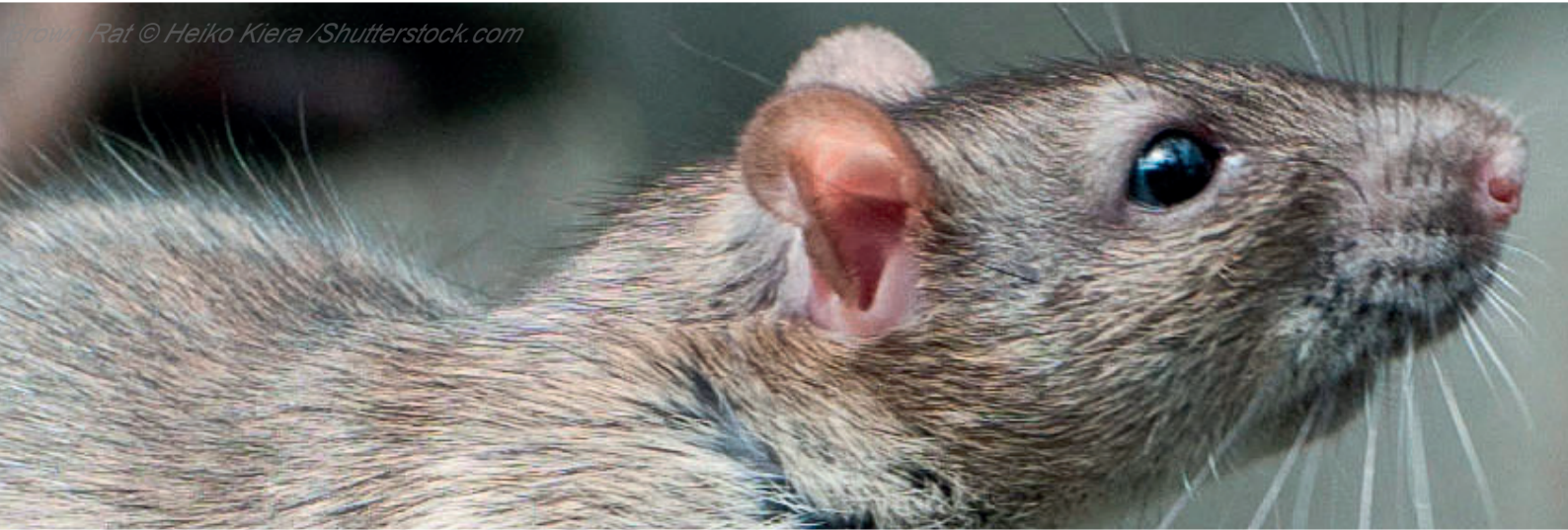




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Pesticide Usage in Scotland



A National Statistics Publication for Scotland



Rodenticides on Arable Farms 2018

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2018

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Executive summary

This report presents the results of a survey of rodenticide use on Scottish farms growing arable crops in 2018. Information was collected from 272 holdings, collectively growing 7 per cent of the 2018 arable crop area. Data from this sample was used to estimate total Scottish rodenticide use in this crop sector.

It was estimated that rodenticides were used on 55 per cent of all arable farms in 2018, significantly fewer than the 78 per cent reported in 2016. Pest control professionals (PCPs) conducted the baiting on 54 per cent of holdings using rodenticides and applied 56 per cent of rodenticides by weight.

In 2018 an estimated 49 tonnes of rodenticide products were used on arable farms. This is a decrease of 47 per cent since 2016 and a decrease of 57 per cent since 2014. The products used contained less than 6 kg of rodenticide active substance. As in previous surveys, almost all products used (>98 per cent) were second generation anticoagulant rodenticides, primarily bromadiolone and difenacoum (95 per cent by weight).

