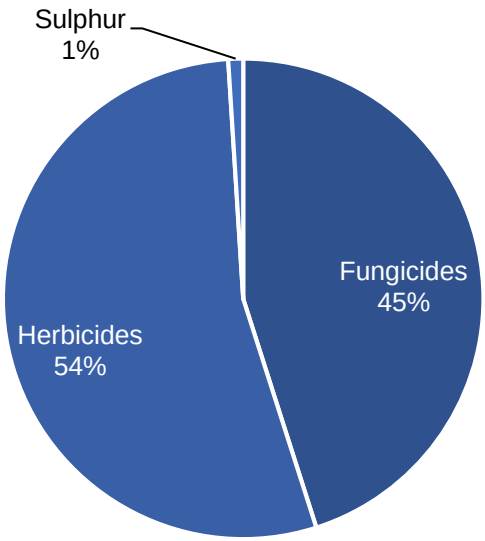
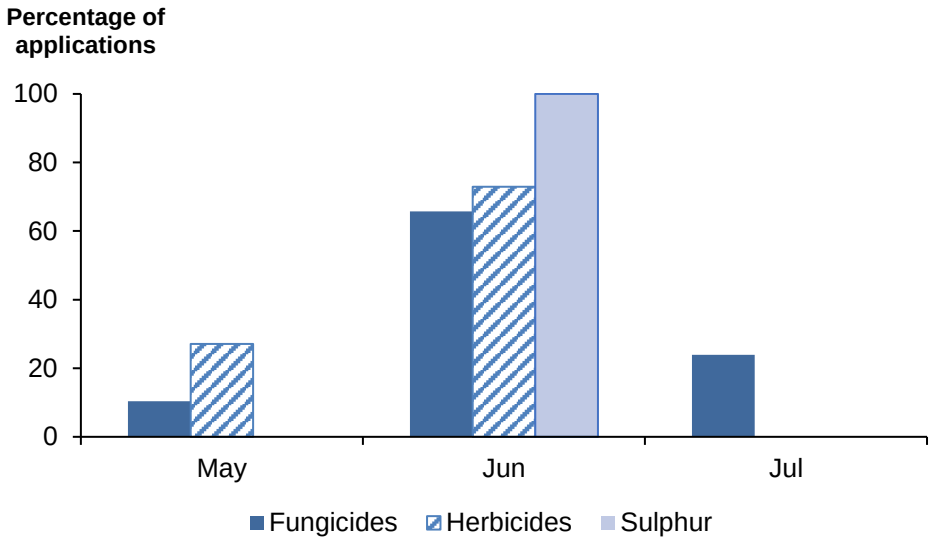


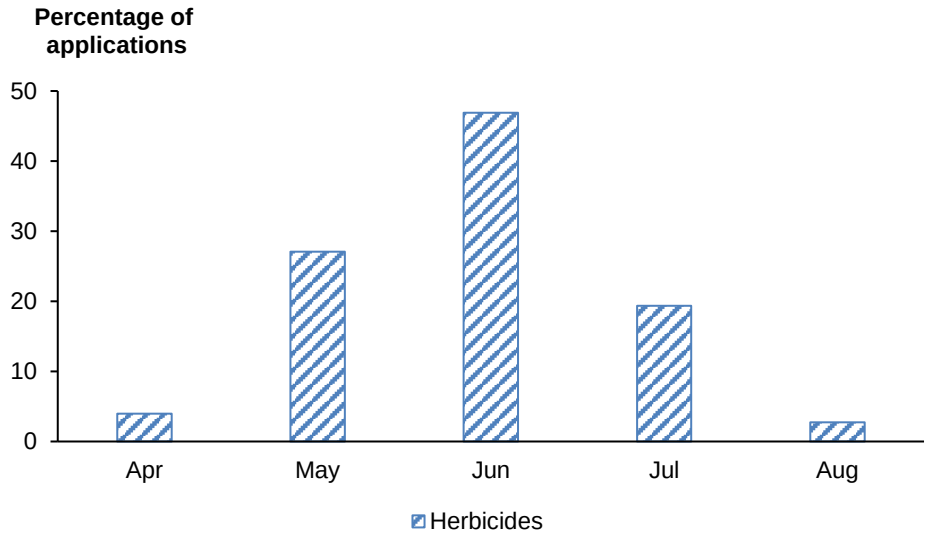

**Figure 21 Timing of pesticide applications on undersown grass - 2021**



## Grass one to four years old

- An estimated 142,453 hectares of grass between one and four years old was grown in Scotland in 2021. This represents a decrease of 24 per cent from 2017
- Only herbicides were applied to grass between one and four years old
- Five per cent of the crop was treated with a herbicide (Table 1)
- 9,614 hectares of herbicide formulations were applied and 6,555 kilograms of herbicide were used in total
- Fluroxypyr (1,938 hectares) and fluroxypyr/triclopyr (1,613 hectares) were the most used herbicide formulations
- Timing of herbicide applications are shown in Figure 22
- Reasons were given for 98 per cent of total herbicide use; 42 per cent for control of docks, 26 per cent for thistles, 19 per cent for general weed control, three per cent for annual broad-leaved weeds, two per cent each for rushes, buttercup and nettles and less than one per cent each for ragwort, dandelion and grass kill

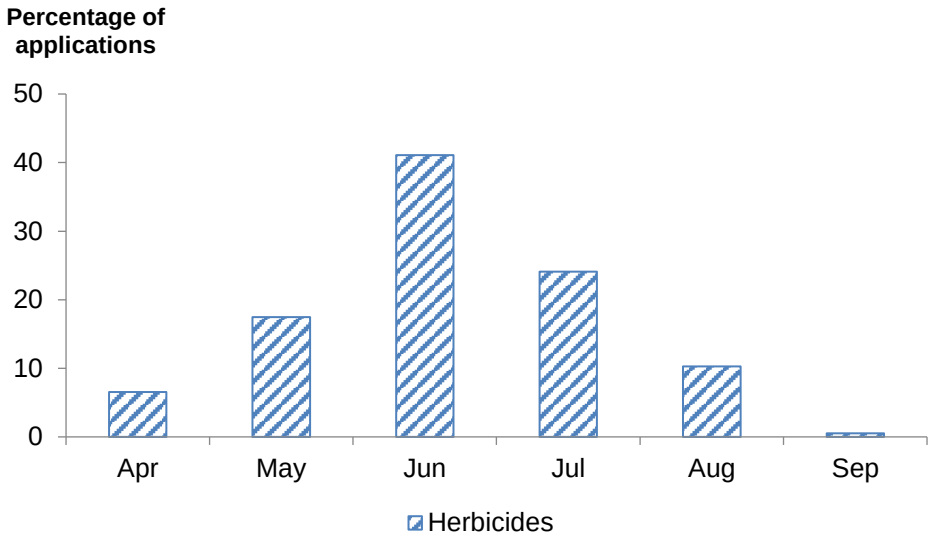
### Figure 22 Timing of herbicide applications on grass one to four years old – 2021



## Grass over five years old

- 1,130,056 hectares of grass over five years old was grown in Scotland in 2021. This was a two per cent increase from 2017
- Only herbicides were applied to grass over five years old
- Three per cent of the crop was treated with a herbicide (Table 1)
- Herbicides were applied to 50,109 hectares and 42,814 kilograms of herbicides in total were applied to the crop
- The most used herbicide formulations were fluroxypyr applied to 10,523 hectares and clorpyralid/triclopyr applied to 10,523 hectares
- Timing of herbicide applications are shown in Figure 23
- Reasons were given for 99 per cent of herbicide use; docks accounted for 30 per cent of herbicide applications, thistles 17 per cent, rushes 16 per cent, general weed control 14 per cent, nettles eight per cent, ragwort, annual broad-leaved weeds and chickweed four per cent each, buttercup two per cent, one per cent grass/crop destruction and less than one per cent for the control of broom and gorse

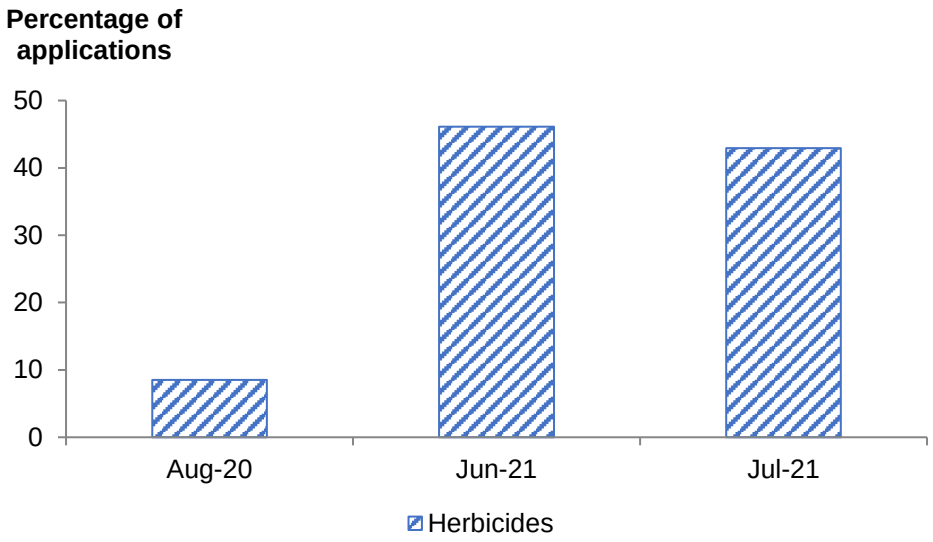
### Figure 23 Timing of herbicide applications on grass over five years old - 2021



## Rough grazing

- 3,072,535 hectares of rough grazing was grown in Scotland in 2021, a two per cent decrease from the 2017 survey
- Only herbicides were applied to rough grazing
- Less than 0.5 per cent of rough grazing was treated with a herbicide, with an average of one application (Table 1)
- An area of 5,426 hectares were treated with herbicide formulations and 7,121 kilograms were applied in total
- The most commonly encountered herbicide formulation was 2,4-D/ MCPA (2,635 hectares)
- Timing of the herbicide applications are shown in Figure 24
- Reasons were supplied for almost all herbicide use on rough grazing; 36 per cent of applications were for thistles, 26 per cent for docks, 19 per cent for nettles, eight per cent gorse, five per cent each for rushes and bracken and less than one percent for hemlock

### Figure 24 Timing of herbicide applications on rough grazing - 2021




Note: there were small amounts of herbicide (two per cent) applied in August 2021 which are not shown in this figure.

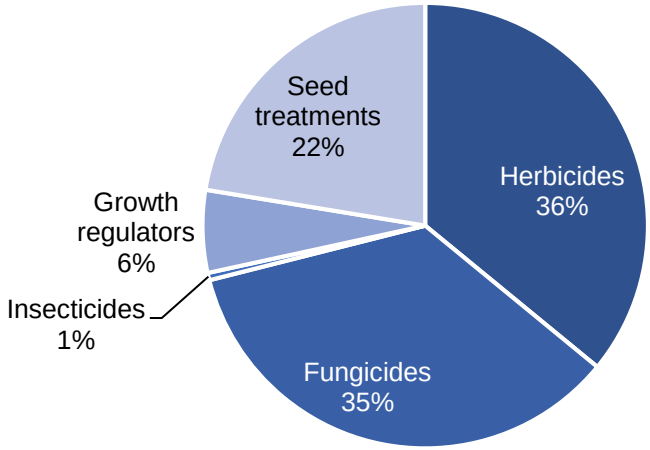
## Arable silage

- An estimated 5,453 hectares of arable silage was grown in Scotland in 2021, a decrease of six per cent from 2017
- Arable silage is recorded in the 'other crops for stock-feeding' category of the Agricultural Census
- Crops grown for arable silage included barley, oats, wheat, peas, lupin, lucerne, sunflower, triticale, clover and vetches, some of which were undersown
- 26 per cent of the crop was treated with a pesticide (see Figure 25 for types of pesticides used)
- An area of 5,749 hectares of pesticide formulations and 1,014 kilograms were applied in total (see summary table below)
- The arable silage crop received on average 1.9 pesticide applications (Table 1). These applications included 1.7 fungicides and one herbicide (applied to 15 and 19 per cent of the crop area respectively
- Timing of the pesticide applications are shown in Figure 26
- Reasons were supplied for 92 per cent of applications of fungicides; 31 per cent was for mildew, 26 per cent for *Septoria*, 25 per cent for rust, and five per cent each for *fusarium* and general disease control
- Reasons were supplied for 82 per cent of herbicide applications; 46 per cent was for general weed control, 17 per cent for annual broad-leaved weeds, 11 per cent for docks, seven per cent for annual meadow grass and one per cent for grass kill
- No reasons were supplied for insecticide use

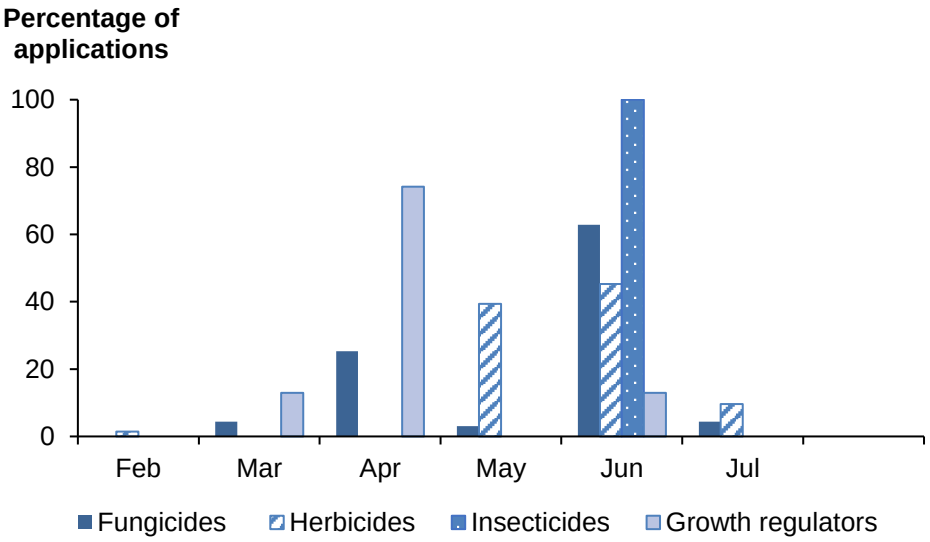
Summary of pesticide use on arable silage

| Pesticide group | Formulation area treated | Weight of pesticides applied | Percentage of crop treated | Most used formulations |
|---|---|---|---|---|
| | ha | kg | % | ha |
| Herbicides | 2,066 | 488 | 19 | Metsulfuron-methyl/thifensulfuron-methyl (382) Fluroxypyr (361) |
| Fungicides | 2,019 | 485 | 15 | Folpet (286), Fluoxastrobin/prothioconazole/ trifloxystrobin (283) |
| Insecticides | 31 | 0.2 | 1 | Lambda-cyhalothrin (31) |
| Growth regulators | 344 | 21 | 6 | Trinexapac-ethyl (300) |
| Seed treatments | 1,289 | 20 | 24 | Fludioxonil (859) |
| **All pesticides** | **5,749** | **1,014** | **26** | |

## Figure 25 Use of pesticides on arable silage (percentage of total area treated with formulations) – 2021




## Figure 26 Timing of pesticide applications on arable silage - 2021




Note: there were small amounts of herbicides (four per cent) applied in September 2020 which are not shown in this figure.

## Fodder beet

- An estimated 1,193 hectares of fodder beet was grown in Scotland in 2021, a 95 per cent increase from 2017
- All of the crop surveyed was treated with a pesticide (see Figure 27 for types of pesticides applied)
- Pesticides were applied to 6,210 treated hectares and 3,101 kilograms were applied in total (see summary table below)
- The fodder beet crop received on average 2.3 pesticide applications (Table 1). These applications included 2.2 herbicides and one insecticide on 100 and 11 per cent of the crop respectively
- Timing of pesticide applications are shown in Figure 28
- Reasons were provided for 90 per cent of herbicide use; 72 per cent was for general weed control, 11 per cent for broad-leaved weeds, two per cent each for volunteer cereals and wild oats and one per cent each for brome and stale seed bed creation
- Mildew was the only reason provided for fungicide use. No reasons were provided for the use of insecticides
- The most common varieties encountered were Brick, Robbos and Lactimo, accounting for 39, 16 and 12 per cent respectively

Summary of pesticide use on fodder beet

| Pesticide group | Formulation area treated | Weight of pesticides applied | Percentage of crop treated | Most used formulations |
|---|---|---|---|---|
| | ha | kg | % | ha |
| Herbicides | 4,674 | 3,047 | 100 | Metamitron (2,026) |
| Fungicides | 49 | 9 | 4 | Cyproconazole/ trifloxystrobin (49) |
| Insecticides | 136 | 10 | 11 | Flonicamid (136) |
| Seed treatments | 1,352 | 35 | 60 | Tefluthrin (722) |
| **All pesticides** | **6,210** | **3,101** | **100** | |

**Figure 27 Use of pesticides on fodder beet (percentage of total area treated with formulations) – 2021**

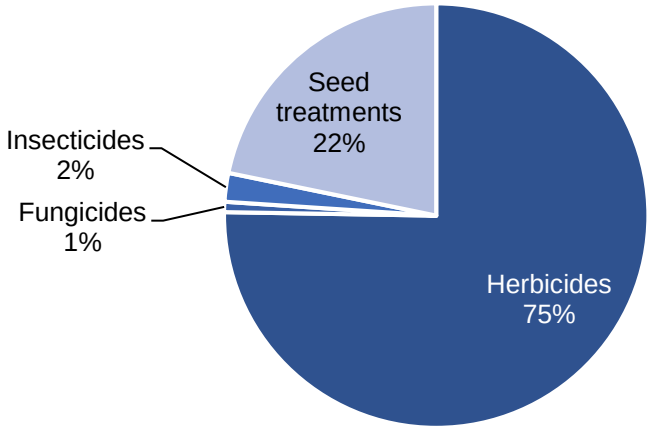
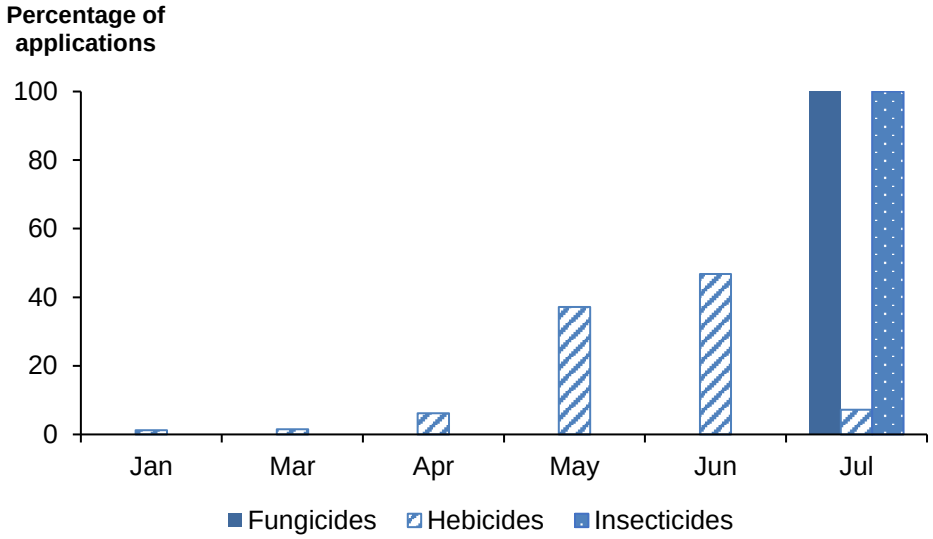



