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Pesticide Usage in Scotland

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A National Statistics Publication for Scotland

Rodenticides on Grassland & Fodder Farms 2017

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Contents

Executive summary	1
Introduction	2
Structure of report and how to use these statistics	3
Rodenticide use data	4
Percentage of farms using rodenticides and type of user	4
Rodenticides encountered and their estimated occurrence	5
Weight of rodenticides used	7
Seasonal use of rodenticides	9
Rodenticide bait type and target	10
Supplementary data	12
Non-chemical rodent control	12
Compliance with rodenticide best practice	13
Farm operation data	14
Rodenticide approval and stewardship	14
Appendix 1 - Estimated rodenticide use and supplementary data tables	16
Appendix 2 - Survey statistics	20
Census and sample information	20
Raising factors	22
Survey response rates	24
Financial burden to survey respondents	25
Appendix 3 - Definitions and notes	26
Appendix 4 - Survey methodology	28
Sampling and data collection	28
Estimation of national rodenticide use	30
Changes from previous years	30
Statistical analyses	30
Data quality assurance	31
Main sources of bias	31
Acknowledgements	32
References	32

List of figures and tables

Figure 1	Percentage of grassland and fodder farms using rodenticides and type of user - 2017.....	4
Figure 2	Percentage of grassland and fodder farms using rodenticides and type of user - 2013 & 2017	5
Figure 3	Percentage occurrence of rodenticide active substances on grassland and fodder farms - 2017.....	6
Figure 4	Percentage occurrence of rodenticides on grassland and fodder farms - 2013 & 2017	7
Figure 5	Percentage weight of rodenticide product used on grassland and fodder farms - 2017	8
Figure 6	Weight of rodenticide product used on grassland and fodder farms - 2013 & 2017	8
Figure 7	Seasonal use of rodenticides on grass and fodder farms - 2017	10
Figure 8	Type of rodenticide bait used on grass and fodder farms - 2017	11
Figure 9	Target of rodenticide use on grass and fodder farms - 2017	11
Figure 10	Non-chemical control on grassland and fodder farms - 2017 ...	12
Figure 11	Land use regions of Scotland	29
Table 1	Occurrence of rodenticide use on grassland and fodder farms - 2017	16
Table 2	Weight of rodenticides used on grassland and fodder farms - 2017	17
Table 3	Farmer and PCP response to training and compliance questions - 2017	18
Table 4	Farmer response to farm operation questions - 2017.....	19
Table 5	Farmer response to rodenticide stewardship questions - 2017	19
Table 6	Distribution of grassland holdings sampled - 2017	20
Table 7	Census distribution of grassland holdings - 2017	20
Table 8	Distribution of fodder holdings sampled - 2017	21
Table 9	Census distribution of fodder holdings - 2017	21
Table 10	Raising and adjustment factors for grassland holdings - 2017 .	22
Table 11	Raising and adjustment factors for fodder holdings - 2017.....	23
Table 12	Response rate for grassland survey - 2017	24
Table 13	Response rate for fodder survey - 2017	24

Executive summary

This report presents the results of a survey of rodenticide use on Scottish farms growing grass and fodder crops in 2017. Information was collected from 635 holdings, which collectively grew 12 and four per cent of the 2017 fodder and grass crops respectively. Data from this sample were used to estimate total Scottish rodenticide use in this crop sector.

It was estimated that rodenticides were used on 35 per cent of all grass and fodder farms in 2017, significantly fewer than the 43 per cent reported in 2013. On those farms where rodenticides were used, farmers were responsible for baiting on the majority (73 per cent), with the remainder conducted by Pest Control Professionals (PCPs). However, in terms of weight, farmers and PCPs each applied around 50 per cent of the total rodenticides used.

In 2017 an estimated 130 tonnes of rodenticide products were used on grassland and fodder farms. This is a decrease of 40 per cent since 2013. There was a similar decrease (30 per cent) in rodenticide use on arable farms between 2012 and 2016. The products used in 2017 contained less than 7 kg of rodenticide active substance. As in previous surveys, almost all products used (> 99 per cent) were second generation anticoagulant rodenticides, primarily bromadiolone and difenacoum (96 per cent by weight).

The majority of rodenticides (54 per cent) were applied throughout the year, either used permanently or as multiple individual baiting operations. This is a reduction in year round use from 2013 (75 per cent). Most rodenticides were used in autumn and winter (69 per cent). Grain baits were the most common product type (88 per cent) and the main targets were rats (57 per cent) or a combination of rats and mice (39 per cent). Fifty six per cent of farms that did not use rodenticides, and 45 per cent of those that did, employed non-chemical rodent control; the most common methods were cats and traps.

Respondents were asked about rodenticide stewardship, training attainment, compliance with best practice and aspects of their farm operation. Sixty one per cent of farmers were aware of rodenticide stewardship, of these seven per cent had completed stewardship compliant rodenticide use training and 32 per cent planned to in future. As in previous surveys, significantly more PCPs had completed training than farmers. In relation to best practice, the majority of both farmers and PCPs stated that they complied with all elements, and responses were very similar to those reported in 2013. Whilst a higher proportion of PCPs reported compliance, the only significant difference was that farmers were less likely to search for and remove rodent carcasses. In relation to farm operation, farmers that practised rodenticide baiting were significantly more likely to be members of a quality assurance scheme and to have a grain store than farmers that did not use rodenticides.

This survey is the first in this series to be conducted since the industry led stewardship scheme was introduced in 2015 and HSE rodenticide product reauthorisations were re-issued in 2016 and 2017. Changes in reported use pattern may have been influenced by stewardship and regulatory changes.

Introduction

The Scottish Government (SG) conducts post-approval surveillance of rodenticide use. This monitoring is conducted by the Pesticide Survey Unit at Science and Advice for Scottish Agriculture (SASA), a division of the Scottish Government's Agriculture and Rural Economy Directorate (ARE). The current rodenticide surveillance programme consists of surveys of rodenticide use on arable farms (biennial), grass and fodder farms (every four years) and use by Scottish local authorities (every four years).

As part of this programme, a survey of rodenticide use on farms growing grassland and fodder crops was carried out in 2017. This is the 6th survey in this series. The previous surveys were conducted in 1993, 1997, 2002, 2005 and 2013. The first four surveys (1993 to 2005) focussed on rodenticide use on farms growing fodder crops (ca 2,000 holdings in Scotland). The 2013 and 2017 surveys were extended to include data from a supplementary sample of grassland farms to allow estimation of rodenticide use on all Scottish farms growing grass and stock feeding crops (ca. 42,000 holdings). Due to this change in data collection methodology, and to the large gap in the time series between the 2005 and 2017 surveys, comparison data in this report are only presented for the 2013 and 2017 datasets. Future surveys in this series will revert to the standard format of comparing results with the two previous surveys.

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

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

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

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

Structure of report and how to use these statistics

This report is intended to provide data in a useful format to a wide variety of data users. The results and comparison section presents the results from this survey in comparison with results from the previous grassland and fodder farm rodenticide survey in 2013 (to allow comparison between years) and, to a lesser extent, the arable farm rodenticide survey in 2016 (to allow comparison between crop sectors).

Appendix 1 contains data, including estimates of rodenticide use, responses to questions about compliance with best practice and rodenticide stewardship and operational information about sample farms. Appendix 2 summarises survey statistics including census and holding information, raising factors, survey response rates and outlines the estimated financial burden to survey respondents. Appendix 3 defines 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. Changes in method or data collection from the previous survey years are also outlined in Appendix 4.

It is important to note that the figures presented in this report are produced by surveying a sample of holdings rather than a census of all the holdings in Scotland. Therefore the figures are estimates of total rodenticide use on Scottish grass and fodder farms and should not be interpreted as exact.