The majority of rodenticides (61 per cent) were applied throughout the year, either used permanently or in multiple individual baiting operations. This is an increase in year-round use from 2016 (46 per cent). Most rodenticides were used in autumn and winter (65 per cent). Grain baits were the most common product type (90 per cent) and the main targets were a combination of rats and mice (52 per cent) or rats (46 per cent). Sixty per cent of farms that did not use rodenticides and 46 per cent of those that did, employed non-chemical rodent control; the most common methods were cats and traps.

Survey respondents were asked about rodenticide stewardship, training attainment, compliance with best practice and aspects of their farm operation. Eighty six per cent of farmers were aware of rodenticide stewardship, of these 25 per cent had completed stewardship compliant rodenticide use training and 21 per cent planned to in the 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 they complied with all elements and responses were similar to those reported in 2016. In 2018, more farmers stated that they searched for and removed carcasses than in 2016, therefore for the first time there was no statistical difference between user groups in relation to this question. 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 dataset is the second in this series to be conducted since the industry led stewardship scheme was introduced in 2015 and subsequent HSE rodenticide product reauthorisations in 2016 and 2017. It is likely that the decreased rodenticide usage, increased adoption of non-chemical control and increased uptake of best practice reported in 2018 has been influenced by the introduction of the 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 SASA, a division of the Scottish Government's Agriculture and Rural Delivery Directorate. 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 arable crops was carried out in 2018. This is the 14th survey in this series carried out biennially since 1992.

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 [privacy](#) 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.gov.scot 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 present the results from this survey in comparison with results from the previous surveys in 2014⁽¹⁾ and 2016⁽²⁾.

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 arable farms and should not be interpreted as exact.

Rodenticide use data

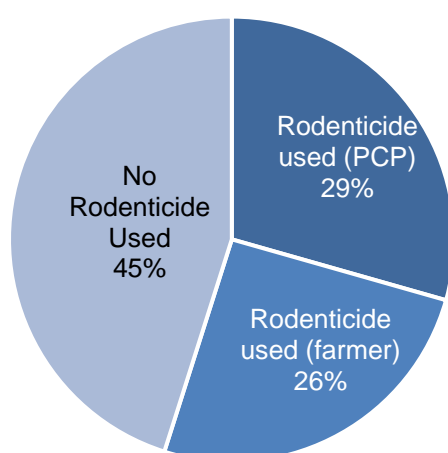
Rodenticide use data were collected from 272 arable holdings in Scotland in 2018. The farms surveyed represented three per cent of the total arable holdings in Scotland. These holdings collectively grew seven per cent of the 2018 arable crop area. The data collected from this sample were used to estimate rodenticide use on all Scottish arable farms in 2018.

Percentage of farms using rodenticides and type of user

It was estimated that approximately 55 per cent of Scottish arable farms used rodenticides in 2018 (Figure 1). Over half of all baiting operations (54 per cent) were implemented by Pest Control Professionals (PCPs). Farmers conducted baiting on the remainder of these farms.

Similar proportions were recorded in relation to the amounts of rodenticides used with PCPs responsible for 56 per cent of the total use by weight of product.