**Figure 28 Timing of pesticide applications on fodder beet - 2021**



## Fodder rape

- 2,248 hectares of fodder rape were grown in 2021, a 12 per cent in increase from 2017
- It is estimated that 52 per cent of the fodder rape encountered was mixed with another crop such as kale or stubble turnips
- A further 193 hectares of fodder rape were recorded in fodder crop mixes in the 'other crops for stock-feeding' category (see the other fodder section for details)
- 20 per cent of the crop was treated with a pesticide (see Figure 29 for types of pesticides used)
- 587 hectares of pesticide formulations were applied and 555 kilograms of pesticides were used in total (see summary table below)
- 20 per cent of the fodder rape crop was treated with a herbicide, receiving on average 1.2 applications (Table 1)
- Timing of pesticide applications are shown in Figure 30
- Reasons were recorded for 75 per cent of the crop; 33 per cent of herbicide use was for general weed control with 14 per cent each for grass/pasture kill, mayweed and shepherd's purse. All recorded insecticide use was for caterpillars (38 per cent)
- The most common varieties encountered were Redstart, accounting for 27 per cent of the sampled area, Hobson 21 per cent and Swift, five per cent. Redstart and Swift are both rape/kale hybrids

Summary of pesticide use on fodder rape

| Pesticide group | Formulation area treated | Weight of pesticides applied | Percentage of crop treated | Most used formulations |
|---|---|---|---|---|
| | ha | kg | % | ha |
| Herbicides | 540 | 555 | 20 | Glyphosate (431) |
| Insecticides | 47 | < 0.5 | 2 | Deltamethrin (29) |
| **All pesticides** | **587** | **555** | **20** | |

**Figure 29 Use of pesticides on fodder rape (percentage of total area treated with formulations) – 2021**

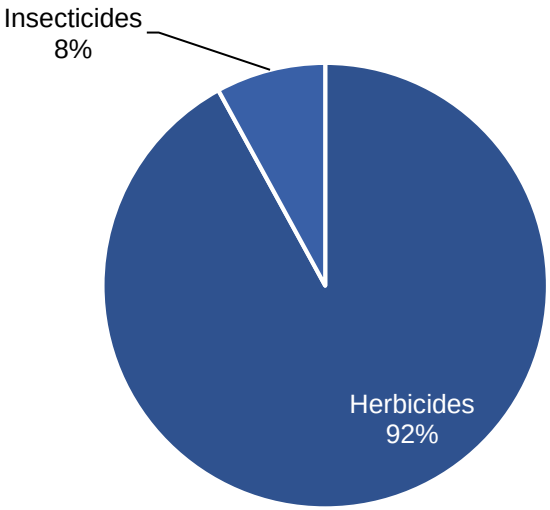
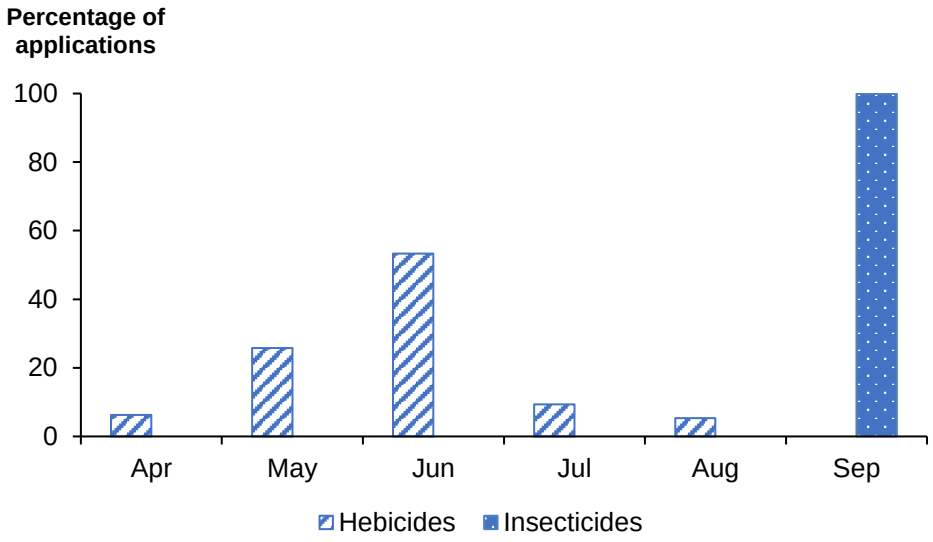



**Figure 30 Timing of pesticide applications on fodder rape - 2021**



## Kale and cabbage

- 2,068 hectares of kale and cabbage were grown in 2021, an eight per cent increase from 2017
- No cabbage was encountered during this survey
- It is estimated that 20 per cent of the kale encountered was mixed with another crop such as fodder rape or turnips
- A further 285 hectares of kale, kale hybrid and kale mixes were recorded in the 'other crops for stock-feeding' category (see the other fodder section for details)
- 52 per cent of the crop was treated with a pesticide (see Figure 31 for types of pesticides applied)
- 1,229 hectares of pesticide formulations were applied and 1,213 kilograms of pesticide used in total (see summary table below)
- The kale crop received on average one herbicide spray (applied to 52 per cent of the crop area) (Table 1)
- Timing of pesticide applications are shown in Figure 32
- Reasons were provided for all herbicide use on kale; 69 per cent was for general weed control, 30 per cent for grass/pasture kill and less than one per cent for chickweed. All insecticide use was for caterpillars
- The most common variety encountered was Maris Kestrel, accounting for 33 per cent of the sample area surveyed

Summary of pesticide use on kale and cabbage

| Pesticide group | Formulation area treated | Weight of pesticides applied | Percentage of crop treated | Most used formulations |
|---|---|---|---|---|
| | ha | kg | % | ha |
| Herbicides | 1,163 | 1,209 | 52 | Glyphosate (626) |
| Insecticides | 33 | < 0.5 | 2 | Lambda-cyhalothrin (33) |
| Molluscicides | 33 | 4 | 2 | Ferric phosphate (33) |
| **All pesticides** | **1,229** | **1,213** | **52** | |

**Figure 31 Use of pesticides on kale and cabbage (percentage of total area treated with formulations) – 2021**

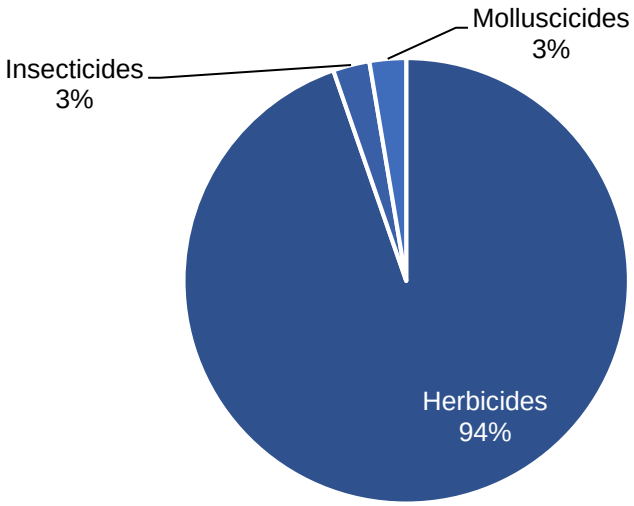
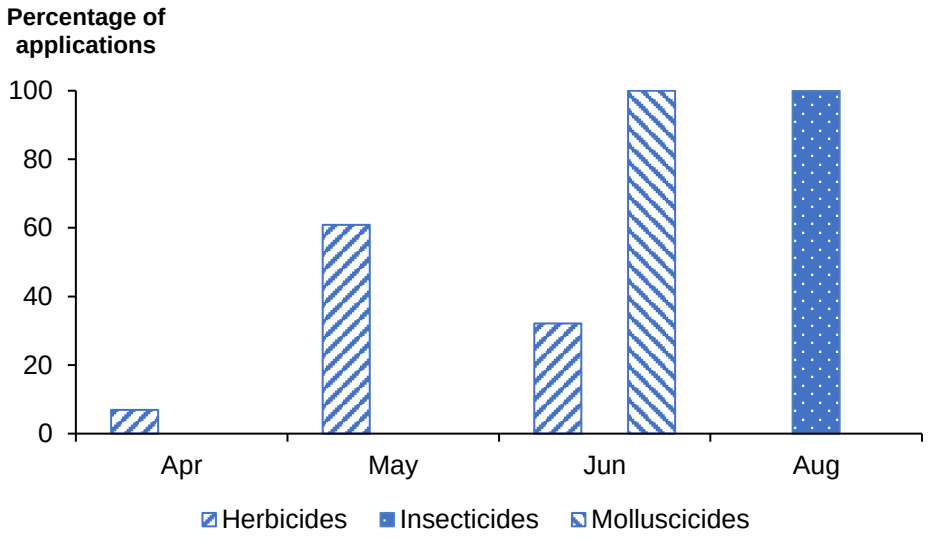



**Figure 32 Timing of pesticide applications on kale and cabbage - 2021**



## Maize

- An estimated 1,229 hectares of maize was grown in Scotland in 2021, a 55 per cent increase since 2017
- All of the maize crop was treated with a pesticide (see figure 33 for types of pesticide used)
- The maize crop received on average 1.4 applications of herbicides (Table 1)
- 4,883 hectares of pesticide formulations were applied and a total of 1,951 kilograms of pesticides were used (see summary table below)
- Timing of pesticide applications are shown in Figure 34
- 98 per cent of herbicide use was for general weed control, with one per cent each for broad-leaved weed control and nettles
- The most common variety encountered was Cito KWS, accounting for 47 per cent of the sampled area, followed by Dignity at 27 per cent

Summary of pesticide use on maize

| Pesticide group | Formulation area treated | Weight of pesticides applied | Percentage of crop treated | Most used formulations |
|---|---|---|---|---|
| | ha | kg | % | ha |
| Herbicides | 2,089 | 1,872 | 100 | Dimethenamid-P/pendimethalin (778) |
| Seed treatments | 2,794 | 80 | 86 | Metalaxyl/prothioconazole (1062) |
| **All pesticides** | **4,883** | **1,951** | **100** | |

**Figure 33 Use of pesticides on maize (percentage of total area treated with formulations) – 2021**

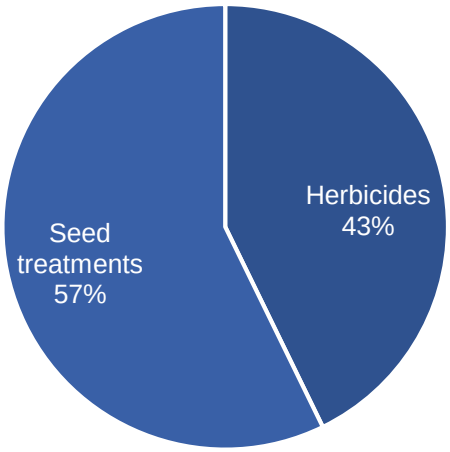
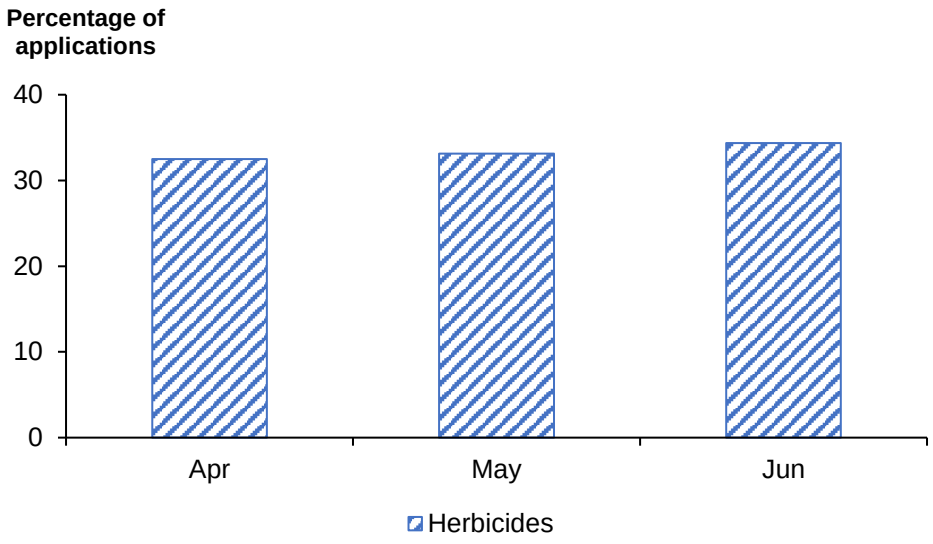



**Figure 34 Timing of herbicide applications on maize - 2021**



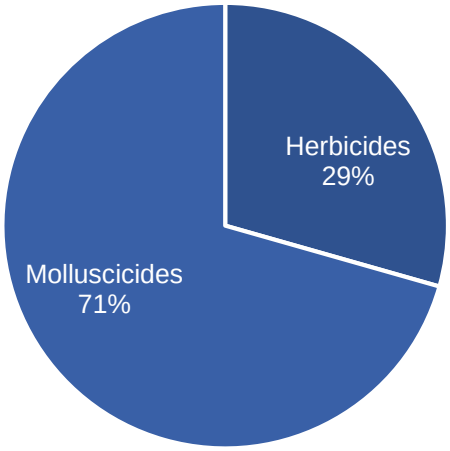
## Stubble turnips

- An estimated 479 hectares of stubble turnips were grown in Scotland in 2021, an increase of 41 per cent from 2017
- A further 295 hectares of stubble turnips and stubble turnips fodder crop mixes were recorded in the 'other crops for stock-feeding' category (see the other fodder section for details)
- Stubble turnips are often a constituent of other fodder mixes and therefore it is likely that the estimated area grown is under-estimated
- 32 per cent of the crop was treated with a pesticide (see Figure 31 for types of pesticides applied)
- 155 hectares of pesticide formulations were applied and 16 kilograms of pesticide used in total (see summary table below)
- Stubble turnips received on average one herbicide and one molluscicides application (applied to 10 and 23 per cent of the crop area respectively) (Table 1). All applications were in August
- The most common variety encountered was Rondo, accounting for 35 per cent of the sampled area

Summary of pesticide use on stubble turnips

| Pesticide group | Formulation area treated | Weight of pesticides applied | Percentage of crop treated | Most used formulations |
|---|---|---|---|---|
| | ha | kg | % | ha |
| Herbicides | 46 | 4 | 10 | Fluazifop-P-butyl (46) |
| Molluscicides | 109 | 12 | 23 | Ferric phosphate (109) |
| **All pesticides** | **155** | **16** | **32** | |

**Figure 35 Use of pesticides on stubble turnips (percentage of total area treated with formulations) – 2021**



## Turnips and swedes

- 3,517 hectares of turnips and swedes were grown in Scotland in 2021, representing an eight per cent decrease from 2017
- A further 64 hectares of turnips and swedes and turnips and swedes fodder crop mixes were recorded in the 'other crops for stock-feeding' category (see the other fodder section for details)
- 77 per cent of the crop was treated with a pesticide (see Figure 36 for types of pesticides applied)
- 6,060 hectares of pesticide formulations were applied and 2,090 kilograms of pesticides were used in total (see summary table below)
- Turnips and swedes received on average 1.8 pesticide applications (Table 1). These included one herbicide application and 1.6 insecticide applications (applied to 71 and 42 per cent of the crop respectively)
- Timing of pesticide applications is shown in Figure 37
- The only reason supplied for fungicide use on turnips and swedes was for general disease control on 20 per cent of the crop. Reasons were given for 83 per cent of herbicide use; 78 per cent was for general weed control, two per cent for grass kill and one per cent each for couch grass and wild oats respectively. Reasons were provided for 81 per cent of insecticide use; 64 per cent for flea beetle, nine per cent for aphids and eight per cent for general insect pests
- The most common variety encountered were Lomond accounting for 37 per cent of the sample area

Summary of pesticide use on turnips and swedes

| Pesticide group | Formulation area treated | Weight of pesticides applied | Percentage of crop treated | Most used formulations |
|---|---|---|---|---|
| | ha | kg | % | ha |
| Herbicides | 3,496 | 1,538 | 71 | Metazachlor (1,378), Clomazone (986) |
| Fungicides | 179 | 38 | 5 | Prothioconazole (119) |
| Insecticides | 2,266 | 19 | 42 | Deltamethrin (1,266) |
| Sulphur | 119 | 495 | 3 | [z] |
| **All pesticides** | **6,060** | **2,090** | **77** | |

Note: some shorthand is used in this table: [z] = not applicable.