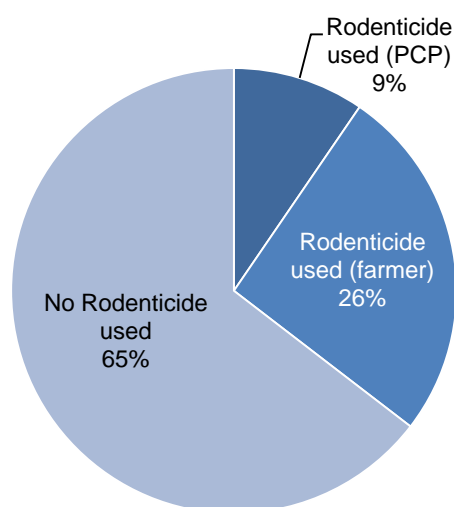
Rodenticide use data

Rodenticide use data were collected from 635 grassland and fodder holdings (472 and 163 respectively) in Scotland in 2017. The growers surveyed represented six per cent of the holdings growing fodder crops and one per cent of those with grassland. These holdings collectively grew 12 and four per cent of the 2017 Scottish fodder and grass crop area respectively. Rodenticide use data from these sampled farms were used to estimate rodenticide use on all Scottish grassland and fodder farms in 2017.

Percentage of farms using rodenticides and type of user

It was estimated that on almost two thirds of Scottish grass and fodder farms (65 per cent) no rodenticides were used in 2017 (Figure 1). On those farms where rodenticides were applied (35 per cent of farms) almost three quarters of baiting operations (73 per cent) were implemented by farmers. Pest Control Professionals (PCPs) conducted baiting on the remainder of these farms. However, it should be noted that, despite the fact that on the majority of farms baiting was conducted by farmers; farmers and PCPs used very similar amounts of rodenticides overall (refer to page 9).

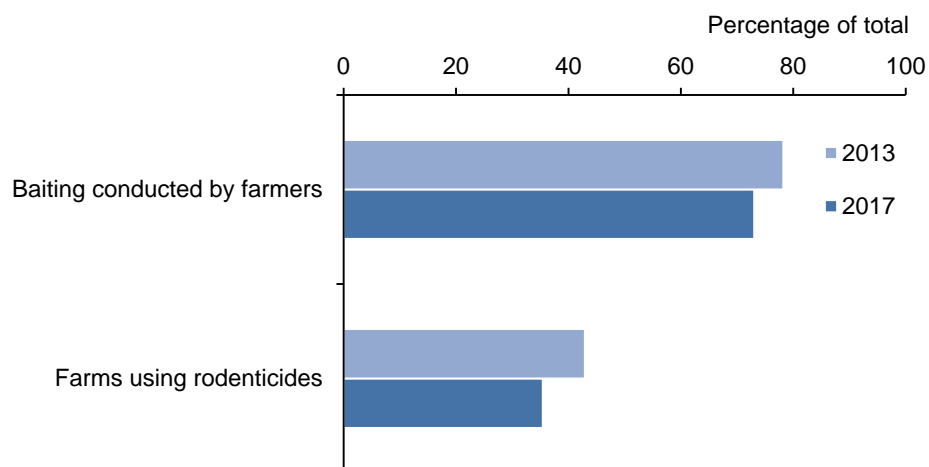
Figure 1 Percentage of grassland and fodder farms using rodenticides and type of user – 2017



Note: in the previous report (2013) farmer and PCP use was based on sample data rather than an estimation of the pattern in the total population (refer to Appendix 4). In the text below the 2013 data has been re-analysed to allow direct comparison between the surveys.

The pattern of rodenticide use, and primary user, encountered in this survey is similar to that reported in the previous survey in this series⁽¹⁾ (Figure 2). However, in 2013 the proportion of grass and fodder farms using rodenticides (43 per cent) was significantly greater ($P < 0.001$) than in 2017. In 2013, on farms where rodenticides were used, 78 per cent of use was by farmers and 22 per cent by PCPs (no significant difference between the 2013 and 2017 surveys, $P = 0.32$).

Figure 2 Percentage of grassland and fodder farms using rodenticides and type of user – 2013 & 2017



Note: The reduction in farms using rodenticides is statistically significant ($P < 0.001$)

This is in contrast to the pattern reported on arable farms where rodenticide use, and use of PCPs, is more prevalent. In the 2016 arable farms survey⁽²⁾, 78 per cent of arable farms used rodenticides and 40 per cent of farm baiting was conducted by PCPs.

Rodenticides encountered and their estimated occurrence

During this survey, product information was recorded for 89 per cent of all occurrences of rodenticide use. For the remaining 11 per cent, whilst it was recorded that rodenticides had been applied, the product used was not specified. This was either a result of farmers not having adequate records of the exact product used or PCPs not responding to requests for product details. The level of unspecified rodenticides in 2017 was similar to that encountered in the previous survey (8 per cent). The following sections only discuss the use of specified rodenticides.

Rodenticide occurrence is the number of holdings on which a formulation (the combination of active substances formulated together in a product) is encountered. Multiple uses of the same formulation at the same holding are counted as a single occurrence (refer to Appendix 3 for further explanation of these definitions).

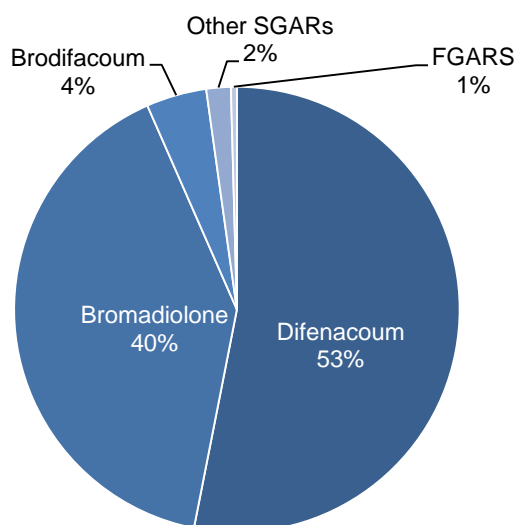
Seven active substances were recorded on grass and fodder farms in 2017; brodifacoum, bromadiolone, coumatetralyl, difenacoum, difethialone, flocoumafen and warfarin (Table 1, Figure 3). All of the rodenticides encountered were anticoagulants, which prevent the synthesis of blood clotting factors and cause rodent death by haemorrhage. The active substances encountered represent all anticoagulant rodenticides currently approved in the UK.

Five of these compounds are second generation anticoagulant rodenticides (SGARs; brodifacoum, bromadiolone, difenacoum, difethialone and flocoumafen) and two are first generation anticoagulant rodenticides (FGARs; coumatetralyl and warfarin). As in the previous survey, the SGAR compounds were the most widely used, accounting for more than 99 per cent of total occurrences of rodenticide use.

The most commonly used active substances were difenacoum and bromadiolone (53 and 40 per cent of all occurrences respectively). More limited use of brodifacoum (4 per cent of occurrences), difethialone (one per cent), flocoumafen (one per cent), coumatetralyl and warfarin (both less than one per cent) was also recorded.

The dominance of difenacoum and bromadiolone occurrence reflects their being the most commonly available rodenticides. At the time of writing, difenacoum and bromadiolone containing products account for 74 per cent of all anticoagulant rodenticide approvals, 73 per cent of those approved for outdoor use around buildings and 97 per cent of those approved for use in open areas⁽³⁾.