Figure 1 Percentage of arable farms using rodenticides and type of user – 2018



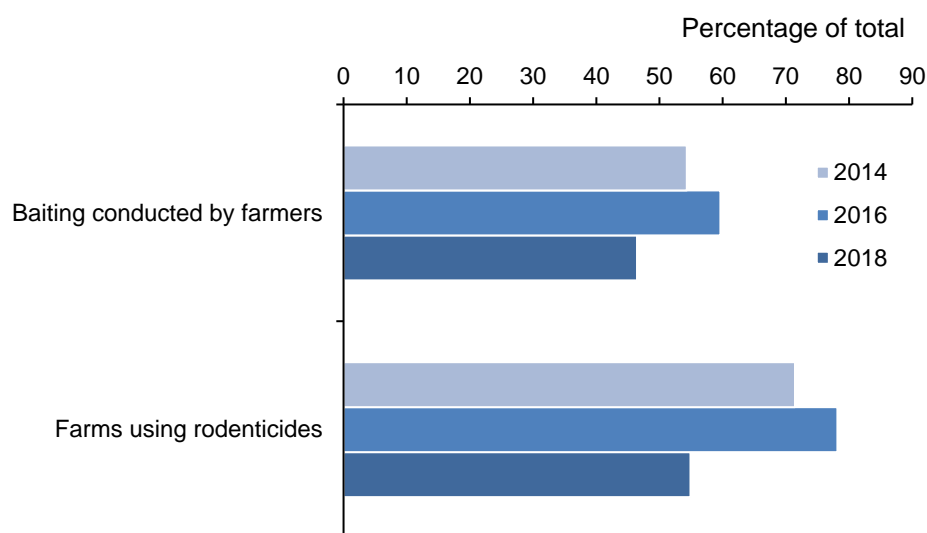
The pattern of rodenticide use, and primary user, encountered in this survey was significantly different ($P < 0.001$) to that reported in 2016 (Figure 2). The proportion of arable farms using rodenticides (55 per cent) was lower than in 2014 (71 per cent) and significantly lower ($P < 0.001$) than in 2016 (78 per cent).

In 2018, on farms where rodenticides were used, the proportion applied by PCPs (54 per cent) was greater than in 2014 (46 per cent) and significantly greater than in 2016 (40 per cent, $P = 0.004$).

Both the decreased use of rodenticides and the increased use in PCPs encountered in 2018 may be influenced by the UK rodenticide Stewardship Scheme. The scheme, which is aimed to improve the uptake of best practice in relation to rodenticide use, was introduced in 2015. As a consequence,

farmers are required to provide proof of competence or membership of a stewardship-approved quality assurance scheme to purchase their rodenticides or alternatively employ the services of a qualified professional.

Figure 2 Percentage of arable farms using rodenticides and type of user – 2014 to 2018



Note: There are statistically significant decreases in the number of farms using rodenticides ($P < 0.001$) and the proportion of baiting conducted by farmers ($P = 0.004$) between 2016 and 2018

Rodenticides encountered and their estimated occurrence

During this survey, product information was recorded for 87 per cent of all occurrences of rodenticide use. For the remaining 13 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 information. The level of unspecified rodenticides in 2018 was three times that encountered in the previous survey (four per cent). The following sections only discuss the use of specified rodenticides.

Rodenticide occurrence is defined as 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).

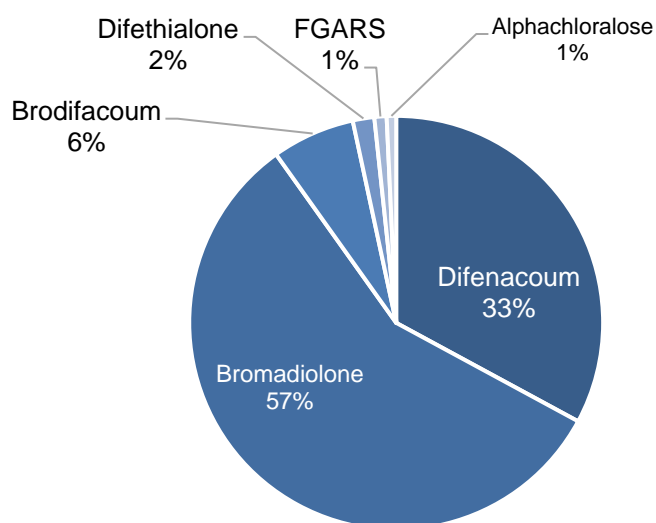
Seven active substances were recorded on arable farms in 2018; alphachloralose, brodifacoum, bromadiolone, coumatetralyl, difenacoum, difethialone and warfarin (Table 1, Figure 3). Alphachloralose has a narcotic mode of action, depressing the central nervous system. All the other rodenticides encountered were anticoagulants, which prevent the synthesis of blood clotting factors and cause rodent death by haemorrhage. Two of the active substances were first generation anticoagulant rodenticides (FGARs; coumatetralyl and warfarin). The other four active substances were second

generation anticoagulant rodenticides (SGARs) and these SGARs collectively accounted for more than 98 per cent of all occurrences of specified rodenticide use in 2018. Over the last three surveys rodenticide use has been almost exclusively composed of SGARs (100, >99 and > 98 per cent in 2014, 2016 and 2018 respectively, no significant difference between years).