**Figure 36 Use of pesticides on turnips and swedes (percentage of total area treated with formulations) – 2021**

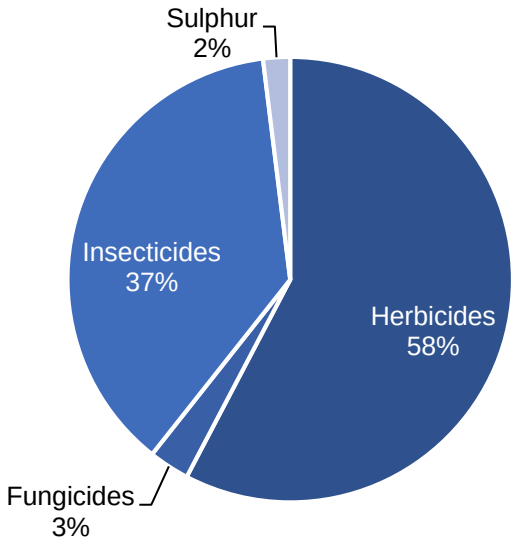
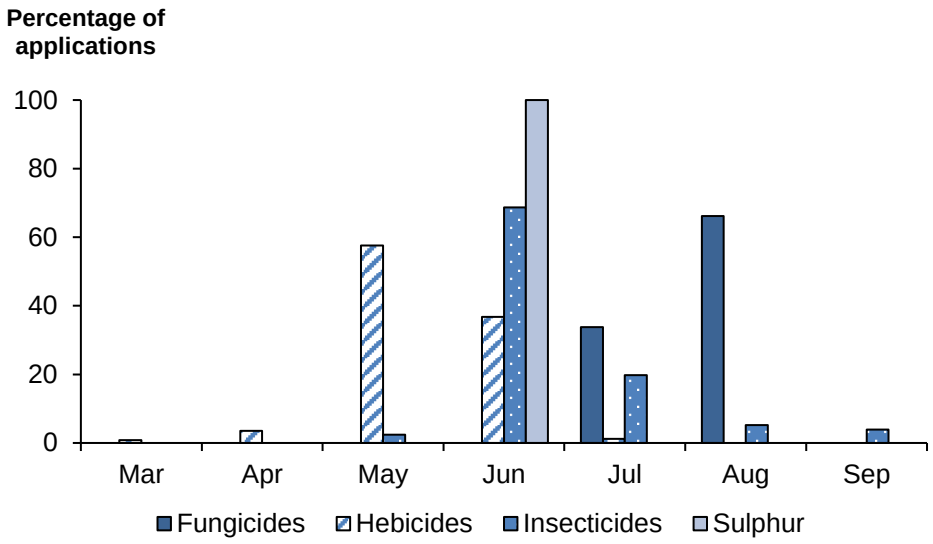



**Figure 37 Timing of herbicide applications on turnips & swedes - 2021**



## Other fodder crops

- 1,028 hectares of other fodder crops were grown in Scotland in 2021, showing very little change from the 1,033 hectares grown in 2017
- Other fodder consists of any crops other than arable silage reported in the 'other crops for stock-feeding' category
- In 2021 this consisted of rape, kale, turnips, stubble turnips and fodder crop mixes
- 27 per cent of the crop was treated with a pesticide (see Figure 38 for types of pesticides applied)
- 316 hectares of pesticide formulations and 378 kilograms of pesticides were applied (see summary table below)
- The other fodder crops received on average one application of herbicide (applied to 27 per cent of the crop area) (Table 1)
- Timing of pesticide applications is shown in Figure 39
- All reported insecticide use was for caterpillars. Reasons for herbicide use was given for 13 per cent of the area, all of which was for destroying the previous crop

Summary of estimated pesticide use on other fodder crops

| Pesticide group | Formulation area treated | Weight of pesticides applied | Percentage of crop treated | Most used formulations |
|---|---|---|---|---|
| | ha | kg | % | ha |
| Herbicides | 281 | 378 | 27 | Glyphosate (232) |
| Insecticides | 35 | < 0.5 | 3 | Lambda-cyhalothrin (35) |
| **All pesticides** | **316** | **378** | **27** | |

**Figure 38 Use of pesticides on other fodder (percentage of total area treated with formulations) – 2021**

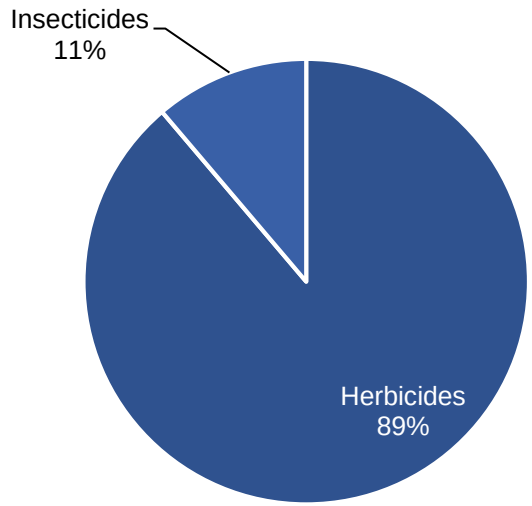
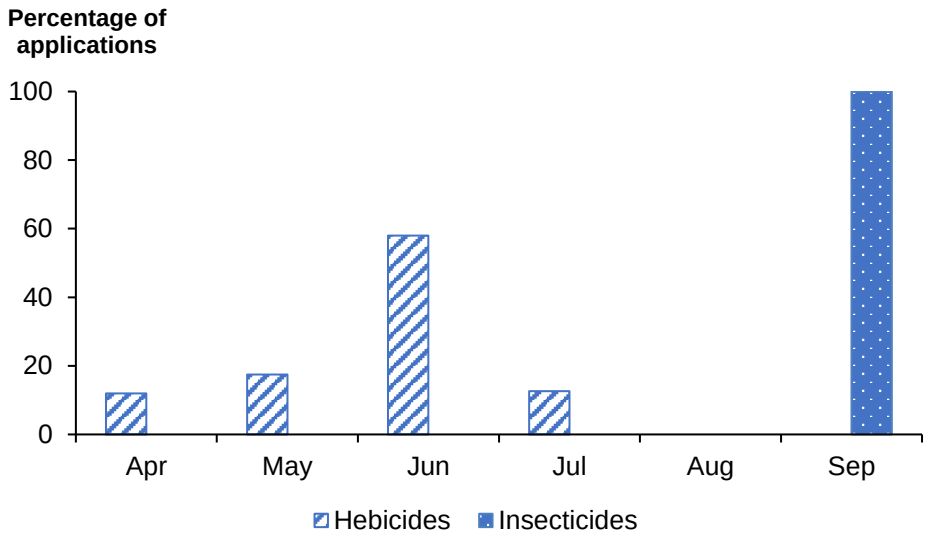



**Figure 39 Timing of herbicide applications on other fodder - 2021**



## Appendix 1 – Estimated application tables

### Table 1 Percentage of each crop treated with pesticides and mean number of spray applications - 2021

| Crop | Fungicides | | Herbicides | | Insecticides | | Molluscicide | | Sulphur | | Growth regulators | | Any pesticide exc. STs | | Seed treatments | Any pesticide inc. STs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | % | spray apps | % | spray apps | % | spray apps | % | spray apps | % | spray apps | % | spray apps | % | % | % | % |
| Direct sown grass | 0 | 0.0 | 23 | 1.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 23 | 1.0 | 0 | 23 |
| Undersown grass | 30 | 1.2 | 34 | 1.0 | 0 | 0.0 | 0 | 0.0 | 1 | 1.0 | 0 | 0.0 | 40 | 1.1 | 0 | 40 |
| Grass 1 - 4 years | 0 | 0.0 | 5 | 1.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 5 | 1.0 | 0 | 5 |
| Grass over 5 years | 0 | 0.0 | 3 | 1.1 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 3 | 1.1 | 0 | 3 |
| **Total grass** | **<0.5** | **1.1** | **4** | **1.1** | **0** | **0.0** | **0** | **0.0** | **0** | **1.0** | **0** | **0.0** | **4** | **1.1** | **0** | **4** |
| Rough grazing | 0 | 0.0 | <0.5 | 1.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | <0.5 | 1.0 | 0 | <0.5 |

**Cont…**

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

| Crop | Fungicides | | Herbicides | | Insecticides | | Molluscicide | | Sulphur | | Growth regulators | | Any pesticide exc. STs | | Seed treatments | Any pesticide inc. STs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | % | spray apps | % | spray apps | % | spray apps | % | spray apps | % | spray apps | % | spray apps | % | % | % | % |
| Arable silage | 15 | 1.7 | 19 | 1.0 | 1 | 1.0 | 0 | 0.0 | 0 | 0.0 | 6 | 1.0 | 19 | 1.9 | 24 | 26 |
| Fodder beet | 4 | 1.0 | 100 | 2.2 | 11 | 1.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 100 | 2.3 | 60 | 100 |
| Fodder rape | 0 | 0.0 | 20 | 1.2 | 2 | 1.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 20 | 1.3 | 0 | 20 |
| Kale & cabbage | 0 | 0.0 | 52 | 1.0 | 2 | 1.0 | 2 | 1.0 | 0 | 0.0 | 0 | 0.0 | 52 | 1.1 | 0 | 52 |
| Maize | 0 | 0.0 | 100 | 1.4 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 100 | 1.4 | 86 | 100 |
| Stubble turnips | 0 | 0.0 | 10 | 1.0 | 0 | 0.0 | 23 | 1.0 | 0 | 0.0 | 0 | 0.0 | 32 | 1.0 | 0 | 32 |
| Turnips & swede | 5 | 1.7 | 71 | 1.0 | 42 | 1.6 | 0 | 0.0 | 3 | 1.0 | 0 | 0.0 | 77 | 1.8 | 0 | 77 |
| Other fodder | 0 | 0.0 | 27 | 1.0 | 3 | 1.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 27 | 1.1 | 0 | 27 |
| **Total fodder crops** | **5** | **1.6** | **34** | **1.3** | **8** | **1.5** | **1** | **1.0** | **1** | **1.0** | **2** | **1.0** | **36** | **1.7** | **13** | **38** |

Note: STs = seed treatments.
The average number of spray applications is calculated only on the areas receiving each pesticide group and therefore the minimum number of applications is always one. (See Appendix 3 – definitions and notes for details).

## Table 2 Grassland fungicide formulations – 2021

Area (ha), weight (kg) and percentage of crop treated

| Fungicides | Direct sown grass | | Undersown grass | | Grass 1 to 4 years | | Grass over 5 years | | Rough grazing | | Total 2021 | Total 2021 | 2017[1] | 2017[1] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ha | % | ha | % | ha | % | ha | % | ha | % | **ha** | **kg** | ha | kg |
| Bixafen/prothioconazole | 0 | 0 | 214 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | **214** | **17** | 83 | 11 |
| Cyflufenamid | 0 | 0 | 144 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | **144** | **1** | 0 | 0 |
| Cyprodinil | 0 | 0 | 895 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | **895** | **152** | 299 | 83 |
| Fluoxastrobin/ prothioconazole/ trifloxystrobin | 0 | 0 | 695 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | **695** | **74** | 842 | 121 |
| Folpet | 0 | 0 | 454 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | **454** | **190** | 87 | 37 |
| Prothioconazole/ spiroxamine | 0 | 0 | 296 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | **296** | **48** | 349 | 55 |
| Prothioconazole/ tebuconazole | 0 | 0 | 971 | 11 | 0 | 0 | 0 | 0 | 0 | 0 | **971** | **123** | 932 | 121 |
| Prothioconazole/ trifloxystrobin | 0 | 0 | 119 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | **119** | **14** | 1,142 | 133 |
| **All fungicides** | **0** | **0** | **3,789** | **30** | **0** | **0** | **0** | **0** | **0** | **0** | 3,789 | **619** | **7,065** | **1,656** |
| Sulphur | 0 | 0 | 84 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | **84** | **139** | 0 | 0 |
| Area grown (ha) | 24,388 | | 9,193 | | 166,844 | | 1,130,056 | | 3,072,535 | | **4,403,017** | | 4,363,985 | |

(1) For a full list of formulations recorded in 2017 please refer to the 2017 report [3].

## Table 3 Grassland herbicide formulations - 2021

Area (ha), weight (kg) and percentage of crop treated

| Herbicides | Direct sown grass | | Undersown grass | | Grass 1 to 4 years | | Grass over 5 years | | Rough grazing | | Total 2021 | Total 2021 | 2017[(1)] | 2017[(1)] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ha | % | ha | % | ha | % | ha | % | ha | % | **ha** | **kg** | ha | kg |
| 2,4-D | 85 | <0.5 | 0 | 0 | 261 | 0 | 1,776 | <0.5 | 0 | 0 | **2,121** | **3,097** | 2,120 | 2,518 |
| 2,4-D/dicamba | 71 | <0.5 | 0 | 0 | 608 | <0.5 | 1,723 | <0.5 | 0 | 0 | **2,403** | **2,890** | 917 | 447 |
| 2,4-D/glyphosate | 0 | 0 | 0 | 0 | 40 | <0.5 | 0 | 0 | 0 | 0 | **40** | **81** | 207 | 331 |
| 2,4-D/MCPA | 974 | 4 | 673 | 7 | 959 | 1 | 6,335 | 1 | 2,635 | <0.5 | **11,575** | **20,693** | 2,888 | 5,307 |
| 2,4-DB | 62 | <0.5 | 100 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | **162** | **156** | 4,577 | 5,033 |
| Amidosulfuron | 354 | 1 | 896 | 10 | 799 | 0 | 94 | <0.5 | 0 | 0 | **2,144** | **76** | 1,049 | 42 |
| Aminopyralid/triclopyr | 0 | 0 | 0 | 0 | 157 | <0.5 | 2,626 | <0.5 | 0 | 0 | **2,783** | **1,233** | 4,436 | 2,185 |
| Asulam* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 42 | <0.5 | **42** | **187** | 6,028 | 24,817 |
| Clopyralid/florasulam/ fluroxypyr | 142 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **142** | **26** | 177 | 32 |
| Clopyralid/fluroxypyr/ triclopyr | 0 | 0 | 0 | 0 | 0 | 0 | 247 | <0.5 | 0 | 0 | **247** | **223** | 606 | 441 |
| Clopyralid/triclopyr | 202 | 1 | 0 | 0 | 1,746 | 1 | 10,087 | 1 | 1,794 | <0.5 | **13,829** | **5,517** | 7,398 | 2,649 |
| Dicamba/mecoprop-P | 0 | 0 | 0 | 0 | 0 | 0 | 83 | <0.5 | 0 | 0 | **83** | **56** | 69 | 40 |
| Florasulam/fluroxypyr | 1,195 | 5 | 0 | 0 | 0 | 0 | 200 | <0.5 | 0 | 0 | **1,394** | **209** | 522 | 60 |
| Fluroxypyr | 880 | 3 | 673 | 7 | 1,938 | 1 | 10,523 | 1 | 0 | 0 | **14,014** | **3,822** | 11,426 | 3,191 |
| Fluroxypyr/triclopyr | 252 | 1 | 0 | 0 | 1,613 | 1 | 6,589 | 1 | 0 | 0 | **8,454** | **3,547** | 9,871 | 4,413 |
| Glyphosate | 2,253 | 9 | 0 | 0 | 168 | <0.5 | 3,281 | <0.5 | 450 | <0.5 | **6,152** | **10,292** | 4,721 | 6,200 |
| MCPA | 701 | 3 | 1,624 | 18 | 750 | 0 | 6,511 | 1 | 504 | <0.5 | **10,090** | **13,722** | 17,140 | 23,761 |
| Mecoprop-P | 115 | <0.5 | 144 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | **259** | **166** | 0 | 0 |

**Cont…**

## Table 3 Grassland herbicide formulations - 2021 continued

Area (ha), weight (kg) and percentage of crop treated

| Herbicides | Direct sown grass | | Undersown grass | | Grass 1 to 4 years | | Grass over 5 years | | Rough grazing | | Total 2021 | Total 2021 | 2017[1] | 2017[1] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ha | % | ha | % | ha | % | ha | % | ha | % | **ha** | **kg** | ha | kg |
| Thifensulfuron-methyl | 0 | 0 | 0 | 0 | 48 | <0.5 | 33 | <0.5 | 0 | 0 | **81** | **1** | 332 | 3 |
| Tribenuron-methyl | 38 | 0 | 424 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | **462** | **4** | 3,802 | 21 |
| Unspecified herbicide | 59 | 0 | 0 | 0 | 526 | <0.5 | 0 | 0 | 0 | 0 | **585** | **[z]** | 355 | [z] |
| **All herbicides** | **7,383** | **23** | **4,533** | **34** | **9,614** | **5** | **50,109** | **3** | **5,426** | **<0.5** | **77,064** | **65,995** | **79,274** | **81,815** |
| Area grown (ha) | 24,388 | | 9,193 | | 166,844 | | 1,130,056 | | 3,072,535 | | **4,403,017** | | 4,363,985 | |

(1) For a full list of formulations recorded in 2017 please refer to the 2017 report [3].
(2) Refer to Appendix 3 for definitions.
Note: some shorthand is used in this table: [z] = not applicable.
*The asulam treated area and weight applied will be underestimated as only one holding applying asulam was encountered in the 2021 sample and none applied via aerial application. The majority of asulam used in Scotland is applied by helicopter. Fera Science Ltd reported that 3,128 ha of bracken were treated with 13,763 kg of asulam via areal application in Scotland in 2021.

## Table 4 Fodder crop seed treatment formulations - 2021

Area (ha), weight (kg) and percentage of crop treated

| Seed treatments | Arable silage | | Fodder beet | | Fodder rape | | Kale & cabbage | | Maize | | Stubble turnips | | Turnips & swedes | | Other fodder[1] | | Total 2021 | Total 2021 | 2017 [2] | 2017 [2] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ha | % | ha | % | ha | % | ha | % | ha | % | ha | % | ha | % | ha | % | **ha** | kg | ha | kg |
| Fludioxonil | 859 | 16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **859** | **14** | 618 | 3 |
| Fludioxonil/ metalaxyl-M/ sedaxane | 0 | 0 | 194 | 16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **194** | **<0.5** | 0 | 0 |
| Fluopyram/ prothioconazole/ tebuconazole | 72 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **72** | **1** | 751 | 11 |
| Hymexazol | 0 | 0 | 436 | 37 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **436** | **11** | 0 | 0 |
| Imazalil/ipconazole | 212 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **212** | **3** | 759 | 8 |
| Metalaxyl/ prothioconazole | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1,062 | 86 | 0 | 0 | 0 | 0 | 0 | 0 | **1,062** | **4** | 0 | 0 |
| Prothioconazole/ tebuconazole | 99 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **99** | **2** | 34 | <0.5 |
| Sedaxane | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 866 | 70 | 0 | 0 | 0 | 0 | 0 | 0 | **866** | **23** | 0 | 0 |
| Tefluthrin | 0 | 0 | 722 | 60 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **722** | **24** | 356 | 8 |
| Unspecified seed treatment | 48 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **48** | **[z]** | 397 | [z] |
| Ziram* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 866 | 70 | 0 | 0 | 0 | 0 | 0 | 0 | **866** | **64** | 0 | 0 |
| **All seed treatments** | **1,289** | **24** | **1,352** | **60** | **0** | **0** | **0** | **0** | **2,794** | **86** | **0** | **0** | **0** | **0** | **0** | **0** | **5,435** | **145** | **11,265** | **222** |
| No information seed treatment | 172 | 3 | 0 | 0 | 26 | 1 | 0 | 0 | 167 | 14 | 0 | 0 | 23 | 1 | 0 | 0 | **388** | **[z]** | 531 | [z] |

**Cont…**

## Table 4 Fodder crop seed treatment formulations – 2021 continued

Area (ha) weight (kg) and percentage of crop treated

| Seed treatments | Arable silage | | Fodder beet | | Fodder rape | | Kale & cabbage | | Maize | | Stubble turnips | | Turnips & swedes | | Other fodder[1] | | Total 2021 | Total 2021 | 2017 [2] | 2017 [2] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ha | % | ha | % | ha | % | ha | % | ha | % | ha | % | ha | % | ha | % | **ha** | kg | ha | kg |
| No Seed treatment | 3,992 | 73 | 471 | 40 | 2,221 | 99 | 2,068 | 100 | 0 | 0 | 479 | 100 | 3,493 | 99 | 1,028 | 100 | **13,752** | **[z]** | 7,679 | [z] |
| Crop grown from transplant | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **[z]** | 12 | [z] |
| Area grown (ha) | 5,453 | | 1,193 | | 2,248 | | 2,068 | | 1,229 | | 479 | | 3,517 | | 1,028 | | **17,214** | | 16,304 | |

(1) Refer to Appendix 3 for definitions.
(2) For a full list of formulations recorded in 2017 please refer to the 2017 report [3].
Note: some shorthand is used in this table: [z] = not applicable.
*Ziram has no authorisation in the UK, however, it is approved for use in several EU countries and was recorded on imported maize seed. Imported seed treated with a plant protection product authorised for that use in EU countries were allowed at the time of use[9].