Figure 3 Percentage occurrence of rodenticide active substances on grassland and fodder farms – 2017

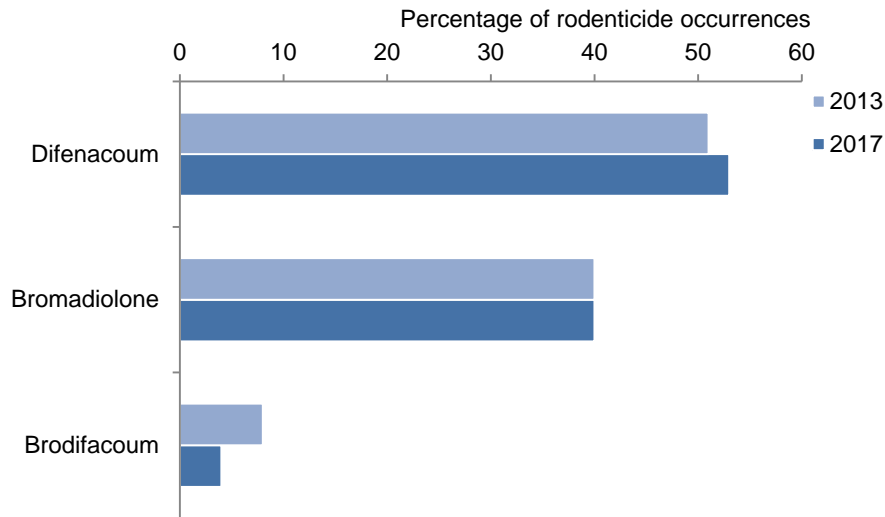


Note: Other SGARs are difethialone and flocoumafen. FGARS are coumatetralyl and warfarin

The occurrence of the three main rodenticides recorded in the 2013 and 2017 surveys (bromadiolone, brodifacoum and difenacoum) shows little difference in use pattern over time, although brodifacoum use decreases from 8 to 4 per cent of total occurrences (Figure 4). These three compounds collectively accounted for 99 and 98 per cent of total occurrences of use in 2013 and 2017 respectively. No non-anticoagulant rodenticides were reported to have been used in the 2017 survey. In 2013 a small amount of aluminium

phosphide was reported to have been used for rodent control (less than one per cent of total rodenticide occurrences).

Figure 4 Percentage occurrence of rodenticides on grassland and fodder farms – 2013 & 2017

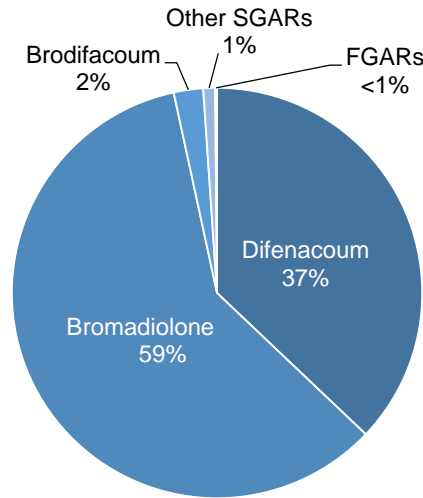


Weight of rodenticides used

Approximately 130 tonnes of rodenticidal products are estimated to have been used on Scottish grass and fodder farms in 2017 (Table 2, Figure 5).

In line with the occurrence data, more than 99 per cent of the total weight used was of SGAR products. Products containing bromadiolone were the most commonly used (ca. 77 tonnes), accounting for 59 per cent of total rodenticide use by weight. Difenacoum products were the second most commonly used (ca. 48 tonnes) accounting for 37 per cent of total use. Brodifacoum was the only other rodenticide regularly encountered (ca. 3 tonnes), accounting for two per cent of total use. Individual formulation weights, the weight of active substances present in the product not including baits, are also presented in Table 2. Anticoagulant rodenticide products contain very small amounts of active substance. The ca. 130 tonnes of rodenticide product used on grass and fodder farms in 2017 contained only ca. 6.5 kg of active substance, the remainder of the product weight is almost exclusively food bait used to attract rodents.

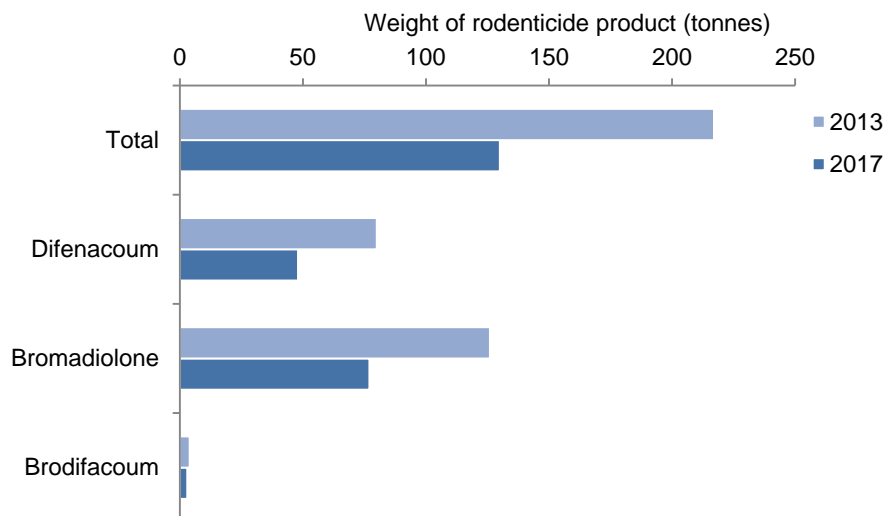
Figure 5 Percentage weight of rodenticide product used on grassland and fodder farms – 2017



Note: Other SGARs are difethialone and flocoumafen. FGARs are coumatetralyl and warfarin

The estimated weights of the three main rodenticides recorded in the 2013 and 2017 grassland and fodder crop surveys are presented in Figure 6. There has been a large decrease in overall weight of rodenticide products applied between these two surveys. Rodenticidal product use in 2017 (ca. 130 tonnes) was 40 per cent lower than in 2013 (ca. 217 tonnes). This decline in overall rodenticide use on grassland and fodder farms is similar to that recorded in recent arable farm surveys. The weight of rodenticide products used on Scottish arable farms in 2016 was 19 per cent lower than in 2014 and 30 per cent lower than 2012.

Figure 6 Weight of rodenticide product used on grassland and fodder farms - 2013 & 2017



Although farmers were responsible for baiting on the majority of farms where rodenticides were used (73 per cent) in 2017, very similar amounts were applied by PCPs (ca. 65.4 tonnes) and farmers (ca. 64.4 tonnes) overall. This pattern in weight applied is different to that encountered in 2013, in which farmers baited on 60 per cent of those farms using rodenticides and applied 69 per cent of the total rodenticides used by weight (unpublished data). Therefore, the decrease in estimated rodenticide use in this survey stems largely from a decrease in use by farmers (57 per cent reduction in weight) whilst use by PCPs remains relatively unchanged over time (3 per cent reduction).

At active substance level, similar declines were recorded for both difenacoum and bromadiolone use (40 and 39 per cent respectively) in 2017. Applications of products containing brodifacoum also decreased, but the decrease (18 per cent) was less marked (Figure 6).

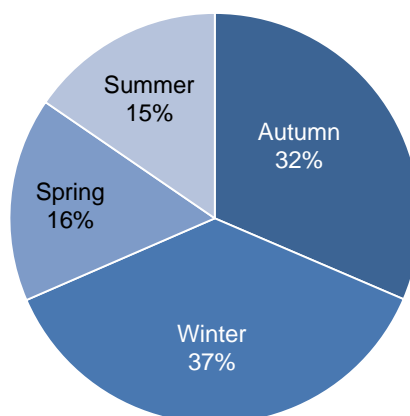
The reasons for these declines are unclear, and it should be noted that rodent populations, and thus rodenticide use, fluctuate over time. However, these declines, which have been detected in both arable and grass and fodder crop systems, may have been influenced by the Campaign for Responsible Rodenticide Usage (CRRU) guidance for best practice⁽⁴⁾ and the 2015 launch of the UK industry led rodenticide stewardship scheme⁽⁵⁾.

Seasonal use of rodenticides

The season in which rodenticides were used was specified for 99 per cent of all rodenticides encountered. Fifty four per cent of use was reported to occur throughout the year. This included farms practising permanent baiting and those conducting multiple separate baiting operations. This is a reduction from the level of year round baiting encountered in the 2013 survey, in which 75 per cent of rodenticides were reported to be used in year round baiting regimes. This pattern of reduction in year round baiting has also been encountered on arable farms; reducing from 65 per cent by weight in 2012 to 51 and 46 per cent in 2014 and 2016 respectively. It is possible that this may have been influenced by the CRRU code of rodenticide best practice, which discourages permanent baiting⁽⁴⁾.