The most commonly encountered active substances were bromadiolone and difenacoum (57 and 33 per cent of occurrences respectively). Other active substances recorded were brodifacoum (six per cent of occurrences), difethialone (two per cent), alphachloralose (one per cent) and coumatetralyl and warfarin (both less than one per cent).

The dominance of bromadiolone and difenacoum occurrence reflects their being the most commonly available rodenticides. At the time of writing, bromadiolone and difenacoum containing products account for 67 per cent of all anticoagulant rodenticide approvals, 69 per cent of outdoor use around buildings and 98 per cent of those approved for use in open areas⁽³⁾.

Figure 3 Percentage occurrence of rodenticide active substances on arable farms – 2018



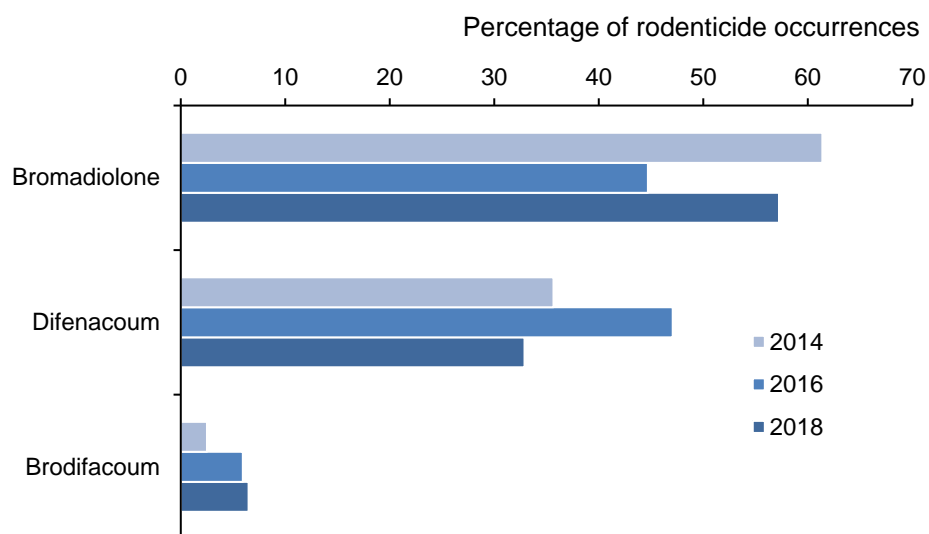
Note: FGARS are coumatetralyl and warfarin.

The combined use of bromadiolone and difenacoum has changed little over time, accounting for 97, 92 and 90 per cent of rodenticide occurrences in 2014, 2016 and 2018 respectively. However, the relative proportions of these two compounds have changed since the last survey. In 2018, the number of farms using bromadiolone was significantly greater (p-value 0.004) than in 2016. In contrast, significantly fewer farms used difenacoum in 2018 (p-value <0.001) than in 2016. However, the proportions of occurrences encountered in 2018 are very similar to those encountered in 2014 (Figure 4). The relative proportions of these compounds vary in the longer-term dataset (1992 onwards) and it is not clear what the drivers for these variations are. It is

possible that this may be a response to product efficacy in some areas; resistance to both difenacoum and bromadiolone has been reported in Scotland⁽⁴⁾. It may also represent a response to differences in the range of approved products available, and their marketing strategies over time.

The use of brodifacoum, the third most commonly encountered rodenticide in this survey is very similar to that recorded in 2016 (six per cent). Prior to 2018, the use of brodifacoum increased from three per cent in 2014 to six per cent in 2016.