## Table 5 Fodder crop insecticide and mollusicide formulations – 2021

Area (ha), weight (kg) and percentage of crop treated

| Insecticides | Arable silage | | Fodder beet | | Fodder rape | | Kale & cabbage | | Maize | | Stubble turnips | | Turnips & swedes | | Other fodder[1] | | Total 2021 | Total 2021 | 2017 [2] | 2017 [2] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ha | % | ha | % | ha | % | ha | % | ha | % | ha | % | ha | % | ha | % | **ha** | kg | ha | kg |
| Deltamethrin | 0 | 0 | 0 | 0 | 29 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1,266 | 29 | 0 | 0 | **1,295** | **8** | 364 | 3 |
| Esfenvalerate | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 142 | 2 | 0 | 0 | **142** | **1** | 0 | 0 |
| Flonicamid | 0 | 0 | 136 | 11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **136** | **10** | 0 | 0 |
| Lambda-cyhalothrin | 31 | 1 | 0 | 0 | 18 | 1 | 33 | 2 | 0 | 0 | 0 | 0 | 858 | 18 | 35 | 3 | **974** | **12** | 333 | 6 |
| **All insecticides** | **31** | **1** | **136** | **11** | **47** | **2** | **33** | **2** | **0** | **0** | **0** | **0** | **2,266** | **42** | **35** | **3** | **2,547** | **30** | 897 | 9 |
| **Molluscicides** | | | | | | | | | | | | | | | | | | | | |
| Ferric phosphate | 0 | 0 | 0 | 0 | 0 | 0 | 33 | 2 | 0 | 0 | 109 | 23 | 0 | 0 | 0 | 0 | **142** | **15** | 0 | 0 |
| **All molluscicides** | **0** | **0** | **0** | **0** | **0** | **0** | **33** | **2** | **0** | **0** | **109** | **23** | **0** | **0** | **0** | **0** | **142** | **15** | **140** | **26** |
| Area grown (ha) | 5,453 | | 1,193 | | 2,248 | | 2,068 | | 1,229 | | 479 | | 3,517 | | 1,028 | | **17,214** | | 16,304 | |

(1) Refer to Appendix 3 for definitions.
(2) For a full list of formulations recorded in 2017 please refer to the 2017 report[3].

## Table 6 Fodder crop fungicide and sulphur formulations - 2021

Area (ha), weight (kg) and percentage of crop treated

| Fungicides | Arable silage | | Fodder beet | | Fodder rape | | Kale & cabbage | | Maize | | Stubble turnips | | Turnips & swedes | | Other fodder[1] | | Total 2021 | Total 2021 | 2017 [2] | 2017 [2] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ha | % | ha | % | ha | % | ha | % | ha | % | ha | % | ha | % | ha | % | **ha** | kg | ha | kg |
| Azoxystrobin | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 61 | 2 | 0 | 0 | **61** | **15** | 0 | 0 |
| Benzovindiflupyr | 31 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **31** | **2** | 0 | 0 |
| Bixafen/fluoxastrobin/ prothioconazole | 45 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **45** | **13** | 181 | 38 |
| Cyflufenamid | 45 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **45** | **<0.5** | 0 | 0 |
| Cyproconazole/ penthiopyrad | 255 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **255** | **48** | 0 | 0 |
| Cyproconazole/ trifloxystrobin | 0 | 0 | 49 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **49** | **9** | 0 | 0 |
| Fluoxastrobin/ prothioconazole | 170 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **170** | **34** | 0 | 0 |
| Fluoxastrobin /prothioconazole/ trifloxystrobin | 283 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **283** | **43** | 148 | 24 |
| Fluxapyroxad/ mefentrifluconazole | 45 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **45** | **5** | 0 | 0 |
| Folpet | 286 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **286** | **194** | 0 | 0 |
| Mefentrifluconazole | 255 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **255** | **22** | 0 | 0 |
| Prochloraz/ tebuconazole | 45 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **45** | **14** | 0 | 0 |
| Prothioconazole | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 119 | 3 | 0 | 0 | **119** | **23** | 79 | 15 |
| Prothioconazole/ spiroxamine | 50 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **50** | **12** | 0 | 0 |

**Cont…**

## Table 6 Fodder crop fungicide and sulphur formulations – 2021 continued

Area (ha) weight (kg) and percentage of crop treated

| Fungicides | Arable silage | | Fodder beet | | Fodder rape | | Kale & cabbage | | Maize | | Stubble turnips | | Turnips & swedes | | Other fodder[1] | | Total 2021 | Total 2021 | 2017 [2] | 2017 [2] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ha | % | ha | % | ha | % | ha | % | ha | % | ha | % | ha | % | ha | % | **ha** | kg | ha | kg |
| Prothioconazole/ tebuconazole | 255 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **255** | **57** | 88 | 5 |
| Tebuconazole | 255 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **255** | **41** | 0 | 0 |
| **All fungicides** | **2,019** | **15** | **49** | **4** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **179** | **5** | **0** | **0** | **2,247** | **532** | **885** | **208** |
| Sulphur | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 119 | 3 | 0 | 0 | **119** | **495** | 0 | 0 |
| Area grown (ha) | 5,453 | | 1,193 | | 2,248 | | 2,068 | | 1,229 | | 479 | | 3,517 | | 1,028 | | **17,214** | | 16,304 | |

(1) Refer to Appendix 3 for definitions.
(2) For a full list of formulations recorded in 2017 please refer to the 2017 report[3].

## Table 7 Fodder crop herbicide and growth regulator formulations – 2021

Area (ha), weight (kg) and percentage of crop treated

| Herbicides | Arable silage | | Fodder beet | | Fodder rape | | Kale & cabbage | | Maize | | Stubble turnips | | Turnips & swedes | | Other fodder[1] | | Total 2021 | Total 2021 | 2017 [2] | 2017 [2] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ha | % | ha | % | ha | % | ha | % | ha | % | ha | % | ha | % | ha | % | **ha** | kg | ha | kg |
| 2,4-D | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 19 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | **19** | **10** | 0 | 0 |
| 2,4-D/MCPA | 34 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **34** | **57** | 97 | 164 |
| 2,4-DB/MCPA | 170 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **170** | **237** | 174 | 290 |
| Clomazone | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 986 | 28 | 0 | 0 | **986** | **58** | 784 | 49 |
| Clopyralid | 0 | 0 | 29 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **29** | **4** | 0 | 0 |
| Clopyralid/florasulam/ fluroxypyr | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 19 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | **19** | **4** | 0 | 0 |
| Diflufenican | 75 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **75** | **5** | 72 | 12 |
| Diflufenican/ iodosulfuron-methyl-sodium/ mesosulfuron-methyl | 255 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **255** | **10** | 0 | 0 |
| Dimethenamid-P/ metazachlor | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 469 | 13 | 0 | 0 | **469** | **358** | 1,064 | 803 |
| Dimethenamid-P/ pendimethalin | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 778 | 63 | 0 | 0 | 0 | 0 | 0 | 0 | **778** | **1,360** | 240 | 431 |
| Dimethenamid-P/ quinmerac | 0 | 0 | 84 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **84** | **18** | 0 | 0 |
| Ethofumesate | 0 | 0 | 214 | 18 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **214** | **41** | 0 | 0 |
| Ethofumesate/ metamitron | 0 | 0 | 399 | 33 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **399** | **352** | 48 | 48 |

**Cont…**

## Table 7 Fodder crop herbicide and growth regulator formulations – 2021 continued

Area (ha), weight (kg) and percentage of crop treated

| Herbicides | Arable silage | | Fodder beet | | Fodder rape | | Kale & cabbage | | Maize | | Stubble turnips | | Turnips & swedes | | Other fodder[1] | | Total 2021 | Total 2021 | 2017 [2] | 2017 [2] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ha | % | ha | % | ha | % | ha | % | ha | % | ha | % | ha | % | ha | % | **ha** | kg | ha | kg |
| Ethofumesate/ phenmedipham | 0 | 0 | 648 | 38 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **648** | **298** | 0 | 0 |
| Florasulam/fluroxypyr | 34 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **34** | **3** | 45 | 5 |
| Florasulam/halauxifen-methyl | 255 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **255** | **1** | 0 | 0 |
| Fluazifop-P-butyl | 0 | 0 | 105 | 9 | 29 | 1 | 0 | 0 | 0 | 0 | 46 | 10 | 0 | 0 | 0 | 0 | **180** | **33** | 0 | 0 |
| Fluroxypyr | 361 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **361** | **51** | 145 | 21 |
| Fluroxypyr/ halauxifen-methyl | 71 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **71** | **9** | 0 | 0 |
| Glyphosate | 31 | 1 | 261 | 22 | 431 | 19 | 626 | 30 | 0 | 0 | 0 | 0 | 454 | 13 | 232 | 23 | **2,034** | **2,358** | 1,362 | 1,877 |
| Lenacil | 0 | 0 | 245 | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **245** | **35** | 0 | 0 |
| Lenacil/ triflusulfuron-methyl | 0 | 0 | 225 | 19 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **225** | **48** | 459 | 99 |
| Mesotrione | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 172 | 14 | 0 | 0 | 0 | 0 | 0 | 0 | **172** | **26** | 0 | 0 |
| Mesotrione/nicosulfuron | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 498 | 41 | 0 | 0 | 0 | 0 | 0 | 0 | **498** | **78** | 0 | 0 |

**Cont...**

## Table 7 Fodder crop herbicide and growth regulator formulations – 2021 continued

Area (ha), weight (kg) and percentage of crop treated

| Herbicides | Arable silage | | Fodder beet | | Fodder rape | | Kale & cabbage | | Maize | | Stubble turnips | | Turnips & swedes | | Other fodder[1] | | Total 2021 | Total 2021 | 2017 [2] | 2017 [2] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ha | % | ha | % | ha | % | ha | % | ha | % | ha | % | ha | % | ha | % | **ha** | kg | ha | kg |
| Metamitron | 0 | 0 | 2,026 | 89 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **2,026** | **1,921** | 919 | 1,010 |
| Metazachlor | 0 | 0 | 0 | 0 | 79 | 4 | 537 | 26 | 0 | 0 | 0 | 0 | 1,378 | 39 | 49 | 5 | **2,044** | **1,073** | 1,329 | 699 |
| Metsulfuron-methyl | 255 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **255** | **2** | 48 | 0 |
| Metsulfuron-methyl/ thifensulfuron-methyl | 382 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **382** | **10** | 110 | 3 |
| Napropamide | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 167 | 5 | 0 | 0 | **167** | **94** | 0 | 0 |
| Nicosulfuron | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 172 | 14 | 0 | 0 | 0 | 0 | 0 | 0 | **172** | **7** | 31 | 1 |
| Pendimethalin | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 429 | 35 | 0 | 0 | 0 | 0 | 0 | 0 | **429** | **386** | 939 | 721 |
| Pendimethalin/ picolinafen | 45 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **45** | **45** | 0 | 0 |
| Phenmedipham | 0 | 0 | 297 | 25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **297** | **92** | 0 | 0 |
| Propaquizafop | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 43 | 1 | 0 | 0 | **43** | **2** | 69 | 10 |
| Thifensulfuron-methyl/ tribenuron-methyl | 50 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **50** | **1** | 0 | 0 |
| Tribenuron-methyl | 0 | 0 | 140 | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **140** | **2** | 312 | 5 |
| Unspecified herbicide | 48 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **48** | **[z]** | 542 | [z] |
| **All herbicides** | **2,066** | **19** | **4,674** | **100** | **540** | **20** | **1,163** | **52** | **2,089** | **100** | **46** | **10** | **3,496** | **71** | **281** | **27** | **14,355** | **9,090** | 11,074 | 7,647 |

**Cont...**

## Table 7 Fodder crop herbicide and growth regulator formulations – 2021 continued

Area (ha), weight (kg) and percentage of crop treated

| Growth regulators | Arable silage | | Fodder beet | | Fodder rape | | Kale & cabbage | | Maize | | Stubble turnips | | Turnips & swedes | | Other fodder[1] | | Total 2021 | Total 2021 | 2017 [2] | 2017 [2] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ha | % | ha | % | ha | % | ha | % | ha | % | ha | % | ha | % | ha | % | **ha** | kg | ha | kg |
| Mepiquat chloride/ prohexadione-calcium | 45 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **45** | **6** | 0 | 0 |
| Trinexapac-ethyl | 300 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **300** | **14** | 0 | 0 |
| **All growth regulators** | **344** | **6** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | 344 | 21 | **0** | **0** |
| Area grown (ha) | 5,453 | | 1,193 | | 2,248 | | 2,068 | | 1,229 | | 479 | | 3,517 | | 1,028 | | **17,214** | | 16,304 | |

(1) Refer to Appendix 3 for definitions
(2) For a full list of formulations recorded in 2017 please refer to the 2017 report[3]
Note: some shorthand is used in this table: [z] = not applicable.

## Table 8 Compounds encountered in the grassland and fodder survey for the first time in 2021

| Active substance | Type [1] | Area treated (ha) | Amount used (kg) |
|---|---|---|---|
| Sedaxane | S | 1,060 | 20 |
| Ziram | S | 866 | 57 |
| Halauxifen-methyl | H | 326 | 1 |
| Mefentrifluconazole | F | 300 | 25 |
| Mesosulfuron-methyl | H | 255 | 1 |
| Napropamide | H | 167 | 94 |
| Flonicamid | I | 136 | 10 |
| Benzovindiflupyr | F | 31 | 2 |

(1) Pesticide type = F: Fungicide, H: Herbicide, I: insecticide and S: seed treatment
Note: Ziram has no authorisation in the UK, however, it is approved for use in several EU countries and was recorded on imported maize seed. Imported seed treated with a plant protection product authorised for that use in EU countries were allowed at the time of use[9].

## Table 9 Mode of action/chemical group of insecticide active substances on all grass and fodder crops - 2021

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

| Mode of action | Active substance | Chemical group | IRAC group | Total grass and fodder 2021 | Total grass and fodder 2021 |
|---|---|---|---|---|---|
| | | | | ha | kg |
| Sodium channel modulators | Deltamethrin | Pyrethroid | 3A | 1,295 | 8 |
| | Esfenvalerate | Pyrethroid | 3A | 142 | 1 |
| | Lambda-cyhalothrin | Pyrethroid | 3A | 974 | 12 |
| **All sodium channel modulators** | | | | **2,411** | **20** |
| Other mode of action | | | | | |
| Chordontonal organ modulators - undefined target site | Flonicamid | Pyridine compound | 29 | 136 | 10 |
| **All other modes of action** | | | | **136** | **10** |
| **All insecticides** | | | | **2,547** | **30** |
| Area grown | | | | 4,395,840 | |

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[10].

## Table 10 Mode of action/chemical group of fungicide active substances on all grass and fodder crops - 2021

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

| Mode of action | Active substance | Group name | Chemical group | FRAC group | Total grass and fodder 2021 | Total grass and fodder 2021 |
|---|---|---|---|---|---|---|
| | | | | | ha | kg |
| Respiration | Benzovindiflupyr | SDHI | Pyrazole-4-carboxamides | 7 | 31 | 2 |
| | Bixafen | SDHI | Pyrazole-4-carboxamides | 7 | 259 | 7 |
| | Fluxapyroxad | SDHI | Pyrazole-4-carboxamides | 7 | 45 | 2 |
| | Penthiopyrad | SDHI | Pyrazole-4-carboxamides | 7 | 255 | 34 |
| | Azoxystrobin | Qo inhibitor | Methoxy-acrylates | 11 | 61 | 15 |
| | Fluoxastrobin | Qo inhibitor | Dihydro-dioxazines | 11 | 1,192 | 50 |
| | Trifloxystrobin | Qo inhibitor | Oximino-acetates | 11 | 1,146 | 40 |
| **All respiration** | | | | | **2,989** | **150** |
| Amino acids and protein synthesis | Cyprodinil | Anilino - pyrimidines | Anilino - pyrimidines | 9 | 895 | 152 |
| **All amino acids and protein synthesis** | | | | | **895** | **152** |
| Sterol biosynthesis in membranes | Cyproconazole | DeMethylation inhibitor | Triazoles | 3 | 304 | 17 |
| | Mefentrifluconazole | DeMethylation inhibitor | Triazoles | 3 | 300 | 25 |
| | Prochloraz | DeMethylation inhibitor | Imidazoles | 3 | 45 | 9 |
| | Prothioconazole | DeMethylation inhibitor | Triazolinthiones | 3 | 3,218 | 250 |
| | Tebuconazole | DeMethylation inhibitor | Triazoles | 3 | 1,527 | 125 |
| | Spiroxamine | Morpholine | Spiroketal-amines | 5 | 346 | 39 |
| **All sterol biosynthesis in membranes** | | | | | **5,740** | **464** |

**Cont…**

## Table 10 Mode of action/chemical group of fungicide active substances on all grass and fodder crops – 2021 continued

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

| Mode of action | Active substance | Group name | Chemical group | FRAC group | Total grass and fodder 2021 | Total grass and fodder 2021 |
|---|---|---|---|---|---|---|
| | | | | | ha | kg |
| Unknown mode of action | Cyflufenamid | Phenyl-acetamide | Phenyl-acetamide | U06 | 189 | 1 |
| **All unknown mode of action** | | | | | **189** | **1** |
| Chemicals with multi-site activity | Folpet | Phthalimide | Phthalimide | M04 | 740 | 384 |
| **All chemicals with multi-site activity** | | | | | **740** | **384** |
| **All fungicides** | | | | | **10,552** | **1,151** |
| **Sulphur** | | | | | **203** | **634** |
| Area grown | | | | | 4,395,840 | |

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[11].