When the weight used, including year-round use, is separated into constituent seasons, the greatest use was in winter (37 per cent) and autumn (32 per cent), with lower use during spring and summer (Figure 7). This is a very similar seasonal pattern to that encountered in previous surveys of rodenticide use in both grassland and arable systems.

Figure 7 Seasonal use of rodenticides on grass and fodder farms (percentage of total weight) - 2017



Rodenticide bait type and target

Baits formulated with grain were the most commonly encountered in this survey, accounting for 88 per cent of use by weight (Figure 8). These baits were primarily loose grain and place packs containing grain, but also included a small amount of pelletized/block grain (one per cent of total grain baits) and grain based paste (less than one per cent).

The other types of rodenticide products encountered included wax based baits, which accounted for 10 per cent of use. Ninety six per cent of wax baits were solid wax blocks and four per cent were soft wax. Pasta based bait contributed two per cent of total use and other paste rodenticides (for which the type of bait wasn't specified) accounted for less than one per cent.

Grain baits also accounted for the majority of rodenticides used in the previous grass and fodder farm survey in 2013 (80 per cent) and in the 2016 arable farm survey (86 per cent).

Survey respondents were asked to state the target of their rodenticide baiting regimes (Figure 9) and this information was supplied for 99 per cent of estimated use by weight. Where reason data were supplied the most common target was rats (57 per cent) followed by a combination of rats and mice (37 per cent). Six per cent of rodenticide use was targeted at mice alone. Rodenticide target data were not collected in the 2013 grass and fodder farm survey. However, the target data reported here are very similar to that recorded in the 2016 arable farm survey (rats 58 per cent, rats and mice 39 per cent and mice 3 per cent).

Figure 8 Type of rodenticide bait used on grass and fodder farms (percentage of total weight) - 2017

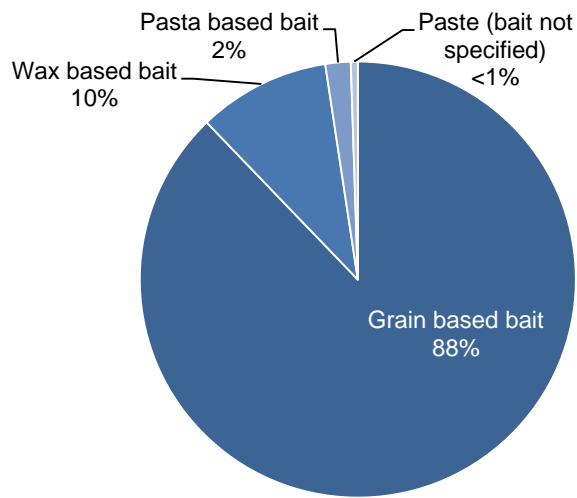
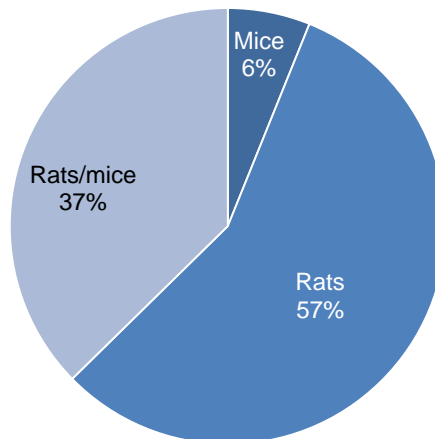


Figure 9 Target of rodenticide use on grass and fodder farms (percentage of total weight) - 2017



Supplementary data

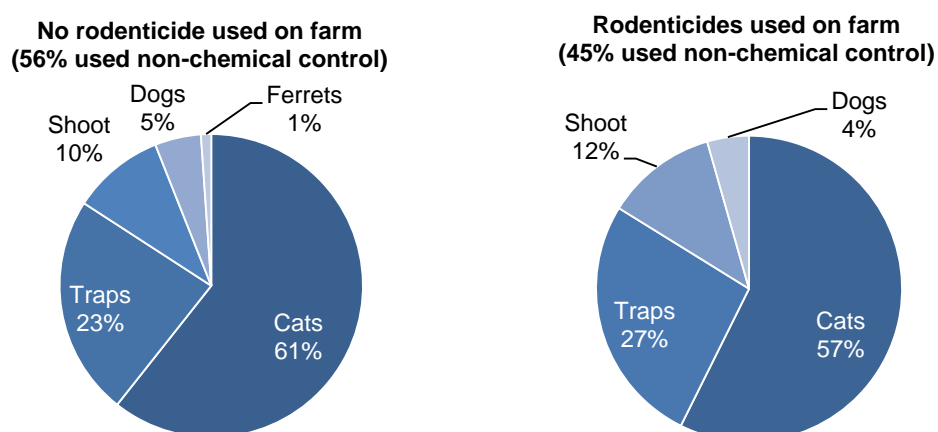
In addition to the collection of rodenticide usage data, farmers were also asked a series of supplementary questions relating to aspects of their farm operation, their use of non-chemical rodent control, rodenticide stewardship and their compliance with best practice in rodenticide use.

In contrast to the rodenticide usage data presented in the previous sections of this report, this information is not raised to provide national estimates of use, but is presented as responses from the sample surveyed.

Non-chemical rodent control

For the first time in this survey series, data were collected about non-chemical methods of rodent control employed on grass and fodder farms. Farmers used a range of non-chemical rodent control measures, with some farmers employing more than one method (Figure 10).

Figure 10 Non-chemical control on grassland and fodder farms (percentage of total methods used) – 2017



On holdings on which rodenticides were not used ($n=252$), 56 per cent of the farmers reported using one or more non-chemical control approaches. The most commonly encountered methods were use of cats and traps (61 and 23 per cent of all methods reported respectively). Shooting, dogs and ferrets were also used to control rodents. In addition, two per cent of farmers who didn't use rodenticides ($n=5$) reported that rodent populations were controlled by natural predators (wild cats, stoats, weasels and owls were cited).

On holdings using rodenticides ($n=383$), 45 per cent reported that they used additional non-chemical methods of rodent control. Again, the most common methods used were cats and traps (57 and 26 per cent of all methods reported respectively) with lower use of shooting and dogs.

Non-chemical control data were not collected in the 2013 grass and fodder farm survey as this data point was added to the rodenticide survey series in 2014. In the arable farm surveys there was a greater difference in non-chemical control uptake between farms using and not using chemical

rodenticides. In 2016, 61 per cent of arable farmers who didn't use rodenticides used non-chemical methods, compared to 26 per cent of farmers who did use rodenticides. The control methods reported in this survey were very similar to those reported in the 2016 arable surveys, with cats and traps being the most commonly used approach.

Compliance with rodenticide best practice

All farmers and PCPs who were responsible for rodenticide baiting on the surveyed farms were asked about their training history and their compliance with the principles of best practice of rodenticide use⁽⁴⁾ (Table 3).

These data are expressed as percentage of respondents giving a positive answer to each question. Not all of those surveyed provided this data, responses were provided by 208 farmers, representing 97 per cent of those farmers who conducted their own rodenticide baiting. Where statistically significant differences in the response between farmers and PCPs were found these are noted.

All PCPs and 12 per cent of farmers had attended a training course on rodenticide use. The uptake of training was significantly different between farmers and PCPs ($P < 0.001$).

All PCPs and 90 per cent of farmers stated that they recorded the quantity and location of baits, and all PCPs and farmers stated that these baits were protected from non-target animals. Bait was reported to be regularly inspected by all PCPs and 99 per cent of farmers.

Sixty eight per cent of PCPs and 57 per cent of farmers removed bait after targeted baiting periods.

Ninety six per cent of PCPs and 63 per cent of farmers stated that they searched for and removed rodent carcasses. Compliance with this element of best practice was significantly different between farmers and PCPs ($P < 0.001$). Most respondents stated that they rarely saw carcasses. However, those farmers who did encounter carcasses employed a range of disposal methods; primarily incineration and burying, but also landfill and disposal in dung heaps, slurry pits and with fallen stock. PCPs disposed of carcasses by incineration, burial and landfill (refer to Table 3 for details).