Figure 4 Percentage occurrence of rodenticides on arable farms – 2014 to 2018

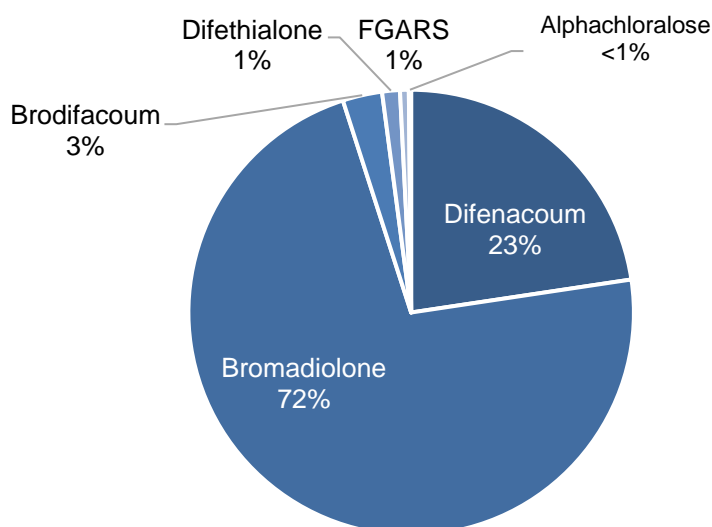


Note: There are statistically more farms used bromadiolone in 2018 (p-value 0.004) than in 2016. In contrast, fewer farms used difenacoum (p-value <0.001). There was no significant difference for the proportion of farms using brodifacoum between 2016 and 2018.

Weight of rodenticides used

Approximately 49 tonnes of rodenticidal products are estimated to have been used on Scottish arable farms in 2018 (Table 2, Figure 5). More than 99 per cent of the total weight used was SGAR products. Products containing bromadiolone were the most commonly used (ca. 35 tonnes), accounting for 72 per cent of total rodenticide use by weight. Difenacoum products were the second most commonly used (ca. 11 tonnes) accounting for 23 per cent of total use. Brodifacoum was the only other rodenticide regularly encountered (ca. one tonne), accounting for three 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. 49 tonnes of rodenticide product used on arable farms in 2018 contained only ca. 5.8 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 arable farms – 2018

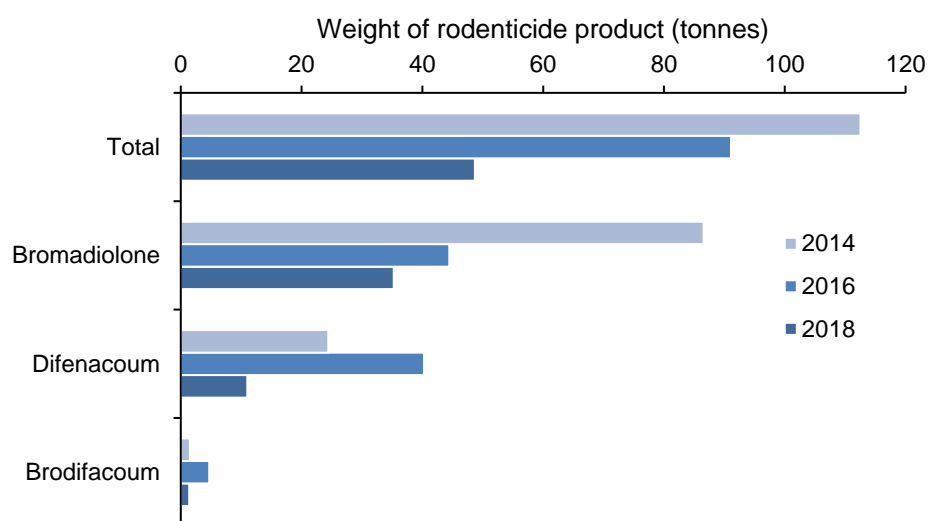


Note: FGARs are coumatetralyl and warfarin.