## Table 11 Mode of action/chemical group of herbicide active substances on all grass and fodder crops – 2021

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

| Mode of action | Active substance | Chemical group | HRAC group | Total grass and fodder 2021 | Total grass and fodder 2021 |
|---|---|---|---|---|---|
| | | | | ha | kg |
| Inhibition of acetyl CoA carboxylase | Fluazifop-P-butyl | Aryloxyphenoxy-propionates (FOPs) | 1 | 180 | 33 |
| | Propaquizafop | Aryloxyphenoxy-propionates (FOPs) | 1 | 43 | 2 |
| **All inhibition of acetyl CoA carboxylase** | | | | **222** | **35** |
| Inhibition of acetolactate synthase ALS | Amidosulfuron | Sulfonylureas | 2 | 2,144 | 76 |
| | Iodosulfuron-Methyl-Sodium | Sulfonylureas | 2 | 255 | 0 |
| | Mesosulfuron-Methyl | Sulfonylureas | 2 | 255 | 1 |
| | Metsulfuron-Methyl | Sulfonylureas | 2 | 637 | 3 |
| | Nicosulfuron | Sulfonylureas | 2 | 670 | 29 |
| | Thifensulfuron-Methyl | Sulfonylureas | 2 | 513 | 10 |
| | Tribenuron-Methyl | Sulfonylureas | 2 | 512 | 4 |
| | Triflusulfuron-Methyl | Sulfonylureas | 2 | 366 | 6 |
| | Florasulam | Triazolopyrimidine - Type 1 | 2 | 1,845 | 6 |
| **All inhibition of acetolactate synthase ALS** | | | | **7,198** | **136** |
| Microtubule assembly inhibition | Pendimethalin | Dinitroanilines | 3 | 1,019 | 1,165 |
| **All microtubule assembly inhibition** | | | | **1,019** | **1,165** |

**Cont…**

## Table 11 Mode of action/chemical group of herbicide active substances on all grass and fodder crops – 2021 continued

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

| Mode of action | Active substance | Chemical group | HRAC group | Total grass and fodder 2021 | Total grass and fodder 2021 |
|---|---|---|---|---|---|
| | | | | ha | kg |
| Auxin mimics | 2,4-D | Phenoxy-carboxylates | 4 | 16,140 | 16,349 |
| | 2,4-DB | Phenoxy-carboxylates | 4 | 331 | 359 |
| | Aminopyralid | Phenoxy-carboxylates | 4 | 2,783 | 137 |
| | Clopyralid | Pyridine-carboxylates | 4 | 14,267 | 2,004 |
| | Dicamba | Benzoates | 4 | 2,486 | 754 |
| | Fluroxypyr | Pyridyloxy-carboxylates | 4 | 24,738 | 5,953 |
| | Halauxifen-methyl | Pyridine-carboxylates | 4 | 326 | 1 |
| | MCPA | Phenoxy-carboxylates | 4 | 21,869 | 23,439 |
| | Mecoprop-P | Phenoxy-carboxylates | 4 | 342 | 216 |
| | Quinmerac | Quinoline-carboxylates | 4 | 84 | 6 |
| | Triclopyr | Pyridyloxy-carboxylates | **4** | 22,519 | 6,547 |
| **All auxin mimics** | | | | **105,886** | **55,764** |
| Inhibition of photosynthesis at photosystem II (Serine 264 Binders) | Lenacil | Uracils | 5 | 471 | 80 |
| | Metamitron | Triazinones | 5 | 2,174 | 2,167 |
| | Phenmedipham | Phenlcarbamates | 5 | 945 | 244 |
| **All inhibition of photosynthesis at photosystem II** | | | | **3,589** | **2,491** |

**Cont…**

## Table 11 Mode of action/chemical group of herbicide active substances on all grass and fodder crops – 2021 continued

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

| Mode of action | Active substance | Chemical group | HRAC group | Total grass and fodder 2021 | Total grass and fodder 2021 |
|---|---|---|---|---|---|
| | | | | ha | kg |
| Inhibition of EPSP synthase | Glyphosate | Glycine | 9 | 8,227 | 12,699 |
| **All inhibition of EPSP synthase** | | | | **8,227** | **12,699** |
| Inhibition of phytoene desaturase | Diflufenican | Phenyl ethers | **12** | 331 | 13 |
| | Picolinafen | Phenyl ethers | **12** | 45 | 2 |
| **All inhibition of phytoene desaturase** | | | | **375** | **15** |
| Inhibition of deoxy-D-xyulose phosphate synthase | Clomazone | Isoxazolidinone | 13 | 986 | 58 |
| **All inhibition of deoxy-D-xyulose phosphate synthase** | | | | **986** | **58** |
| Inhibition of VLCFAs | Dimethenamid-P | α-Chloroacetamides | 15 | 1,332 | 816 |
| | Ethofumesate | Benzofurans | 15 | 1,214 | 292 |
| | Metazachlor | α-Chloroacetamides | 15 | 2,513 | 1,251 |
| **All inhibition of VLCFAs** | | | | **5,059** | **2,360** |
| Inhibition of DHP | Asulam | Carbamate | 18 | 42 | 187 |
| **All inhibition of DHP** | | | | **42** | **187** |
| Inhibition of hydroxyphenyl pyruvate dioxygenase | Mesotrione | Triketone | 27 | 670 | 82 |
| **All inhibition of hydroxyphenyl pyruvate dioxygenase** | | | | **670** | **82** |
| Unknown mode of action | Napropamide | Acetamides | 0 | 167 | 94 |
| **All unknown mode of action** | | | | **167** | **94** |
| **All herbicides** | | | | **133,440** | **75,085** |
| Area grown | | | | 4,395,840 | |

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[12].

## Table 12 Principal active substances by area treated

Area treated (ha) of the 20 most used active substances on all grass and fodder crops surveyed

| | Active substance | Type[1] | 2021 | 2017 | % change |
|---|---|---|---|---|---|
| 1 | Fluroxypyr | H | 24,738 | 22,742 | 9 |
| 2 | Triclopyr | H | 22,519 | 19,831 | 14 |
| 3 | MCPA | H | 21,869 | 20,560 | 6 |
| 4 | 2,4-D | H | 16,140 | 6,150 | 162 |
| 5 | Clopyralid | H | 14,267 | 8,181 | 74 |
| 6 | Glyphosate | H | 8,227 | 6,083 | 35 |
| 7 | Prothioconazole | F/S | 4,451 | 5,026 | -11 |
| 8 | Aminopyralid | H | 2,783 | 4,436 | -37 |
| 9 | Metazachlor | H | 2,513 | 2,392 | 5 |
| 10 | Dicamba | H | 2,486 | 1,214 | 105 |
| 11 | Metamitron | H | 2,174 | 1,013 | 114 |
| 12 | Amidosulfuron | H | 2,144 | 1,049 | 104 |
| 13 | Florasulam | H | 1,845 | 745 | 148 |
| 14 | Tebuconazole | F/S | 1,697 | 1,805 | -6 |
| 15 | Fluoxastrobin | F | 1,192 | 1,171 | 2 |
| 16 | Trifloxystrobin | F | 1,146 | 2,247 | -49 |
| 17 | Dimethenamid-P | H | 1,332 | 1,304 | 2 |
| 18 | Deltamethrin | I | 1,295 | 364 | 256 |
| 19 | Ethofumesate | H | 1,214 | 954 | 27 |
| 20 | Metalaxyl | S | 1,062 | 0 | [z] |

## Table 13 Principal active substances by weight

Weight (kg) of the 20 most used active substances on all grass and fodder crops surveyed

| | Active substance | Type[1] | 2021 | 2017 | % change |
|---|---|---|---|---|---|
| 1 | MCPA | H | 23,439 | 26,536 | -12 |
| 2 | 2,4-D | H | 16,349 | 5,934 | 176 |
| 3 | Glyphosate | H | 12,699 | 8,319 | 53 |
| 4 | Triclopyr | H | 6,547 | 5,872 | 12 |
| 5 | Fluroxypyr | H | 5,953 | 5,646 | 5 |
| 6 | Metamitron | H | 2,167 | 1,133 | 91 |
| 7 | Clopyralid | H | 2,004 | 1,236 | 62 |
| 8 | Metazachlor | H | 1,251 | 1,100 | 14 |
| 9 | Pendimethalin | H | 1,165 | 954 | 22 |
| 10 | Dimethenamid-P | H | 816 | 599 | 36 |
| 11 | Dicamba | H | 754 | 138 | 448 |
| 12 | Sulphur | SU | 634 | 0 | [z] |
| 13 | Folpet | F | 384 | 37 | 937 |
| 14 | 2,4-DB | H | 359 | 5,678 | -94 |
| 15 | Ethofumesate | H | 292 | 114 | 156 |
| 16 | Prothioconazole | F/S | 256 | 331 | -23 |
| 17 | Phenmedipham | H | 244 | 79 | 210 |
| 18 | Mecoprop-P | H | 216 | 105 | 106 |
| 19 | Asulam* | H | 187 | 24,817 | -99 |
| 20 | Cyprodinil | F | 152 | 83 | 84 |

(1) Pesticide type = F: Fungicide, H: Herbicide, I: Insecticide, S: Seed treatment, SU: Sulphur. Note: some shorthand is used in this table: [z] = not applicable.
* The asulam treated area and weight applied will be underestimated. See footnote Table 3, page 47 for further information.

## Table 14 Grassland and rough grazing, comparison with previous years

Pesticide usage in 2013, 2017 and 2021, area treated with formulations, active substances (a.s.) and weight (kg) applied

| | 2013 | | | 2017 | | | 2021 | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Formulations** | **a.s.** | **Weight** | **Formulations** | **a.s.** | **Weight** | **Formulations** | **a.s.** | **Weight** |
| | **ha** | **ha** | **kg** | **ha** | **ha** | **kg** | **ha** | **ha** | **kg** |
| Insecticides | 5,811 | 5,811 | 4,113 | 69 | 69 | 0 | 0 | 0 | 0 |
| Molluscicides | 179 | 179 | 27 | 0 | 0 | 0 | 0 | 0 | 0 |
| Fungicides | 12,081 | 22,127 | 2,508 | 7,065 | 12,873 | 1,656 | 3,789 | 6,781 | 619 |
| Sulphur | 0 | 0 | 0 | 0 | 0 | 0 | 84 | 84 | 139 |
| Herbicides | 66,602 | 86,020 | 78,348 | 79,274 | 104,770 | 81,815 | 77,064 | 115,558 | 65,995 |
| Growth regulators | 721 | 914 | 270 | 606 | 764 | 250 | 0 | 0 | 0 |
| Seed treatments | 1,490 | 1,490 | 53 | 925 | 925 | 83 | 0 | 0 | 0 |
| **All pesticides** | **86,884** | **116,541** | **85,319** | **87,939** | **119,401** | **83,804** | **80,938** | **122,424** | **66,753** |
| Area grown | 4,400,870 | | | 4,363,985 | | | 4,403,017 | | |

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 weight applied.

## Table 15 Fodder crops, comparison with previous years

Pesticide usage in 2013, 2017 and 2021, area treated with formulations, active substances (a.s.) and weight (kg) applied

| | 2013 | | | 2017 | | | 2021 | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Formulations** | **a.s.** | **Weight** | **Formulations** | **a.s.** | **Weight** | **Formulations** | **a.s.** | **Weight** |
| | **ha** | **ha** | **kg** | **ha** | **ha** | **kg** | **ha** | **ha** | **kg** |
| Insecticides | 1,796 | 1,796 | 413 | 897 | 897 | 9 | 2,547 | 2,547 | 30 |
| Molluscicides | 126 | 126 | 25 | 140 | 140 | 26 | 142 | 142 | 15 |
| Fungicides | 6,030 | 10,312 | 1,553 | 885 | 1,800 | 208 | 2,247 | 3,770 | 533 |
| Sulphur | 49 | 49 | 197 | 0 | 0 | 0 | 119 | 119 | 495 |
| Herbicides | 17,574 | 23,658 | 11,769 | 11,074 | 15,631 | 7,647 | 14,355 | 18,515 | 9,090 |
| Growth regulators | 658 | 658 | 228 | 0 | 0 | 0 | 344 | 389 | 21 |
| Seed treatments | 15,703 | 19,907 | 557 | 11,265 | 14,020 | 222 | 5,416 | 7,302 | 135 |
| **All pesticides** | **41,935** | **56,505** | **14,740** | **24,262** | **32,488** | **8,111** | **25,064** | **32,784** | **10,318** |
| Area grown (ha) | 19,524 | | | 16,304 | | | 17,214 | | |

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 weight applied. Fodder crops include arable silage, fodder beet, fodder rape, kale & cabbage, maize stubble turnips and other mixes of fodder crops. It should be noted that there may be minor differences in the range of crops surveyed between years.

# Appendix 2 – Survey statistics

## Census and sample information

### Table 16 Regional distribution of grassland and rough grazing crop areas in 2021

Census area (ha) of grassland and rough grazing grown in Scotland

| | Highlands & Islands | Caithness & Orkney | Moray Firth | Aberdeen | Angus | East Fife | Lothian |
|---|---|---|---|---|---|---|---|
| Grass under 5 years | 10,440 | 12,159 | 15,993 | 33,359 | 14,703 | 5,668 | 5,828 |
| Grass over 5 years | 217,295 | 74,002 | 58,336 | 99,913 | 34,724 | 19,591 | 23,563 |
| Rough grazing | 2,230,277 | 83,300 | 150,466 | 41,681 | 40,745 | 2,582 | 16,990 |

| | Central Lowlands | Tweed Valley | Southern Uplands | Solway | Scotland 2021 | Scotland 2017 | % change |
|---|---|---|---|---|---|---|---|
| Grass under 5 years | 23,234 | 14,427 | 9,426 | 21,608 | **166,844** | 206,254 | -19 |
| Grass over 5 years | 244,743 | 64,254 | 129,301 | 164,334 | **1,130,056** | 1,112,553 | 2 |
| Rough grazing | 129,744 | 30,855 | 289,440 | 56,455 | **3,072,535** | 3,037,615 | 1 |

## Table 17 Regional distribution of fodder crop areas in 2021

Census area (ha) of fodder crops grown in Scotland

| | Highlands & Islands | Caithness & Orkney | Moray Firth | Aberdeen | Angus | East Fife | Lothian |
|---|---|---|---|---|---|---|---|
| Fodder beet | 54 | 0 | 87 | 229 | 185 | 89 | 79 |
| Fodder rape | 369 | 156 | 319 | 199 | 53 | 35 | * |
| Kale & cabbage | 120 | 50 | 158 | 359 | 128 | 115 | 102 |
| Turnips & swede | 328 | 152 | 798 | 1,282 | 313 | 46 | 70 |
| Maize | * | 0 | 0 | * | * | * | 0 |
| Other stock-feeding crops | 669 | 682 | 706 | 822 | 439 | 107 | 305 |

| | Central Lowlands | Tweed Valley | Southern Uplands | Solway | Scotland 2021 | Scotland 2017 | % change |
|---|---|---|---|---|---|---|---|
| Fodder beet | 127 | 88 | * | 236 | 1,193 | 611 | 95 |
| Fodder rape | 289 | 351 | 357 | 99 | 2,248 | 2,007 | 12 |
| Kale & cabbage | 308 | 298 | 256 | 174 | 2,068 | 1,915 | 8 |
| Turnips & swede | 247 | 61 | 164 | 55 | 3,517 | 3,806 | -8 |
| Maize | 100 | 30 | * | 1,010 | 1,229 | 792 | 55 |
| Other stock-feeding crops | 707 | 574 | 407 | 1,063 | 6,481 | 6,834 | -5 |

*Regional data have not been provided in order to prevent disclosure of information relating to fewer than five holdings.
Note: 'other stock-feeding crops' include arable silage, fodder rape, kale, stubble turnips and fodder crop mixes.

## Table 18 Distribution of grassland sample - 2021

Number of holdings surveyed in each region and size group

| Size[1] (ha) | H&I[2] | C&O[2] | Moray Firth | Abdn[2] | Angus | East Fife | Lothian | Central Low-lands | Tweed Valley | S. Uplands[2] | Solway | Scotland |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.1 - 19.9 | 19 | 2 | 8 | 11 | 5 | 2 | 3 | 10 | 3 | 3 | 3 | **69** |
| 20.0 - 49.9 | 14 | 4 | 5 | 14 | 2 | 2 | 2 | 19 | 2 | 2 | 4 | **70** |
| 50.0 - 99.9 | 9 | 12 | 4 | 14 | 4 | 2 | 2 | 28 | 10 | 7 | 8 | **100** |
| 100.0 - 149.9 | 12 | 5 | 5 | 6 | 1 | 1 | 3 | 17 | 1 | 5 | 10 | **66** |
| 150.0 + | 13 | 14 | 3 | 5 | 2 | 3 | 2 | 27 | 16 | 28 | 20 | **133** |
| **All sizes** | **67** | **37** | **25** | **50** | **14** | **10** | **12** | **101** | **32** | **45** | **45** | **438** |

## Table 19 Distribution of fodder sample - 2021

Number of holdings surveyed in each region and size group

| Size[1] (ha) | H&I[2] | C&O[2] | Moray Firth | Abdn[2] | Angus | East Fife | Lothian | Central Low-lands | Tweed Valley | S. Uplands[2] | Solway | Scotland |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.1 - 4.9 | 6 | 4 | 5 | 8 | 2 | 1 | 0 | 3 | 1 | 1 | 1 | **32** |
| 5.0 - 9.9 | 5 | 5 | 7 | 12 | 4 | 1 | 2 | 6 | 3 | 4 | 3 | **52** |
| 10.0 - 14.9 | 3 | 2 | 5 | 4 | 2 | 1 | 0 | 4 | 5 | 2 | 6 | **34** |
| 15.0 - 19.9 | 2 | 1 | 1 | 4 | 1 | 1 | 2 | 3 | 2 | 3 | 3 | **23** |
| 20.0 + | 4 | 0 | 5 | 4 | 4 | 0 | 1 | 5 | 6 | 3 | 9 | **41** |
| **All sizes** | **20** | **12** | **23** | **32** | **13** | **4** | **5** | **21** | **17** | **13** | **22** | **182** |

(1) Size refers to the area of fodder crops grown on the holding.
(2) H&I = Highlands & Islands, C&O = Caithness & Orkney, Abdn = Aberdeen, S. Uplands = Southern Uplands.

## Table 20 Sampled area of grassland - 2021

Area (ha) of grassland and rough grazing in the sample

| | H&I[1] | C&O[1] | Moray Firth | Abdn[1] | Angus | East Fife | Lothian | Central Low-lands | Tweed Valley | S. Uplands[1] | Solway | Scotland |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Grassland | 9,647 | 7,128 | 3,490 | 6,538 | 1,993 | 1,118 | 1,893 | 12,676 | 8,126 | 11,081 | 10,431 | 74,119 |
| Rough grazing | 9,413 | 6,925 | 3,230 | 6,390 | 1,931 | 1,024 | 1,850 | 12,413 | 7,887 | 10,886 | 10,057 | 72,005 |

## Table 21 Census area of grassland - 2021

Area (ha) of grassland and rough grazing in Scotland

| | H&I[1] | C&O[1] | Moray Firth | Abdn[1] | Angus | East Fife | Lothian | Central Low-lands | Tweed Valley | S. Uplands[1] | Solway | Scotland |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Grassland[2] | 227,735 | 86,160 | 74,329 | 133,272 | 49,427 | 25,259 | 29,391 | 267,976 | 78,681 | 138,728 | 185,942 | 1,296,900 |
| Rough grazing | 2,230,277 | 83,300 | 150,466 | 41,681 | 40,745 | 2,582 | 16,990 | 129,744 | 30,855 | 289,440 | 56,455 | 3,072,535 |

(1) H&I = Highlands & Islands, C&O = Caithness & Orkney, Abdn = Aberdeen, S. Uplands = Southern Uplands.
(2) These areas do not include the estimated 7,563 hectares of undersown grass as this is not recorded on the census (refer to Appendix 3).
Note: data taken from the 2021 June Agricultural Census[13].

## Table 22 Sampled area of fodder crops - 2021

Area (ha) of fodder crops grown in the sample

| Size[1] (ha) | H&I[2] | C&O[2] | Moray Firth | Abdn[2] | Angus | East Fife | Lothian | Central Lowlands | Tweed Valley | S. Uplands[2] | Solway | Scotland |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.1 - 4.9 | 22 | 32 | 15 | 22 | 1 | 22 | 0 | 5 | 6 | 6 | 4 | **136** |
| 5.0 - 9.9 | 36 | 25 | 40 | 87 | 27 | 7 | 12 | 44 | 24 | 33 | 55 | **390** |
| 10.0 - 14.9 | 27 | 27 | 59 | 47 | 26 | 25 | 0 | 50 | 66 | 25 | 100 | **452** |
| 15.0 - 19.9 | 37 | 19 | 41 | 81 | 15 | 28 | 24 | 49 | 38 | 49 | 51 | **433** |
| 20.0 + | 84 | 0 | 117 | 112 | 144 | 0 | 26 | 142 | 198 | 127 | 282 | **1,232** |
| **All sizes** | **206** | **103** | **272** | **349** | **213** | **83** | **62** | **291** | **333** | **239** | **492** | **2,643** |

(1) Size refers to the area of fodder crops grown on the holding.
(2) H&I = Highlands & Islands, C&O = Caithness & Orkney, Abdn = Aberdeen, S. Uplands = Southern Uplands.