The pattern of responses to these questions, both by farmers and PCPs, are very similar to those provided in the 2013 grass and fodder crop survey. In 2013 the only significant differences in farmer and PCP responses were also in relation to uptake of training and searching for rodent carcasses.

During this survey, 32 per cent of the PCPs who provided information volunteered that they used monitor bait to assess rodent populations to inform their control strategies. Use of placebo baits (without any active substance) confirms rodent activity levels before baiting regimes are implemented and is good practice when using rodenticides. Use of monitor baits was not a formal

data collection point in this study, but will be added to the future rodenticide surveys.

Farm operation data

Farmers were asked a series of questions relating to aspects of farm operation which might affect rodenticide use pattern (Table 4). Not all of those surveyed provided this data, responses were provided by 578 farmers, representing 91 per cent of the farms sampled overall.

The majority of respondents (86 per cent) were a member of a quality assurance scheme, greater than the 68 per cent recorded in 2013. A range of assurance schemes were encountered; the most common were Quality Meat Scotland (QMS) and Scottish Quality Crops (SQC). Both of these schemes specify that effective rodent control measures must be in place, although the use of anticoagulant rodenticides is not mandatory. Membership of both QMS and SQC also permits purchase and use of rodenticide products authorised under stewardship conditions. More farms that practised rodenticide baiting were members of a quality assurance scheme (93 per cent) than farms that did not use rodenticides (73 per cent) and this difference was significant ($P < 0.001$).

Ninety six per cent of those surveyed kept livestock on their holdings, compared to 91 per cent in 2013. Only one per cent of farms had a pig unit and two per cent had a poultry unit. These intensive livestock production sectors tend to be greater users of rodenticides due to storage of large volumes of feed and concern about feed spoilage and rodent related disease introduction.

Lastly, 19 per cent of holdings surveyed had an on-farm grain store, and a significantly greater number of farms using rodenticides had a grain store (25 per cent) than farms that did not use rodenticides (6 per cent) ($P < 0.001$).

In 2013, as in 2017, statistically significant differences between those farmers using and not using rodenticides were only found in relation to quality assurance membership uptake and presence of a grain store.

Rodenticide approval and stewardship

EU and UK Regulatory risk assessments have concluded that the use of First and Second Generation Anticoagulant Rodenticides outdoors present a higher level of risk to non-target animals (such as predatory birds and mammals) than would normally be considered acceptable. As a result, outdoor use of these rodenticides would not usually be approved. However the UK Government recognises that, despite these risks, outdoor use of anticoagulant rodenticides is necessary for rodent control.

In order to be able to re-authorise these rodenticides for use outdoors, Government must be assured that the risks will be properly managed to minimise unacceptable effects to non-target species. This has been

addressed by an industry led stewardship scheme, managed by the Campaign for Responsible Rodenticide Use (CRRU)⁽⁵⁾, which was launched in 2015.

With the launch of the stewardship scheme providing environmental risk mitigation measures for rodenticide use, HSE has, during 2016 and 2017, re-approved rodenticide product authorisations. As part of this re-authorisation the approval conditions for some products have been amended, notably in relation to the outdoor use of active substances that were previously restricted to use inside buildings (brodifacoum, flocoumafen and difethialone).

Some additional questions were included in the 2017 survey to investigate knowledge and participation in the rodenticide stewardship scheme (Table 5). Not all of those surveyed provided this data, responses were provided by 208 farmers, representing 97 per cent of those farmers who conducted their own rodenticide baiting.

Sixty one per cent of farmers were aware of the rodenticide stewardship scheme's existence. Seven per cent of the farmers surveyed had attended a stewardship compliant training scheme which provided certification acceptable for point of sale purchase of professional rodenticide products. In addition, 32 per cent of farmers stated they intended to complete this training in future.

Farmers were also asked if they had purchased rodenticides after April 2016, when the product authorisations under stewardship had been implemented. Seventy six per cent of farmers had purchased rodenticides; the majority (53 per cent of purchases) were made by demonstrating membership of a compliant quality assurance scheme. Followed by purchase of amateur products (15 per cent of purchases), production of a stewardship compliant training certificate (7 per cent) and purchasing non-stewardship products available until September 2016 (6 per cent).

This is the first time that the grassland and fodder crop survey has been conducted since the introduction of rodenticide stewardship. The same questions were asked in the 2016 arable survey. In 2016, 68 per cent of farmers were aware of the scheme, 9 per cent had completed stewardship compliant rodenticide use training and 51 per cent intended to complete training in future. This difference in intention to complete stewardship training may be associated with traits displayed by growers in different crop sectors. However, as professional rodenticide products can now be purchased by membership of a compliant QA scheme, an arrangement which was an interim measure at the time of the 2016 survey, the motivation to complete training may have decreased over time. Data relating to rodenticide best practice compliance and stewardship will continue to be collected in future surveys.

Appendix 1 - Estimated rodenticide use and supplementary data tables

Table 1 Occurrence of rodenticide use on grassland and fodder farms - 2017

Number of occurrences of each rodenticide formulation and percentage of total occurrences

Formulation	Number of occurrences	Percentage of total specified occurrences
Brodifacoum	694	4
Bromadiolone	6,344	40
Bromadiolone/difenacoum ⁽¹⁾	87	1
Coumatetralyl ⁽¹⁾	10	<1
Difenacoum	8,348	53
Difethialone ⁽¹⁾	113	1
Flocoumafen ⁽¹⁾	169	1
Warfarin ⁽¹⁾	58	<1
Unspecified Rodenticide ⁽²⁾	1,858	
Total (excluding unspecified use)	15,812	
Total first generation anticoagulant ⁽³⁾	68	<1
Total second generation anticoagulant ⁽⁴⁾	15,744	>99

(1) Estimates are based on <10 occurrences in the sample and should therefore be treated with caution

(2) Rodenticides are recorded as unspecified when use has been recorded but product information is not available (refer to Appendix 3)

(3) First generation anticoagulant compounds: coumatetralyl, warfarin

(4) Second generation anticoagulant compounds: brodifacoum, bromadiolone, difenacoum, difethialone, flocoumafen

Table 2 Weight of rodenticides used on grassland and fodder farms – 2017

Weight of rodenticides applied (kg), expressed as formulations (combination of active substances) and products (active substances, bait and other co-formulants)

Formulation	Formulation weight	Product weight	
	Kg	Kg	Percentage of total specified use
Brodifacoum	0.15	3,009	2
Bromadiolone	3.80	76,719	59
Bromadiolone/Difenacoum ⁽¹⁾	0.06	1,113	1
Coumatetralyl ⁽¹⁾	0.01	16	<1
Difenacoum	2.38	47,602	37
Difethialone ⁽¹⁾	0.02	674	<1
Flocoumafen ⁽¹⁾	0.03	542	<1
Warfarin ⁽¹⁾	0.08	165	<1
Total⁽²⁾	6.52	129,841	
Total first generation anticoagulant ⁽³⁾	0.09	182	<1
Total second generation anticoagulant ⁽⁴⁾	6.43	129,659	>99

(1) Estimates are based on <10 occurrences in the sample and should therefore be treated with caution

(2) Not including unspecified rodenticides (refer to Appendix 3)

(3) First generation anticoagulant compounds: coumatetralyl, warfarin

(4) Second generation anticoagulant compounds: brodifacoum, bromadiolone, difenacoum, difethialone, flocoumafen

Table 3 Farmer and PCP response to training and compliance questions - 2017

Response to questions regarding training and compliance with best practice of rodenticide use provided by farmers and pest control professionals responsible for rodenticide baiting on the surveyed farms

Question	Percentage yes response	
	Farmer (n=208) ⁽¹⁾	PCPs (n=28) ⁽²⁾
1) Have you attended a training course on rodenticide use? ⁽³⁾	*12	*100
2) Are quantity and location of baits recorded?	90	100
3) Are bait points protected from non-target animals?	100	100
4) Is bait regularly inspected?	99	100
5) Is bait removed after targeted baiting periods?	57	68
6) Are rodent carcasses searched for and removed? ⁽⁴⁾	*63	*96