The estimated weights of the three main rodenticides recorded in the 2014, 2016 and 2018 arable crop surveys are presented in Figure 6. There has been a large decrease in overall weight of rodenticide products applied between these surveys. Rodenticide use in 2018 (ca. 49 tonnes) was 47 per cent lower than in 2016 (ca. 91 tonnes) and 57 per cent lower than in 2014 (ca. 113 tonnes). This may have been influenced by the increase in unspecified rodenticides recorded in 2018. Rodenticides are recorded as unspecified when use has been recorded but product information is not available, therefore these rodenticides are excluded from weight calculations. However, this decline in overall rodenticide use on arable farms is similar to that recorded in recent grassland and fodder farms surveys. The weight of rodenticide products used on Scottish grassland and fodder farms in 2017 was 40 per cent lower than in 2013⁽⁵⁾. The decline recorded in this survey appears to be a continuation of a longer term-trend of decreasing use in arable agriculture. The estimated use in 2018 is 66 per cent lower than that reported in 2000 (ca. 144 tonnes)⁽⁶⁾. This has partly been driven by a decline in the proportion of farms on which baiting is conducted (76 and 55 per cent in 2000 and 2018 respectively).

At active substance level, large decreases in the weight used were recorded for both difenacoum and brodifacoum use (73 and 70 per cent from 2016 to 2018 respectively). Applications of products containing bromadiolone also decreased, but the decrease (21 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, are also likely to have been influenced by the Campaign for Responsible Rodenticide Usage (CRRU) guidance for best practice⁽⁷⁾ and the 2015 launch of the UK industry led rodenticide stewardship scheme⁽⁸⁾.

Figure 6 Weight of rodenticide product used on arable farms – 2014 to 2018

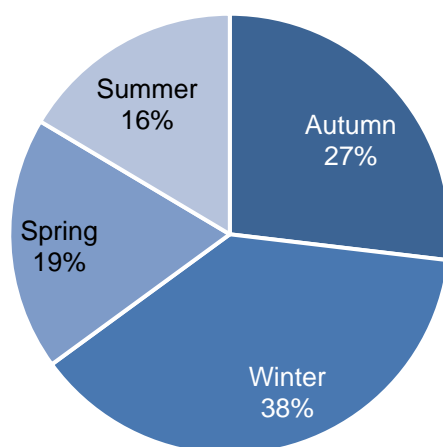


Seasonal use of rodenticides

The season in which rodenticides were used was specified for all the rodenticides encountered in this survey. Sixty-one 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 an increase from the level of year-round baiting encountered in 2016, in which 46 per cent of rodenticides were reported to be used throughout the year. However, similar levels of year round baiting for anticoagulant rodenticides have been reported previously, with 65 and 51 per cent in 2012 and 2014 respectively.

When the weight used, including year-round use, is separated into constituent seasons, the greatest use was in winter (38 per cent) and autumn (27 per cent), with lower use in spring and summer (Figure 7). This is a very similar seasonal pattern to that encountered in previous surveys.

Figure 7 Seasonal use of rodenticides on arable farms (percentage of total weight) - 2018



Rodenticide bait type and target

Baits formulated with grain were the most commonly encountered in this survey, accounting for 90 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 grain based paste (two per cent of total grain baits).

The other types of rodenticide products encountered included wax based baits, which accounted for seven per cent of use. Ninety per cent of wax baits were solid wax baits and 10 per cent were soft waxes. Pasta based bait contributed three per cent of total use, gel rodenticides and other paste baits (for which the type of bait was not specified) were both estimated to account for less than one per cent.

Grain baits also accounted for the majority of rodenticides used in the previous two arable surveys in 2014 (93 per cent) and 2016 (86 per cent).

Survey respondents were asked to state the target of their rodenticide baiting regimes (Figure 9) and this information was supplied by over 99 per cent of estimated use by weight. Where reason data were supplied the most common target was a combination of rats and mice (52 per cent), followed by rats (46 per cent). Only two per cent of rodenticide use was targeted at mice alone. In the previous two surveys the principal target was also rats (60 and 58 per cent in 2014 and 2016 respectively).