## Table 23 Census area of fodder crops - 2021

Area (ha) of fodder crops grown in Scotland

| Size[1] (ha) | H&I[2] | C&O[2] | Moray Firth | Abdn[2] | Angus | East Fife | Lothian | Central Lowlands | Tweed Valley | S. Uplands[2] | Solway | Scotland[3] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.1 - 4.9 | 415 | 327 | 414 | 835 | 145 | 63 | 56 | 269 | 79 | 102 | 159 | **2,865** |
| 5.0 - 9.9 | 481 | 404 | 593 | 972 | 399 | 126 | 132 | 454 | 256 | 281 | 426 | **4,525** |
| 10.0 - 14.9 | 141 | 202 | 311 | 379 | 163 | 84 | 92 | 390 | 366 | 222 | 373 | **2,724** |
| 15.0 - 19.9 | 188 | 53 | 185 | 311 | 139 | 18 | 99 | 192 | 190 | 190 | 378 | **1,940** |
| 20.0 + | 326 | 54 | 567 | 402 | 314 | 103 | 198 | 472 | 511 | 434 | 1,302 | **4,682** |
| **All sizes** | **1,551** | **1,040** | **2,069** | **2,899** | **1,160** | **393** | **577** | **1,777** | **1,401** | **1,229** | **2,638** | **16,736** |

(1) Size refers to the area of fodder crops grown on the holding.
(2) H&I = Highlands & Islands, C&O = Caithness & Orkney, Abdn = Aberdeen, S. Uplands = Southern Uplands.
(3) These areas do not include the estimated 479 hectares of stubble turnips as this is not recorded on the census (refer to Appendix 3).
Note: Data taken from the 2021 June Agricultural Census[13].

## Table 24 Raising factors for grassland - 2021

| | H&I[1] | C&O[1] | Moray Firth | Abdn[1] | Angus | East Fife | Lothian | Central Low-lands | Tweed Valley | S. Uplands[1] | Solway |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Grassland | 24.19 | 12.44 | 23.02 | 20.86 | 25.60 | 24.68 | 15.89 | 21.59 | 9.98 | 12.74 | 18.49 |
| Rough Grazing | 80.08 | 29.51 | 47.94 | 50.68 | 102.63 | 56.88 | 240.58 | 16.49 | 31.45 | 30.52 | 19.87 |

(1) H&I = Highlands & Islands, C&O = Caithness & Orkney, Abdn = Aberdeen, S. Uplands = Southern Uplands.
Note: raising factors are calculated by comparing the sampled crop area to the census crop area. Please see Appendix 4 – survey methodology for a full explanation.

## Table 25 Raising factors for fodder crops- 2021

| | H&I[1] | C&O[1] | Moray Firth | Abdn[1] | Angus | East Fife | Lothian | Central Low-lands | Tweed Valley | S. Uplands[1] | Solway |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.1 - 4.9 | 18.98 | 10.12 | 27.35 | 37.46 | 137.67 | 2.81 | [z] | 49.41 | 13.14 | 18.59 | 37.58 |
| 5.0 - 9.9 | 13.28 | 16.42 | 14.77 | 11.13 | 14.88 | 18.35 | 11.11 | 10.24 | 10.47 | 8.51 | 7.80 |
| 10.0 - 14.9 | 5.21 | 7.58 | 5.28 | 8.13 | 6.21 | 3.33 | [z] | 7.73 | 5.54 | 9.01 | 3.74 |
| 15.0 - 19.9 | 5.10 | 2.77 | 4.50 | 3.82 | 9.14 | 0.62 | 4.11 | 3.88 | 5.01 | 3.89 | 7.38 |
| 20.0 + | 3.88 | [z] | 4.84 | 3.60 | 2.18 | [z] | 7.68 | 3.33 | 2.58 | 3.41 | 4.62 |

(1) H&I = Highlands & Islands, C&O = Caithness & Orkney, Abdn = Aberdeen, S. Uplands = Southern Uplands.
Note: some shorthand is used in this table: [z] = not applicable.
Note: raising factors are calculated by comparing the sampled crop area to the census crop area. Please see Appendix 4 – survey methodology for a full explanation.

## Table 26 First and second adjustment factors - 2021

| | H&I[1] | C&O[1] | Moray Firth | Abdn[1] | Angus | East Fife | Lothian | Central Low-lands | Tweed Valley | S. Uplands[1] | Solway | Adj 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Grass under 5 years | 0.61 | 0.81 | 1.05 | 0.85 | 0.95 | 0.79 | 0.92 | 0.65 | 0.84 | 0.61 | 0.96 | 1.00 |
| Grass over 5 years | 1.01 | 1.01 | 0.94 | 1.05 | 0.99 | 0.96 | 0.99 | 1.03 | 1.01 | 1.03 | 0.97 | 1.00 |
| Rough grazing | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Fodder rape | 0.89 | 1.27 | 1.12 | 2.09 | [z] | 1.64 | [z] | 0.57 | 0.98 | 0.96 | 0.45 | 1.03 |
| Fodder beet | [z] | [z] | 0.79 | 1.53 | 0.82 | 29.68 | 0.60 | 0.79 | 0.67 | 0.00 | 2.32 | 1.07 |
| Kale and cabbage | 0.60 | 0.15 | 3.90 | 1.75 | 0.72 | 10.90 | 1.03 | 1.56 | 1.10 | 1.13 | 0.67 | 1.00 |
| Maize | [z] | [z] | [z] | [z] | [z] | [z] | [z] | 0.51 | [z] | [z] | 1.27 | 1.11 |
| Turnip and swedes | 1.55 | 4.67 | 0.79 | 0.65 | 0.70 | 2.28 | 5.26 | 0.90 | 1.16 | 3.47 | [z] | 1.02 |
| Other Fodder | 1.31 | 1.58 | 1.37 | 1.73 | 1.56 | 0.63 | 1.66 | 1.57 | 0.98 | 0.70 | 0.84 | 1.00 |

(1) H&I = Highlands & Islands, C&O = Caithness & Orkney, Abdn = Aberdeen, S. Uplands = Southern Uplands.
Note: some shorthand is used in this table: [z] = not applicable.

## Response rates

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

### Table 27 Response rate - Grassland postal survey

| | 2021 | % total |
|---|---|---|
| Target sample (no. of forms sent out) | 1,298 | 100 |
| | | |
| **Total achieved (no. of returns)** | **438** | **34** |
| | | |
| Total number of non-returns | 860 | |
| **Total number of farms approached** | **1,298** | |

### Table 28 Response rate - Fodder

| | 2021 | % total |
|---|---|---|
| Target sample | 200 | 100 |
| | | |
| **Total achieved** | **182** | **91** |
| | | |
| Total number of refusals/non-contact | 99 | |
| **Total number of farms approached** | **281** | |

## Financial burden to farmers

In order to minimise the burden on farmers and to comply with the restrictions imposed by COVID - 19, the survey team used non-visit methods of collection such as email, post or telephone call.

The grassland survey was carried out by postal questionnaire, with a few follow-up telephone calls when required. The fodder survey was carried out by telephone and email.

All respondents to the grassland postal survey were asked how long it had taken for them to fill out the survey form. Out of 438 respondents, 408 provided this information (93 per cent). The median time taken to provide the information for the grassland survey was 10 minutes.

The time taken to provide the data requested was recorded for 181 respondents to the fodder survey (99 per cent). The median time taken to provide information for the fodder survey was 15 minutes.

The following formula was used to estimate the 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 £)[14].

The total financial burden, accounting for all farmers’ participation in the 2021 grassland survey was £1093 and for the fodder survey was £727. Therefore, the overall financial burden to growers for 2021 survey participation was £1820.

## 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.

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 data are reported in two formats. For each pesticide formulation (mixture of active substances in a product) the area treated and weight applied is reported (Tables 2 to 7). Areas and weights for individual active substances are not included in this report but are published in Excel format as supplementary tables. These 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. In addition, both weight 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 weight 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 famers 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) The census category '**grass under five years old**' includes the survey categories '**direct sown grass**' and '**grass one to four years old**'. For this survey, direct sown grass is grass that has been sown either in autumn 2020 or spring 2021 without a nurse crop. **Undersown grass** is grass that has been sown with a nurse crop, to aid establishment of the grass. As undersown grass is not included in the 'grass under five years old' census category, the area grown is estimated by multiplying the area encountered in the sample by the grassland raising factors. **Rough grazing** is uncultivated grazing land, such as mountain, hill or moor. Where '**grassland**' is stated in the text, this refers to all grass under five years and grass over five years. It does not include rough grazing.

18) **Stubble turnips** are not included in the fodder crop census category; the area grown is estimated by multiplying the area encountered in the sample by the fodder crop raising factors.

19) '**Other fodder**' consists of any crops other than arable silage, reported in the 'other stock crops for stock-feeding' category. In 2021 this includes fodder rape, kale, stubble turnips and fodder crop mixes.

20) Where quoted in the text, reasons for application are the grower's stated reasons for use of that particular pesticide on that crop and may not always seem appropriate.

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

22) Data from the 2013[4] and 2017[3] 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.

23) 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.

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

25) 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.

26) **Integrated pest management:** The sustainable use directive and the equivalent retained EU law[15] defines IPM as; "'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 2021 Agricultural Census [13] (Tables 21 & 23), two samples were drawn. The first sample was taken from holdings with grassland (Table 18), the second from holdings growing fodder crops (Table 19). For the purpose of sampling, the country was divided into 11 land–use regions (Figure 37). The sample was stratified by these regions and also according to holding size. The holding size groups were different for grassland and fodder crops (Tables 18 & 19) and were based on the total areas of crops grown on the holding. Holdings were chosen at random within each of these strata, with the numbers of holdings selected being proportional to the total area of crops grown. Sample sizes for each stratum were based on area rather than number of holdings, so that smaller holdings did not dominate the sample.

The survey period for pesticide applications to grassland was from August 2020 to August 2021. For fodder crops, the survey period covered pesticide applications during the 2021 growing season, including any post-harvest applications following the 2020 harvest through to the end of harvest in 2021. As well as recording treatments applied directly to the crop, land preparation treatments prior to sowing the crop were also collected.

For holdings in the fodder sample, an introductory letter was sent to farmers followed up by a telephone call. The majority of information was gathered during this telephone call, although some holdings required a subsequent telephone call or email. When necessary, data were also collected from consultant agronomists, contractors and seed merchants. In addition to information about fodder crops, pesticide use data were also collected for grassland crops grown on holdings selected in the fodder sample. In total, data were collected from 182 fodder holdings. These 182 holdings collectively grew 16 per cent of the census fodder area. Details of the distribution of the fodder sample can be found in Table 19.

Postal questionnaires were sent to holdings selected in the grassland sample. This postal survey supplemented the grassland data collected during the fodder survey. This combined dataset ensures that the proportionately large areas of grassland grown in Scotland are adequately represented in the survey. Of 1,298 questionnaires sent out there were 438 (34 per cent) useable responses (Table 27). Details of the distribution of the grassland sample can be found in Table 18. The grassland sample represented six per cent of the total grassland grown in Scotland and two per cent of the total rough grazing.

For both samples, the data collected included the area of grassland and/or fodder crops grown, selected agronomic information and a record of the area and weight of all pesticide applications. Holdings that were not able or not

willing to provide data were replaced with alternative holdings from the same region and size group where possible.

## 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 (Tables 24 & 25). These factors were calculated by comparing the sampled area to the areas recorded in the 2021 Agricultural Census within each region and size group. Grassland is raised only by region, size groups are not taken into account. An adjustment (Table 26) 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.

## Changes from previous years

There have been no changes in methods or presentation between 2021 and the previous report in 2017. However, as described in the 2017 report[3], the following change should be noted when making comparisons with the 2013 data:

In 2015 there was a change in the census definition of temporary and permanent grass on the Single Application Form (SAF). This change is explained in clause 4.8 of the 2017 Scottish agriculture census[17]. From 2015, temporary grass relates to whether it has been reseeded in the last five years, whereas previously it related to how long it had been used for grass. The new definition only includes land that is included in a holding's crop rotation. This means changes in grass one to four years and grass over five years between 2013 and subsequent surveys do not solely represent genuine changes in land use but include differences in the way crop data has been recorded. As sampled areas are raised to census areas this will also influence our estimates of pesticides used. Whilst it is not possible to quantify the impact of these changes, data users should be aware of them when making comparisons of total pesticide use over time. To aid interpretation, the trends section presents pesticide usage information in relation to crop area grown as well as overall estimates of use.

## Data quality assurance

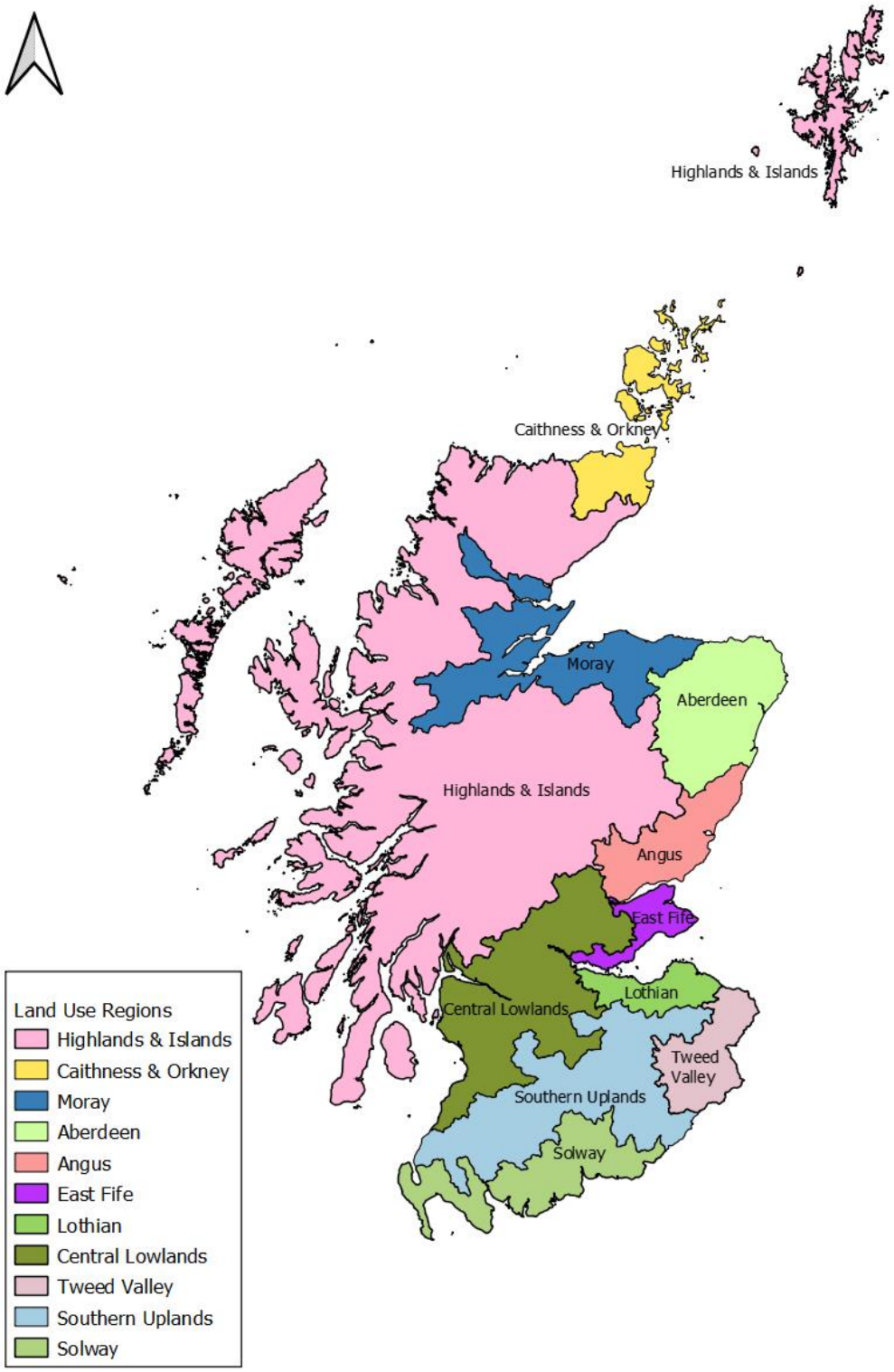
The dataset undergoes several validation processes as follows; (i) checking for any obvious errors upon data receipt (ii) checking and identifying inconsistencies with use and pesticide approval conditions once entered into the database (iii) 100 per cent checking of data held in the database against 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 be 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.

## Figure 40 Land use regions of Scotland[16]



## 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 31). Standard errors are produced using the raising factors. An overall variance was calculated by summing the variance estimates for individual strata (region and size groups) 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 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 29) 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 grassland crops (Table 29) was 11 per cent for both area and weight. The RSE for total pesticide use for fodder crops was eight per cent for area and 12 per cent for weight. Rough grazing estimates have a particularly high RSE (60 per cent for both area and weight) due to the very low pesticide use on this type of grassland. Total estimates of pesticide use for fodder and grassland have lower standard errors than those for their constituent crops as sample sizes are greater.

## Table 29 Relative standard errors

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

| | Area SE | Weight SE (%) |
|---|---|---|
| Grass over 5 years old | 12 | 12 |
| Grass under 5 years old | 13 | 14 |
| **All grass** | **11** | **11** |
| Rough grazing | 60 | 60 |
| | | |
| Fodder beet(1) | 16 | 20 |
| Fodder rape | 33 | 35 |
| Kale and cabbage(1) | 11 | 10 |
| Maize(1) | 13 | 23 |
| Turnips and swedes | 23 | 49 |
| Other stock-feeding crops(2) | 18 | 28 |
| **All fodder** | **8** | **12** |

(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) Other stock-feeding crops include arable silage as well as other fodder crops (fodder rape, kale, stubble turnips and fodder crop mixes) all recorded under ‘other stock-feeding crops’ in the June 2021 Agricultural Census

## Appendix 6 – Integrated pest management

It is a requirement of the retained EU law Directive 2009/128/EC of the European Parliament and of the Council[15] (equivalent to the EU Sustainable use of Pesticides Directive 2009/128/EC) 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."

Information about the uptake of IPM measures by Scottish growers was collected alongside the 2021 grass and fodder crop pesticide usage survey. IPM data have previously been collected and published for all crop groups in our cycle of pesticide usage surveys (vegetable crops 2015 & 2019, protected edible crops 2015 & 2019, arable crops 2020 & 2016, soft fruit crops 2020 & 2016 and fodder crops 2017). Our intention is to monitor IPM uptake in each crop sector every four years. This 2021 IPM survey represents the second in the series of surveys of IPM measures on fodder crops, allowing the adoption of IPM techniques to be monitored. These datasets will be used as an indicator of the success of Scottish Government funded IPM research, knowledge transfer and promotion activities.