(1) Not all farmers returned compliance data. These farmers represent 97% of the 214 farmers who conducted their own rodenticide baiting during this survey

(2) Not all PCPs returned compliance data. These 28 PCPs represented 74 per cent of the contractors encountered during this survey and collectively conducted baiting on 66 per cent of those farms using a PCP

(3) Training uptake by farmer here refers to all rodenticide use training, this differs from that reported in Table 5 which only records training that is compliant with rodenticide stewardship and allows professional rodenticide products to be purchased

(4) 122 farmers gave a response in relation to carcass disposal method; the most common methods were incineration (48 per cent) and burying (38 per cent). Other methods included landfill, disposal in dung middens, in slurry pits and with fallen stock (8, 4, 1 and 1 per cent respectively). Twenty six PCPs supplied disposal methods, the most common was incineration (58 per cent) followed by burial (23 per cent) and landfill (19 per cent)

* Responses marked with an asterisk are significantly different between farmers and PCPs (P<0.001)

Table 4 Farmer response to farm operation questions - 2017

Question	Percentage yes response		
	All farms (n=578) ⁽¹⁾	Farms using rodenticides (n=374) ⁽¹⁾	Farms not using rodenticides (n=204) ⁽¹⁾
1) Is your farm a member of a quality assurance scheme	86	*93	*73
2) Is livestock kept on your farm?	96	96	96
3) Do you have a pig unit on your farm?	1	2	<1
4) Do you have a poultry unit on your farm?	2	3	1
5) Do you have a grain store?	19	*25	*6

(1) Not all farmers returned farm operation data. These data represent 91 per cent of the farms sampled overall, 98 per cent of those using rodenticide and 81 per cent of those not using rodenticides

* Responses marked with an asterisk are significantly different between farms that did and did not use rodenticides (P<0.001)

Table 5 Farmer response to rodenticide stewardship questions - 2017

Question	Percentage yes response (n=208) ⁽¹⁾
1) Are you aware of the rodenticide stewardship scheme?	61
2a) Have you completed a stewardship compliant training course?	7
2b) If no, do you intend to complete a stewardship compliant training course in the future?	32
3) Have you purchased any rodenticides since April 2016 ⁽¹⁾	76

(1) Not all farmers responded to stewardship questions. These farmers represent 97% of the 214 farmers who conducted their own rodenticide baiting during this survey

(2) The farmers who purchased rodenticides post April 2016 (76% of respondents) used a variety of methods to obtain them, some farmers used more than one method. The majority of purchases were made by proving membership of a compliant QA scheme (53 per cent of purchases), followed by purchase of amateur products (15 per cent), production of a stewardship compliant training certificate (7 per cent) and purchasing non-stewardship products (6 per cent, these were available until September 2016).

Appendix 2 - Survey statistics

Census and sample information

Table 6 Distribution of grassland holdings sampled - 2017

Size Group (ha)	H & I and C & O	Moray Firth	Aberdeen	Angus & East Fife	Lothian & Central Lowlands	Tweed Valley & Southern Uplands	Solway	Scotland
0.01 – 19.99	19	4	5	3	7	5	2	45
20.00 – 49.99	21	11	15	7	13	6	5	78
50.00 – 99.99	25	6	17	5	23	11	22	109
100.00 – 149.99	17	3	12	3	23	14	14	86
150.00 +	36	5	8	7	29	39	30	154
Total	118	29	57	25	95	75	73	472

H&I=Highlands & Islands, C&O=Caithness & Orkney. Note: These 472 holdings collectively grew 175,758 ha, four per cent of the 2017 total grass census area

Table 7 Census distribution of grassland holdings (excluding rough grazing) - 2017

Size Group (ha)	H & I and C & O	Moray Firth	Aberdeen	Angus & East Fife	Lothian & Central Lowlands	Tweed Valley & Southern Uplands	Solway	Scotland
0.01 - 19.99	11,134	2,009	3,818	2,160	4,210	1,688	1,248	26,267
20.00 - 49.99	1,566	477	1,004	440	1,324	487	419	5,717
50.00 - 99.99	936	248	557	239	1,159	436	528	4,103
100.00 - 149.99	374	94	186	94	468	271	331	1,818
150.00 +	370	89	109	92	391	483	347	1,881
Total	14,380	2,917	5,674	3,025	7,552	3,365	2,873	39,786

H&I=Highlands & Islands, C&O=Caithness & Orkney

Table 8 Distribution of fodder holdings sampled - 2017

Size Group (ha)	H & I and C & O	Moray Firth	Aberdeen	Angus & East Fife	Lothian & Central Lowlands	Tweed Valley & Southern Uplands	Solway	Scotland
0.01 – 4.99	12	4	7	3	2	2	2	32
5.00 – 9.99	10	8	13	7	7	6	4	55
10.00 – 14.99	4	2	4	4	6	6	4	30
15.00 – 19.99	3	1	2	1	2	3	7	19
20.00 +	3	5	3	2	3	6	5	27
Total	32	20	29	17	20	23	22	163

H&I=Highlands & Islands, C&O=Caithness & Orkney. Note: These 163 holdings collectively grew 1,901 ha, 12 per cent of the 2017 total fodder census area

Table 9 Census distribution of fodder holdings - 2017

Size Group (ha)	H & I and C & O	Moray Firth	Aberdeen	Angus & East Fife	Lothian & Central Lowlands	Tweed Valley & Southern Uplands	Solway	Scotland
0.01 – 4.99	472	212	358	102	141	101	56	1,442
5.00 – 9.99	105	79	155	79	95	78	71	662
10.00 – 14.99	30	29	43	24	39	40	45	250
15.00 – 19.99	10	13	19	6	13	29	19	109
20.00 +	10	15	19	8	23	15	21	111
Total	627	348	594	219	311	263	212	2,574

H&I=Highlands & Islands, C&O=Caithness & Orkney

Raising factors

Table 10 Raising and adjustment factors for grassland holdings - 2017

Region	Size group (ha)					Adjustment factor
	0.01–19.99	20.00–49.99	50.00–99.99	100.00-149.99	150 +	
Highlands & Islands/Caithness & Orkney	586.00	74.57	37.44	22.00	10.28	1
Moray Firth	502.25	43.36	41.33	31.33	17.80	1
Aberdeen	763.60	66.93	32.76	15.50	13.63	1
Angus/East Fife	720.00	62.86	47.80	31.33	13.14	1
Central Lowlands & Lothian	601.43	101.85	48.29	20.35	13.96	1
Southern Uplands & Tweed Valley	337.60	81.17	39.64	19.36	12.38	1
Solway	624.00	83.80	24.00	23.64	11.57	1

Note: The sampled data within a region and size group were multiplied by the appropriate raising and adjustment factors to create an estimate of national use (please refer to Appendix 4 for description of statistical estimation process). For example, a total recorded rodenticide use of 10 kg on 100-150 ha sized farms in Aberdeen would be multiplied by 15.5 (raising factor) and 1.00 (adjustment factor) to give an estimated rodenticide use in that region and size group of 155 kg.

Table 11 Raising and adjustment factors for fodder holdings - 2017

Region	Size group (ha)					Adjustment factor
	0.01 – 4.99	5.00 - 9.99	10.00 – 14.99	15.00 – 19.99	20 +	
Highlands & Islands/Caithness & Orkney	39.33	10.50	7.50	3.33	3.33	1
Moray Firth	53.00	9.88	14.50	13.00	3.00	1
Aberdeen	51.14	11.92	10.75	9.50	6.33	1
Angus/East Fife	34.00	11.29	6.00	6.00	4.00	1
Central Lowlands & Lothian	70.50	13.57	6.50	6.50	7.67	1
Southern Uplands & Tweed Valley	50.50	13.00	6.67	9.67	2.50	1
Solway	28.00	17.75	11.25	2.71	4.20	1

Note: The sampled data within a region and size group were multiplied by the appropriate raising and adjustment factors to create an estimate of national use (please refer to Appendix 4 for description of statistical estimation process). For example, a total recorded rodenticide use of 10 kg on 15-19.99 ha sized farms in Aberdeen would be multiplied by 9.5 (raising factor) and 1.00 (adjustment factor) to give an estimated rodenticide use in that region and size group of 95 kg.