It should be noted that in the main pesticide usage survey two samples are drawn, one based on holdings cultivating fodder crops (from which data are collected by personal interview) and another of holdings cultivating grass (from which data are collected by postal form, Appendix 4). These dual samples ensure that both fodder crops and Scotland's large grass area are adequately represented in the sample. The IPM data presented here were collected only from the fodder proportion of the sample. This reflects that this data collection is more suited to personal interview than postal return and it ensures methodological consistency with previous IPM surveys. The fodder holdings surveyed also cultivated grass and the survey covers the IPM measures implemented on all grass and fodder production on those farms.

Unlike the other statistics in this report, the figures reported in this section are not raised to produce national estimates but represent only the responses of those surveyed. The IPM sample, whilst smaller than that sampled for the pesticide usage survey, provides a good representation of Scottish regions and farm size groups.

Pearson chi-square tests were used to assess statistical evidence for changes, with permutation tests used when expected values were five or less. When comparing between 2017 and 2021, any evidence of a statistical change in the proportion of growers reporting under a category is indicated by a p-value. Any other notable differences that might indicate a direction of

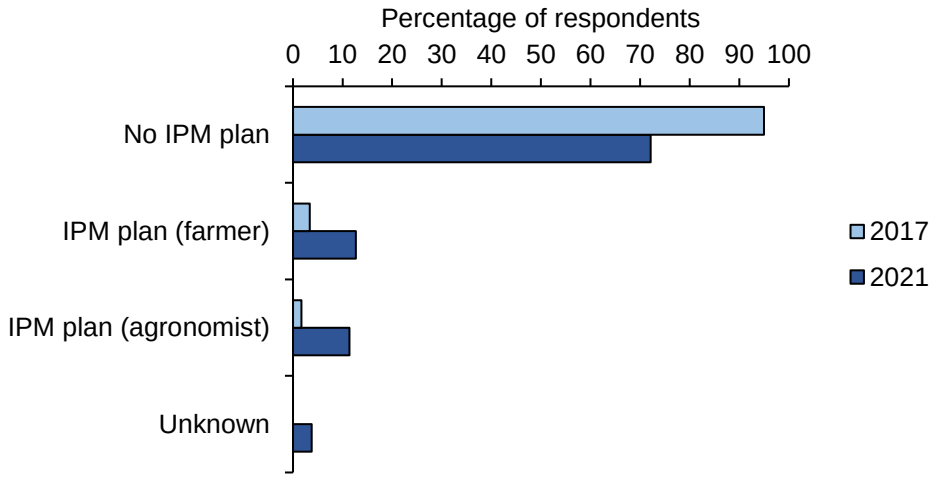
travel are also recorded in the text. If no comparison is made, then the responses recorded are similar between 2017 and 2021.

In total IPM data was collected from 158 growers representing 163 holdings and collectively growing 39,380 ha of crops (2,189 ha of fodder, 22,279 ha of grass and 14,912 ha of rough grazing); a 33 per cent increase in grower response rate from the previous survey in 2017. This sample represented thirteen per cent of Scotland's 2021 census fodder crop area (16,736 ha), 1.7 per cent of the grass area (1,296,900 ha) and 0.5 per cent of the rough grazing area (3,072,535 ha). Of these growers, 24 per cent had an IPM plan (13 per cent completed their own IPM plan and 11 per cent had a plan completed by their agronomist), 72 per cent did not have an IPM plan and four per cent were unsure whether a plan had been completed (Figure 38). There was very strong evidence that the proportion of growers completing an IPM plan increased, from five per cent in the 2017 survey, to 26 per cent in 2021, excluding those who were unsure whether a plan had been completed (p-value ≤ 0.001). Although more plans were completed in 2021 compared to 2017, there was no evidence of change in the proportion of plans completed by growers or agronomists (p-value > 0.05).

Using an IPM plan helps growers make the best possible, and most sustainable, use of all available methods for pest control.

Since the 2017 survey, the requirement to complete an IPM plan has been added to the most widely used UK farm assurance schemes; for example, farmers certified with Red Tractor are required to complete the NFU/VI IPM plan. Scottish farm businesses certified by Scottish Quality Crops (SQC Ltd) must complete an annual IPM plan, a biodiversity plan and a soil testing plan[18].

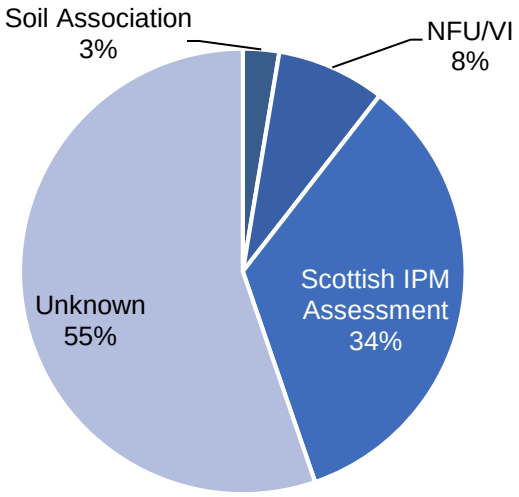
**Figure 41 IPM: Percentage of respondents with an IPM plan 2017-2021**




Note: there was very strong evidence for an increase in the proportion of growers completing an IPM plan (p-value ≤ 0.001). In 2021, four percent of growers sampled were unsure if a plan had been completed or not.

Of those growers who had an IPM plan in 2021, either completed by themselves or by their agronomist, 34 per cent used the Scottish IPM assessment plan, eight per cent used the NFU/VI plan, three per cent used the Soil Association plan and 55 per cent were unsure which plan was completed (Figure 42).

**Figure 42 IPM: Type of IPM plan 2017-2021**




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 each grower conducted in relation to these categories and the responses are reported in the following sections. The term 'pest' is used throughout to denote diseases, weeds and invertebrate pests.

## Risk management

IPM programmes aim to prevent or reduce the risk of pests becoming a threat by minimising the likelihood of damage occurring that will require subsequent control. Table 30 presents an overview of the risk management measures adopted by those growers surveyed and the statistical evidence for change between 2017 and 2021.

In 2021, all growers sampled reported that they implemented at least one IPM risk management activity compared with 97 per cent in 2017. There was strong, or very strong, evidence for an increase in the proportion of growers reporting the implementation of three risk management activities between 2017 and 2021.

There was very strong evidence for an increase in the proportion of growers reporting the use of catch and cover cropping (p-value ≤ 0.001), and strong evidence for an increase in the proportion of growers reporting the use of varietal or seed choice to reduce pest risk (p-value ≤ 0.01) and through protection or enhancement of beneficial organism populations (p-value ≤ 0.01) (Table 30).

### Table 30 IPM: Summary of responses to risk management questions 2017-2021

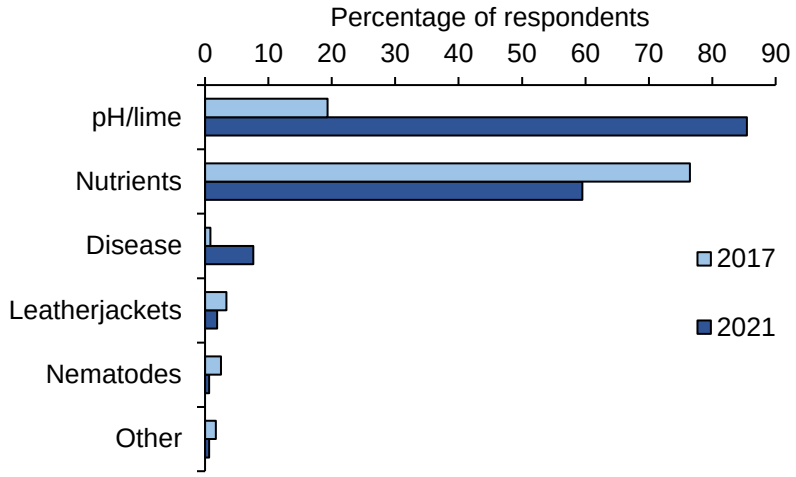
| Risk management activity | % positive response | | % change | p-value | Evidence |
|---|---|---|---|---|---|
| | 2021 | 2017 | | | |
| Crop rotation | 78 | 65 | 13 | ≤ 0.05 | Some |
| Soil testing | 87 | 84 | 3 | > 0.05 | None |
| Cultivation of seed bed to reduce pest risk | 89 | 82 | 7 | > 0.05 | None |
| Cultivation at sowing to reduce pest risk | 37 | 48 | -11 | > 0.05 | None |
| Varietal or seed choice to reduce pest risk | 69 | 51 | 18 | ≤ 0.01 | Strong |
| Catch and cover cropping | 27 | 9 | 17 | ≤ 0.001 | Very strong |
| Protection or enhancement of beneficial organism populations | 73 | 57 | 16 | ≤ 0.01 | Strong |
| Cleaning machinery between fields | 61 | [x] | [z] | [z] | [z] |
| **Any risk management activity** | **100** | **97** | **3** | **> 0.05** | **None** |

Note: in 2017 growers were not directly asked about cleaning machinery between fields. % change is absolute change. Some shorthand is used in this table: [x] = not available, [z] = not applicable.

There was some evidence for an increase in the proportion of growers implementing crop rotation to reduce risk of pest damage (78 per cent in 2021 and 65 per cent in 2017) (p-value ≤ 0.05). Rotation breaks the link between pathogen and host, reducing pest population build-up. It can also improve soil fertility and structure, and consequently crop vigour.

Overall, there was no evidence of change in the proportion of growers performing any soil testing. Most testing encountered in 2021 was for pH or lime (85 per cent in 2021 compared with 19 per cent in 2017) (Figure 43). This was the largest change observed from 2017, however, growers were not directly asked about testing pH in 2017, therefore these responses are underestimated in 2017. The proportion of growers testing for soil nutrients decreased from 76 per cent in 2017 to 59 per cent in 2021. Conducting a pH/lime test and testing for nutrients can inform growers' decisions on the inputs required and crop choice for that field to ensure crops are healthy and less susceptible to pest pressure. There was also an increase in the proportion of growers testing for soil-borne disease (eight per cent in 2021 compared with one per cent in 2017). Other soil tests used can be seen in Figure 43.

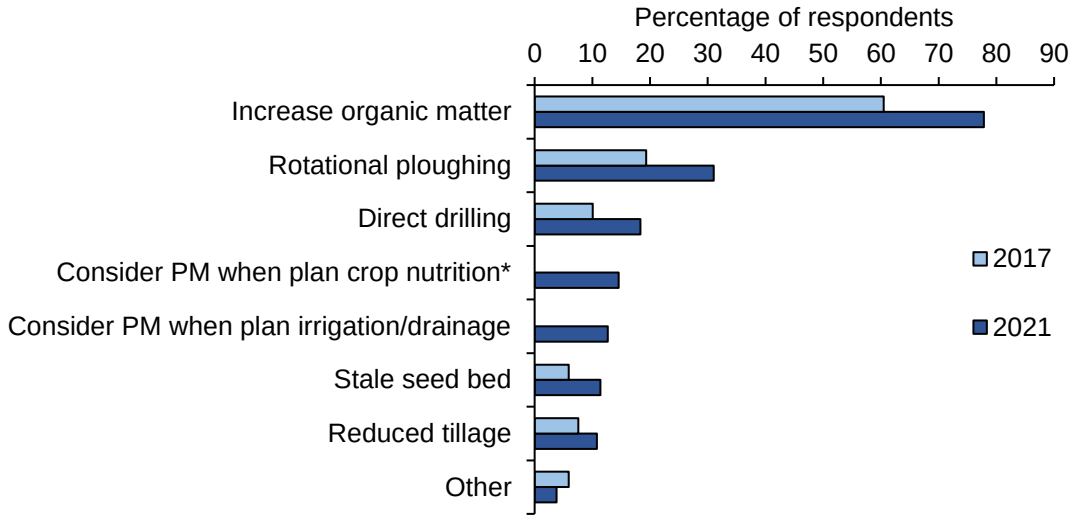
## Figure 43 IPM: Soil testing 2017-2021




Note: in 2017 growers were not directly asked about testing for pH or lime, therefore the 2017 data may be underestimated.
Other in 2021 included a carbon test.
Other in 2017 included testing for wheat bulb fly, worm testing and soil mapping.

There was no evidence of change in the proportion of growers using cultivation of the seed bed prior to sowing to reduce pest risk in 2021 (p-value > 0.05). There was an increase in the percentage of respondents responding positively to all questions on the cultivation of seed bed in 2021 from 2017 (see Figure 44 for a list of all activities growers were asked about). The largest change was reported for the number of growers increasing soil organic matter (78 per cent in 2021 compared with 61 per cent in 2017). Similarly, the number of growers who consider pest management when planning crop nutrition and planning irrigation/drainage increased (15 and 13 per cent respectively in 2021 compared to none in 2017, however growers were only asked if they consider pest management when planning irrigation/drainage in 2017 and not crop nutrition). Considering pest management when planning crop nutrition can also improve the seed bed and ensure that soil fertility and pH is optimised for the crop. The use of non-inversion techniques increased in 2021 with 18 per cent using direct drilling compared to 10 per cent in 2017. Non-inversion techniques can preserve soil moisture and organic matter and reduce compaction and erosion. There is also evidence that it is beneficial for populations of earth worms and predatory ground beetles. Thirty-one per cent employed rotational ploughing between periods of non-inversion cultivation (19 per cent in 2017); rotational ploughing can reduce the weed burden and is also used to incorporate organic matter. Other seed bed cultivation methods can be seen in Figure 44.

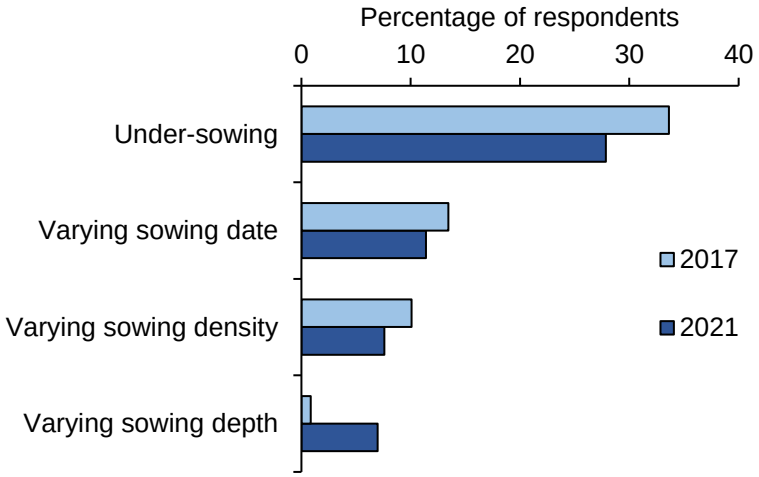
## Figure 44 IPM: Seed bed cultivations 2017-2021




Note: in 2021, other included using mechanical methods for leatherjacket (rolling) control.
In 2017, other included using mechanical methods for slug (harrowing and rolling) and leatherjacket (rolling) control and liming soil.
*In 2017, consider pest management (PM) when planning crop nutrition was not asked.

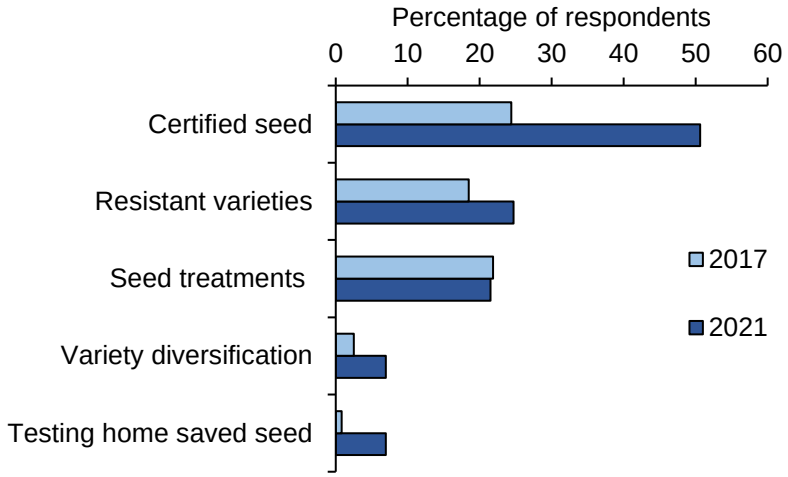
There was no evidence the proportion of growers using cultivations at sowing to reduce pest risk from 2017 (37 per cent in 2021 and 48 per cent in 2017) (p-value > 0.05). This was the only risk management activity that was reported lower than in 2017. Growers' ability to vary sowing date, which will also impact sowing density, is influenced by seasonal factors. The proportion of growers under-sowing crops decreased six per cent (28 per cent in 2021 compared with 34 per cent in 2017), while the number of growers who reported varying sowing depth increased six per cent (seven per cent in 2021 compared to one per cent in 2017) (Figure 45). Growers cited varying sowing depth to reduce seed loss to crows and geese.

## Figure 45 IPM: Cultivations at sowing 2017-2021



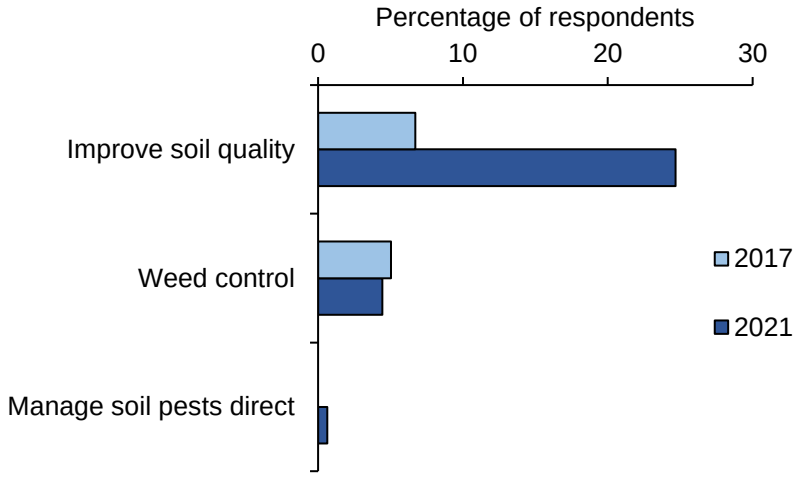
There was strong evidence the proportion of growers considering the varietal or seed choice to reduce pest risk increased from 2017 (69 per cent in 2021 compared with 51 per cent in 2017) (p-value ≤ 0.01). The largest change was reported for the number of growers choosing to use certified seed (51 per cent in 2021 compared with 24 per cent in 2017), and there was an increase in the number of growers testing home saved seed (seven per cent in 2021 compared with one per cent in 2017) (Figure 46). These actions ensure seed meets the required quality standards and is pathogen free. Although the same proportion of growers used seed treatments in 2021 as 2017 (22 per cent), the type of seed treatment applied was different. In 2017, all seed treatments were pesticides; in contrast, in 2021, 76 per cent of seed treatments used were pesticides, nine per cent were fertilisers (including nutrients and biostimulants) and for the remaining 15 per cent, growers were unsure what seed treatment was applied. Other variety and seed choice methods used can be seen in Figure 46.

**Figure 46 IPM: Variety and seed choice 2017-2021**




There was very strong evidence for an increase in the proportion of positive responses to using catch and cover crops (27 per cent in 2021 compared with nine per cent in 2017) (p-value ≤ 0.001). In 2021, 25 per cent of respondents reported that they used catch and cover crops to improve soil quality compared to seven per cent in 2017. Growers used a variety of catch and cover crops to improve soil quality, including mixes containing brassicas and cereals or nitrogen fixing crops including clover and peas. Catch and cover crops were often ploughed in as a green manure. Some cover crops were also reported to be used to control weeds or for managing soil pests directly (Figure 47).

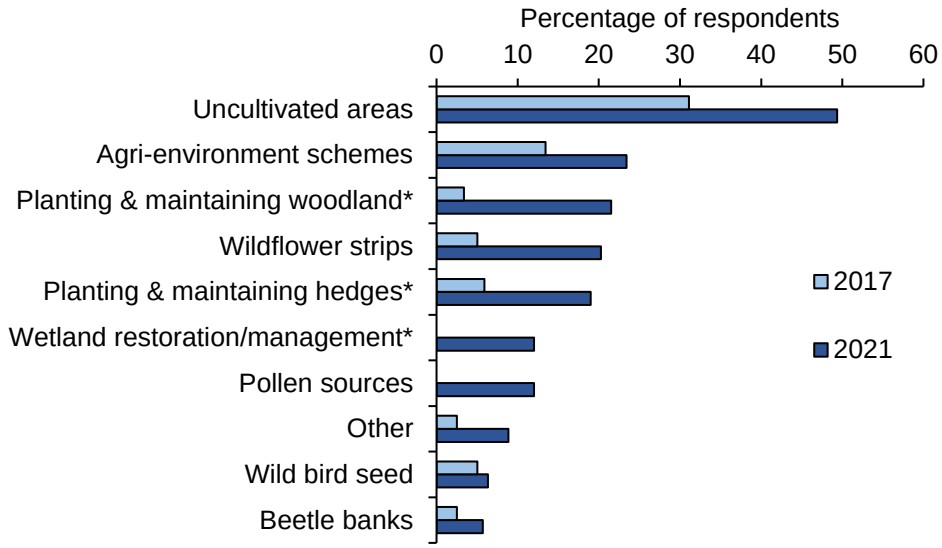
## Figure 47 IPM: Catch and cover cropping 2017-2021




There was strong evidence the proportion of growers protecting or enhancing beneficial organism populations to reduce pest risk increased from 2017 (73 per cent in 2021 compared with 57 per cent in 2017) (p-value ≤ 0.01). There was an increase in the percentage of growers responding positively to all questions on protecting or enhancing beneficial organism populations from 2017 (Figure 48). Almost half of all growers had uncultivated areas (49 per cent in 2021 compared to 31 per cent in 2017), while planting and maintaining woodland, hedges and wildflower strips each received positive responses from ca. 20 per cent of all growers, an increase of 18, 13 and 15 per cent respectively compared with 2017 (however, growers were not directly asked about planting and maintaining woodland or hedges in 2017). Wetland restoration received positive responses from 12 per cent of growers, including the creation of wader scrapes (i.e. shallow depressions constructed in fields to hold water for only part of the year, providing feeding sites for wading birds such as lapwing and redshank).

Around one in four respondents were part of an agri-environment scheme (23 per cent in 2021 compared to 13 per cent in 2017), with 16 per cent participating in the Scottish Government agri-environment climate scheme (AECS). Several other actions to support beneficial organism populations were also reported in 2021. These additional measures included growers having Ecological Focus Areas (EFA) (seven per cent), sowing wild bird seed and game bird mixes (six per cent). Other activities growers adopted to protect and enhance beneficial organism populations are shown in Figure 48.

## Figure 48 IPM: Protecting and enhancing beneficial organism populations 2017-2021




Note: in 2021, other included Ecological Focus Areas (EFA, seven per cent), keeps bees, retain winter stubbles, species rich grassland and wildlife corridor (all less than one per cent each). In 2017, other included conservation grazing, protecting ground nesting birds and maintenance of ponds.
*In 2017, growers were not specifically asked about planting & maintaining woodland, hedges or wetland restoration/management, therefore 2017 figures may be underestimated.

Finally, 61 per cent of respondents said they had good hygiene measures to reduce pest risk, with responses predominately being clean machinery between fields to reduce the risk of spreading pests, with some growers stating they do not use contractor machinery and only their own equipment.

### Pest monitoring

In IPM, pests are monitored both to determine whether control is economically justified and to effectively target control options. IPM programmes aim to monitor and identify pests, so that appropriate control decisions can be made in conjunction with action thresholds. Table 31 presents an overview of the pest monitoring measures adopted by those growers surveyed and the statistical evidence for change between 2017 and 2021.

In 2021, there was strong evidence for an increase in the proportion of growers conducting pest monitoring activity (p-value ≤ 0.01), with all respondents reporting they implemented at least one measure associated with an IPM pest monitoring approach.

There was strong evidence for an increase in the proportion of growers reporting setting action thresholds for crops (p-value ≤ 0.01) (Table 31), while there was no evidence of change for any other pest monitoring activity.

## Table 31 IPM: Summary of responses to pest monitoring questions 2017-2021

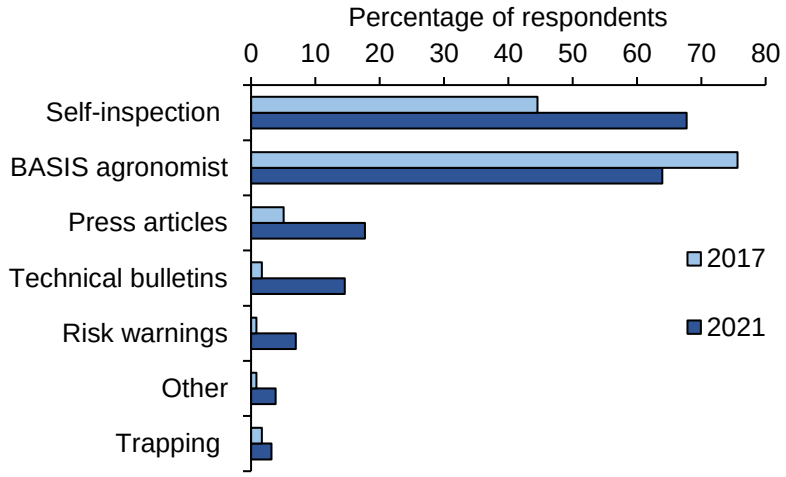
| Pest monitoring activity | % positive response | | % change | p-value | Evidence |
|---|---|---|---|---|---|
| | 2021 | 2017 | | | |
| Monitor and identify pests | 94 | 93 | 1 | > 0.05 | None |
| Regular monitoring of crop growth stage | 77 | 81 | -3 | > 0.05 | None |
| Setting action thresholds for crops | 34 | 18 | 16 | ≤ 0.01 | Strong |
| Use of specialist diagnostics | 22 | 17 | 5 | > 0.05 | None |
| **Any pest monitoring activity** | **100** | **94** | **6** | **≤ 0.01** | **Strong** |

Note: % change is absolute change.

Although there was no evidence of change in the overall proportion of growers monitoring and identifying pests (p-value > 0.05), there was an increase in the proportion of respondents self-inspecting crops (68 per cent in 2021 compared with 45 per cent in 2017) (Figure 49) and a decrease in growers using a BASIS qualified agronomist to monitor crops for pests (64 per cent in 2021 compared to 76 per cent in 2017).

In addition, the proportion of growers that used press articles and technical bulletins to monitor and identify pests increased (18 and 15 per cent in 2021 compared with five and two per cent in 2017), primarily Scottish Agricultural College (SAC) bulletins. This may have been influenced by growers opting to inspect crops themselves and using alternative sources of pest monitoring information in addition to or instead of an agronomist. Other monitoring and identifying pest activities can be seen in Figure 49.

## Figure 49 IPM: Monitoring and identifying pests 2017-2021




Note: in 2021, other included: information from other farmers and growers, social media and engage with experts.
In 2017, other included: attend SRUC advice scheme discussion group.

There was no evidence for change to the percentage of respondents regularly monitoring crop growth stage (77 per cent in 2021 compared with 81 per cent in 2017) (p-value > 0.05), nor for the use of specialist diagnostics (22 per cent in 2021 compared to 17 per cent in 2017) (p-value > 0.05).

However, there was strong evidence for an increase in positive responses for setting action thresholds for crops (34 per cent in 2021 compared to 18 per cent in 2017) (p-value ≤ 0.01). This is still lower than the uptake of setting action thresholds in other cropping systems, reflecting the lower pesticide input to grass and fodder crops. The threshold level at which pests become an economic threat (e.g. a certain density per plant or unit area at a pre-determined crop growth stage) is critical to guide pest control decisions.

### 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 32 presents an overview of the pest control measures adopted by the growers surveyed and the statistical evidence for change between 2017 and 2021.

In 2021, all growers sampled reported that they implemented at least one IPM pest control activity.

There was very strong evidence for a decrease in the proportion of growers following anti-resistance strategies (p-value ≤ 0.001), and strong evidence for a decrease in the proportion of growers reporting targeted pesticide application (p-value ≤ 0.01) (Table 32). The reason for the decrease in these activities is unclear, however, the wide scale loss of active substances discussed earlier in this report may have influenced growers' ability to implement anti-resistance strategies.

There was no evidence of a change in the portion of growers using non-chemical control in partnership or instead of chemical control or monitoring success of crop protection measures. Of the holdings sampled in 2021, eight per cent were organic, an increase from four per cent reported in 2017.

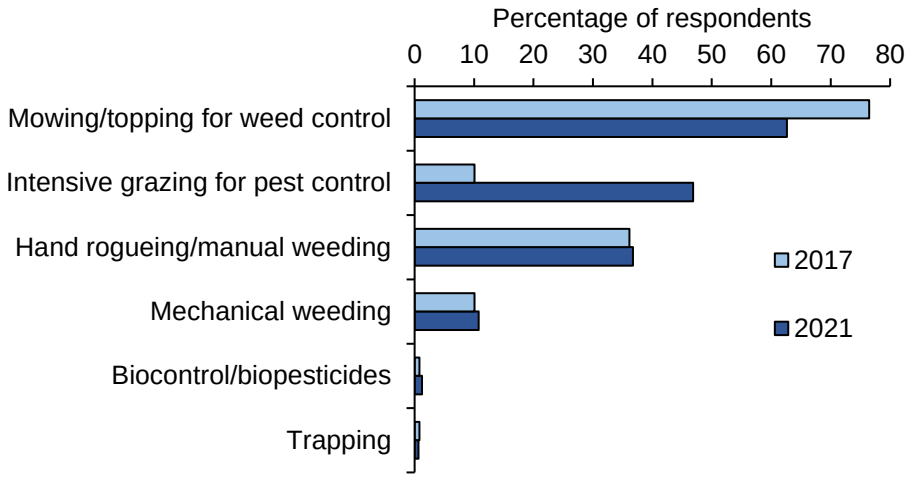
## Table 32 IPM: Summary of responses to pest control questions 2017-2021

| Pest control activity | % positive response | | % change | p-value | Evidence |
|---|---|---|---|---|---|
| | 2021 | 2017 | | | |
| Non-chemical control used in partnership or instead of chemical control | 85 | 87 | -2 | > 0.05 | None |
| Targeted pesticide application | 35 | 51 | -16 | ≤ 0.01 | Strong |
| Follow anti-resistance strategies | 16 | 39 | -22 | ≤ 0.001 | Very strong |
| Monitor success of crop protection measures | 84 | 82 | 2 | > 0.05 | None |
| Any pest control activity | 100 | 97 | 3 | > 0.05 | None |

Note: % change is absolute change.

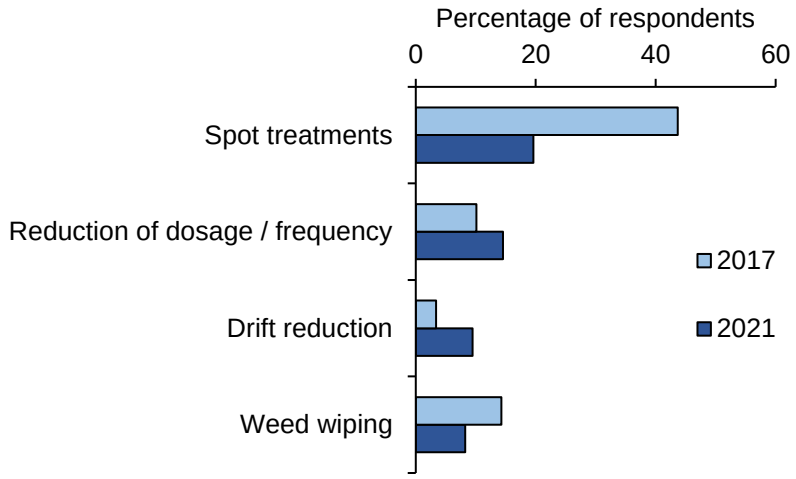
Although there was no evidence of change in the overall proportion of growers who reported they used non-chemical control in partnership or instead of chemical control (p-value > 0.05), there was an increase in the number of respondents using intensive grazing for pest control (47 per cent in 2021 compared with 10 per cent in 2017) (Figure 50), of which 92 per cent was for weed control, one per cent for disease control, and six per cent for both weed and disease control. The only other notable change reported was for a decrease in the percentage of respondents mowing/topping for weed control (63 per cent in 2021 compared with 76 per cent in 2017). Other non-chemical control methods used can be seen in Figure 50.

## Figure 50 IPM: Non-chemical control 2017-2021



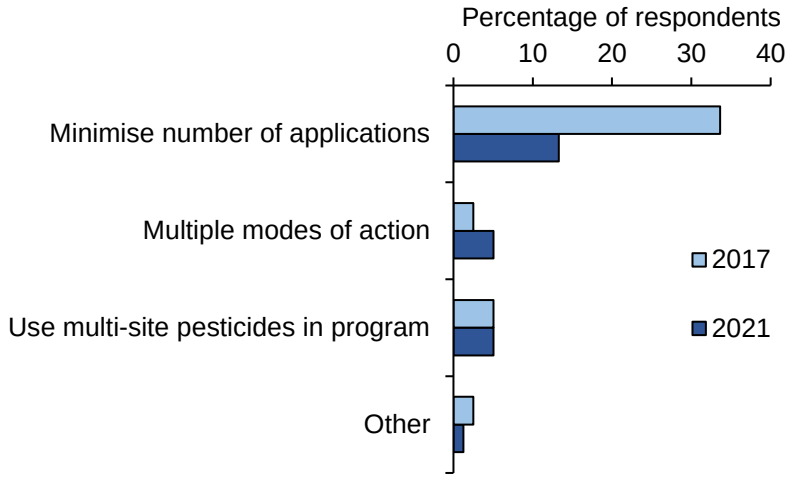
There was strong evidence the proportion of growers using targeted pesticide applications to control pests decreased from 2017 (35 per cent in 2021 compared with 51 per cent in 2017) (p-value ≤ 0.01). This was largely driven by a decrease in the number of growers who reported use of spot treatments and weed wiping (20 and eight per cent in 2021 compared with 44 and 14 per cent in 2017, respectively) (Figure 51). This was partially offset by an increase in percentage of growers reporting the use of drift reduction nozzles and reducing the dosage/frequency of applications (nine and 15 per cent in 2021 compared to three and 10 per cent in 2017, respectively).

**Figure 51 IPM: Targeted pesticide application 2017-2021**




There was very strong evidence for a decrease in the proportion of growers following anti-resistance strategies from 2017 (16 per cent in 2021 compared with 39 per cent in 2017) (p-value ≤ 0.001). This was driven by a decrease in the percentage of respondents who reported minimising number of applications (13 per cent in 2021 compared with 34 per cent in 2017). There was very little change in other anti-resistance strategies used (Figure 52).

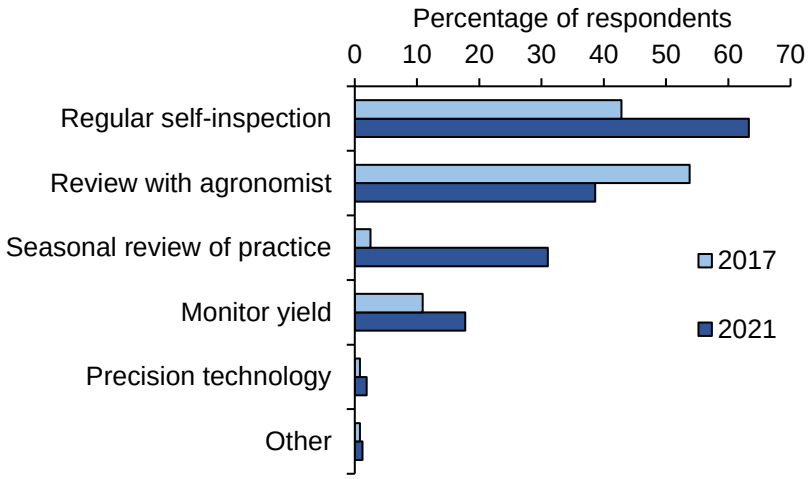
## Figure 52 IPM: Follow anti-resistance strategies 2017-2021




Note: in 2021, other included taking advice from agronomist.
In 2017, other included taking advice from agronomist and following advice from SRUC consulting.

An important aspect of IPM is monitoring the success of risk management and crop protection practices to continually improve regimes. Although there was no evidence of change in the proportion of growers who reported they monitored the success of crop protection measures (p-value > 0.05), there was an increase in the number of growers conducting a seasonal review of practices (31 per cent in 2021 compared with three per cent in 2017) (Figure 53). There was a decrease in the percentage of respondents conducting a review with their agronomist (39 per cent in 2021 compared with 54 per cent in 2017). The other notable change was the increase in the percentage of growers who reported they conducted regular self-inspections of their crops (63 per cent in 2021 compared with 43 per cent in 2017). Other methods used to monitor success of crop protection measures can be seen in Figure 53.

## Figure 53 IPM: Monitoring success of crop protection measures 2017-2021




Note: in 2021, other included use of GPS.
In 2017, other included monitoring crop input costs.

## Acknowledgements

The authors would like to thank all the farmers, agronomists, contractors and seed merchants who agreed to provide information for this survey. Thanks are also due to Jackie Hughes (SASA), Fiona Burnett (SRUC), Sarah Cook, Philip Walker and Duncan Coston (ADAS), Lucy Darnton (HSE) and Rosemary Anfield (SASA) for editorial assistance. In addition, the authors are grateful for support and advice from David Garthwaite, Elena Stroda and Lewis Ridley at Fera Science Ltd, Paul Gavin at the Scottish Government's Agricultural Census Analysis Team and Adrian Roberts of Biomathematics & Statistics Scotland.

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St Andrew's House
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ISBN: 978-1-80525-016-6 (web only)

Published by The Scottish Government, October 2022

Produced for The Scottish Government by APS Group Scotland, 21 Tennant Street, Edinburgh EH6 5NA
PPDAS1166322 (10/22)