Survey response rates

Table 12 Response rate for grassland survey - 2017

	2016	Percentage of total
Number of postal surveys sent out	1,335	
Achieved rodenticide responses (no. returns)	472	35
Total number of refusals/non-contact	863	

Table 13 Response rate for fodder survey - 2017

	2016	Percentage of total
Target sample	200	
Total achieved	163	82
Total number of farms approached	283	
Total number of refusals/non-contact	120	

Financial burden to survey respondents

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

To determine the total burden that the 2017 rodenticide use on grassland and fodder farms survey placed on those providing the information, farmers were asked to estimate the time that they spent providing data. Fifty four per cent of the farmers surveyed provided this information. The median time taken was five minutes.

In addition, PCPs were also asked to estimate how long they took to provide information. Eighty two per cent of the PCPs supplying data provided this information. The median time taken was 10 minutes.

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

Burden (£) = No. surveyed x median time taken (hours) x typical hourly rate*

(* using median “full Time Gross” hourly pay for Scotland of £13.98⁽⁶⁾)

It is estimated that the total financial burden to respondents for the 2017 grassland and fodder crop rodenticide survey was £805.

Appendix 3 - Definitions and notes

- 1) **Rodenticide** is used throughout this report to describe a substance used to kill or control rodents.
- 2) An **active substance** is any substance which has a general or specific action against harmful organisms. In this report this refers to a substance with a detrimental effect on rodents.
- 3) The term **product** is used to describe a marketed rodenticide product which contains active substance(s), bait and other co-formulants.
- 4) The term **formulation** is used to describe an active substance or mixture of active substances formulated together in a product. A formulation is not synonymous with a product; the same formulation of active substances is present in many different products.
- 5) Rodenticides are classified as **anticoagulant** (which prevent the synthesis of blood clotting factors resulting in rodent death by haemorrhage) or **non-anticoagulant** compounds. No non-anticoagulant rodenticides were encountered in this survey. The anticoagulant rodenticides are classified into first and second generation compounds (**FGARs** and **SGARs** respectively). The FGARs, which were the first anticoagulant compounds to be developed, are less acutely toxic than SGARs.
- 6) The **rodenticides approved for use** in the UK during the 2017 survey period were: FGARs (coumatetralyl and warfarin), SGARs (brodifacoum, bromadiolone, difenacoum, difethialone and flocoumafen) and non-anticoagulant rodenticides (alphachloralose, aluminium phosphide and powdered corn cob). The **rodenticides encountered** in this survey were; brodifacoum, bromadiolone, coumatetralyl, difenacoum, difethialone, flocoumafen and warfarin.
- 7) The term **holding** is the basic unit used in the agricultural census and, in this report, is synonymous with the term 'farm'. In this survey, fodder farms are defined as farms growing crops for stock-feeding such as turnips, swede, kale, fodder rape, fodder beet, maize and arable silage (grain and legumes). Grassland farms primarily grow grass for grazing or silage. Fodder farms usually also have some grassland and grassland farms may also grow some fodder crops.
- 8) The term **occurrence** is used to describe the number of holdings on which a formulation has been used. Multiple uses of the same formulation at a holding are recorded as a single occurrence.
- 9) When collecting information regarding **seasonal use** of rodenticides, farmers and contractors were asked to report seasonal baiting patterns. The definition of season may vary among respondents. Where exact dates of use were provided these were assigned to season as follows: spring (March, April,

May), summer (June, July, August), autumn (September, October, November) and winter (December, January, February).

10) Throughout the tables, data based **on 10 or less sampled occurrences** (rodenticide formulations encountered on 10 or less holdings) are highlighted and should be treated with caution as these estimates are likely to have a high associated error. In this survey only bromadiolone, difenacoum and brodifacoum were encountered on more than 10 holdings.

11) Data from the 2013⁽¹⁾ grassland and fodder farm rodenticide survey and the arable 2016⁽²⁾ rodenticide survey are provided for comparison with the estimates in this survey. It should be noted that differences in use between years may be influenced by a number of factors such as rodent populations or the proportion of farms sampled in that year which had livestock or grain stores or were members of a quality assurance scheme in which rodenticide use was mandatory or encouraged.

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

13) The **June Agricultural Census**⁽⁷⁾ 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 Census was used to draw a sample of farms growing the relevant crops to participate in the survey.

14) The UK Rodenticide Stewardship Scheme⁽⁵⁾ was implemented in April 2016 to reduce risks to wildlife and the environment from anticoagulant rodenticides. By mitigating these risks to the environment, the scheme aims to provide the Health and Safety Executive (HSE) with the confidence it requires to permit the continued authorisation of anticoagulant rodenticides for rodent pest management.

Appendix 4 - Survey methodology

Sampling and data collection

Using the June 2017 Agricultural Census⁽⁷⁾ two samples were selected, one taken from holdings with grassland, the second from holdings growing fodder crops. For the purpose of sampling, the country was divided into 11 land-use regions⁽⁸⁾ (Figure 11) and five size groups. The size groups were different for grassland and fodder crops (Table 7 & 9 respectively) 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 number of holdings selected being proportional to the total area of crops grown. Sample size groups were based on crop area rather than number of holdings, so that smaller holdings did not dominate. This stratification was designed to take into account differences in rodenticide use in relation to geography and farm size when making estimates of national use.

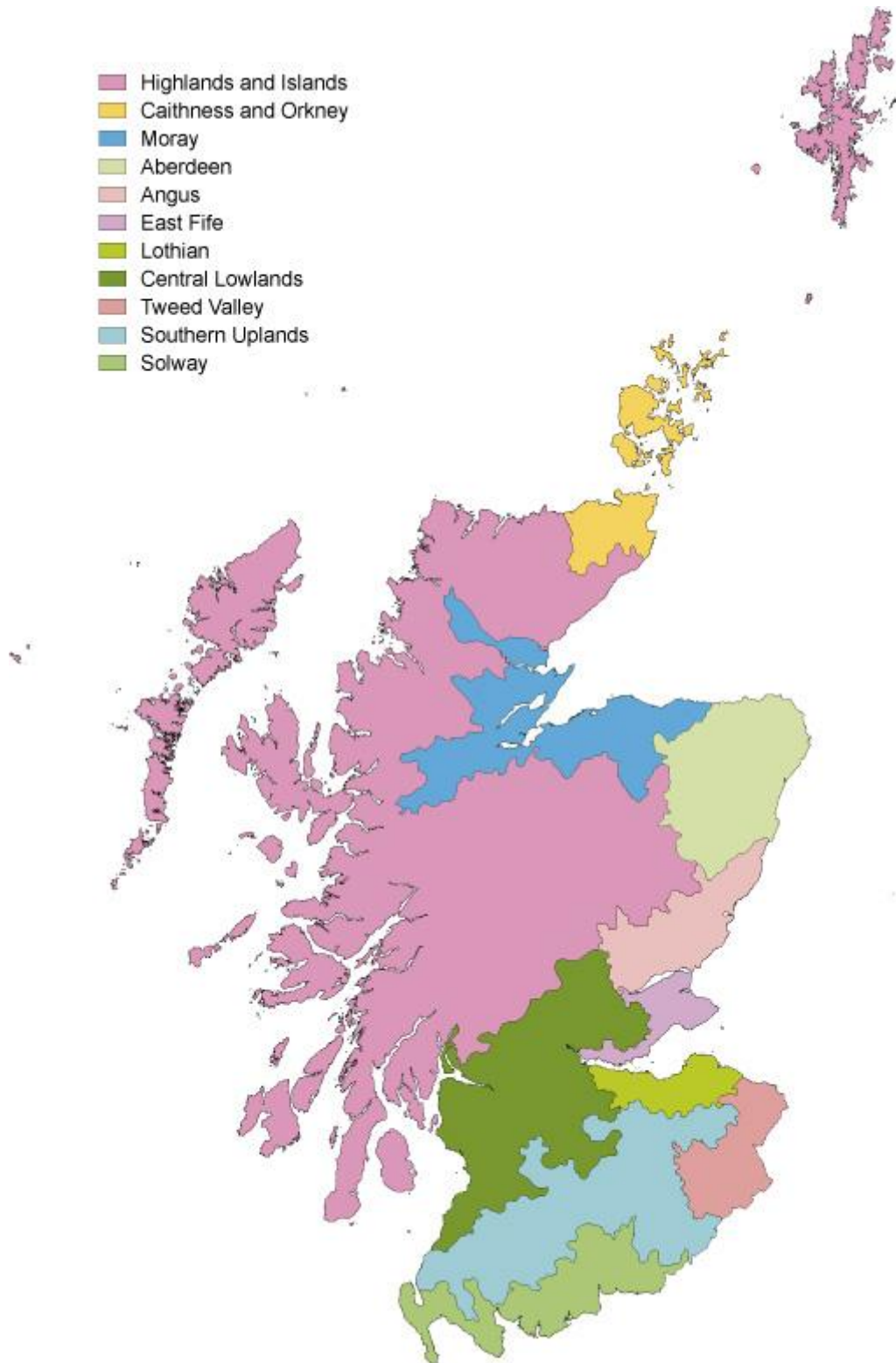
The survey covered rodenticide use during the 12 month period January to December 2017. Following an introductory letter, data was gathered from farms growing fodder crops by telephone interview or email. For the grassland survey a postal questionnaire was sent out which farmers completed and returned, followed up with a phone call where necessary. When rodenticides were applied by a pest control professional (PCP) and data were not available from the farmer the information was obtained directly from the contractor. If it was recorded that rodenticides were used but product data were not obtainable from either the farmer or PCP this was recorded as unspecified rodenticide use.

In total, information was collected from 635 holdings. These holdings represent 6.3 per cent of the 2017 Scottish fodder crop holdings (Table 8) and 1.2 per cent of the grassland holdings (Table 6). The data collected were; rodenticide user, product(s) used, bait type, weight applied, target and season of use. Information about use of non-chemical rodent control methods was also recorded.

All farmers and PCPs encountered in the survey were also asked to respond to a simple questionnaire containing questions relating to whether they had received training in use of rodenticides and their self-reported compliance with best use practice for rodenticides. Farmers were also asked to answer questions about their knowledge of rodenticide stewardship and details about their farm, such as whether they kept livestock or had a grain store.

It should be noted that, in relation to all data collected, responses are as reported by the rodenticide users and no attempt has been made to check their accuracy

Figure 11 Land use regions of Scotland⁽⁸⁾



Estimation of national rodenticide use

The figures presented in this report are produced by surveying a sample of holdings rather than conducting a census of all the holdings in Scotland. Therefore the figures are estimates of total rodenticide use for Scotland and should not be interpreted as exact.

National rodenticide use (holdings using rodenticides, rodenticide occurrence and weight) was estimated from the sample data by ratio raising. This is a standard statistical technique for producing estimates from a sample. This method involves multiplying the sample data by a factor dependent on the number of farms within each region and size group to match the data recorded in the relevant June Agricultural Census for arable crops. Due to small sample sizes the data from some regions were merged and a secondary adjustment factor was applied to the raising factors to account for region and size groups for which no holdings were sampled. Details of regions, size groups, raising and adjustment factors are presented in Tables 10 and 11.

The remainder of the data (use of non-chemical control methods, details of farm operation, compliance with best practice and knowledge of rodenticide stewardship) are unraised and represent the information collected from the sample.

Changes from previous years

In previous reports in this series, data about the type of rodenticide user (i.e. farmer or PCP) were based on the proportions encountered in the sample surveyed. Whilst this was made clear in the reports, it was in contrast to the weight and occurrence data presented, which were estimates of use in the total population of arable farms. Due to database improvements, population estimates of user type are now available and replace the sample data in this report for both 2017 and historical data. This has resulted in differences in 2013 user data presented in this report and in the original report.

For the first time in this series of surveys we asked questions about target of rodenticide use, non-chemical controls employed, knowledge of rodenticide stewardship, uptake of stewardship affiliated training and how rodenticides had been purchased post-stewardship.

Statistical analyses

As estimates are based on a random stratified sample of farms in each survey year and individual farms may be sampled more than once in the time series, there is no simple method of statistical comparison for estimated rodenticide use on arable farms over time. However, the percentage of farms using rodenticides, the percentage of farms on which baiting was conducted by PCPs and the percentage occurrence of first and second generation compounds have been analysed using Pearson's chi-squared test. The percentage occurrence of first and second generation compounds was analysed using the number of holdings as a base. These conservative analyses do not take into account the stratification, finite population sampling

or common farms between years and are therefore less likely to find significant differences. All significant differences are highlighted in the text and tables of this report.

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 farmer if necessary. Additional quality assurance is provided by sending reports for independent review. 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 output is audited against these SOPs by internal auditors annually and by external auditors every three years.

Main sources of bias

These surveys may be subject to measurement bias as they are reliant on respondents recording data accurately. As surveys are not compulsory they may also be subject to non-response bias, as some farmers and PCPs may be more likely to respond than others. However, the use of a random stratified sample is an appropriate survey methodology and reserve lists of farms are held for each stratum to allow non-responding farms 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.

Acknowledgements

The authors would like to thank the farmers and pest control professionals who provided the information used in this report. The authors would also like to thank Steve Campbell and Elizabeth Sharp (SASA) for helpful comments on the manuscript. In addition, Paul Gavin at the Scottish Government's Agricultural Census Analysis Team provided the census data and Adrian Roberts of Biomathematics & Statistics Scotland performed the statistical analyses.

References

1. Hughes, J., Watson, J., Monie, C. & Reay, G. Pesticide Usage in Scotland: Rodenticide Use on Grassland and Fodder Farms 2013, SGRPID, Edinburgh 2014 <http://www.sasa.gov.uk/document-library/rodenticide-use-grassland-fodder-farms-2013>
2. Wardlaw, J., Hughes, J., Monie, C. & Reay, G. Pesticide Usage in Scotland: Rodenticides on Arable Farms 2016, Scottish Government, AFRC, Edinburgh <http://www.sasa.gov.uk/document-library/rodenticides-arable-farms-2016>
3. HSE Biocides Rodenticide Database <https://webcommunities.hse.gov.uk/connect.ti/pesticides/view?objectId=10116> [accessed 04 August 2018]
4. Campaign for Responsible Rodenticide Use (CRRU) Guidance <http://www.thinkwildlife.org/crru-code/> [Accessed 04 August 2018]
5. Buckle, A., Prescott, C., Davies, M., Broome, R. (2017) The UK Rodenticide Stewardship Regime. A model for anticoagulant risk mitigation? In: Proceedings of the Ninth International Conference on Urban Pests. Davies, M., Pfeiffer, C., Robinson, W.H. (Eds.). Aston University, Birmingham, 9-12 July 2017. Pp. 165-170
6. Annual Survey of Hours and Earnings (ASHE) 2017 (Table 3.5a) <https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/earningsandworkinghours/datasets/regionbyoccupation2digitsocashetable3>
7. Agricultural Statistics, Scotland 2017. HMSO, Edinburgh 2017. EU
8. Wood, H.J. An Agricultural Atlas of Scotland. George Gill and Sons, London, 1931.

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The Scottish Government
St Andrew's House
Edinburgh
EH1 3DG

ISBN: 978-1-78781-234-5 (web only)

Published by The Scottish Government, September 2018

Produced for The Scottish Government by APS Group Scotland, 21 Tennant Street, Edinburgh EH6 5NA
PPDAS452226 (09/18)