Figure 8 Type of rodenticide bait used on arable farms (percentage of total weight) - 2018

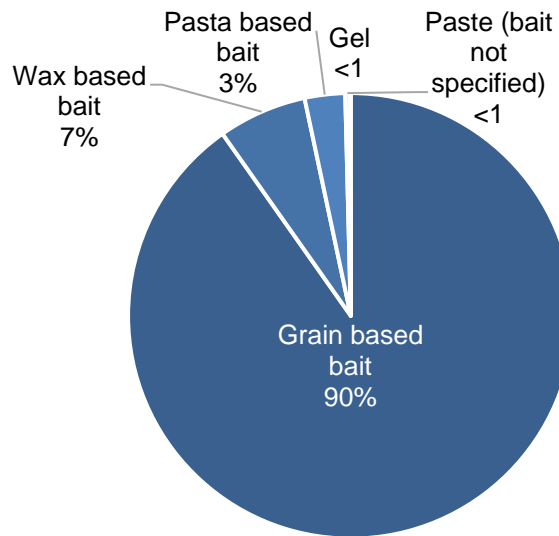
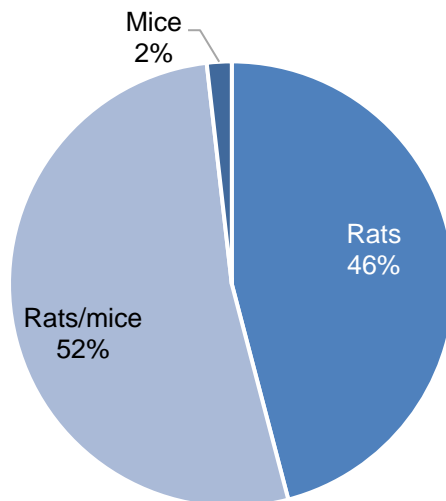


Figure 9 Target of rodenticide use on arable farms (percentage of total weight) - 2018



Supplementary data

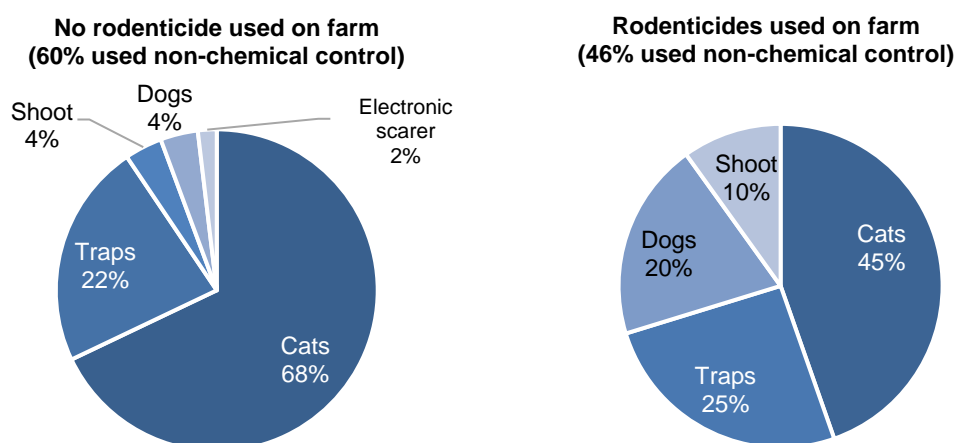
In addition to the collection of rodenticide usage data, farmers were also asked a series of supplementary questions relating to aspects of their farm operation, their use of non-chemical rodent control, rodenticide stewardship and their compliance with best practice in rodenticide use.

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

Farmers were asked about non-chemical methods employed for rodent control. A range of measures were conducted, with some farmers employing more than one method (Figure 10).

Figure 10 Non-chemical control on arable farms (percentage of total methods used) – 2018



On holdings on which rodenticides were not used (n=60), 60 per cent of the farmers reported using one or more non-chemical controls. The most commonly encountered methods were use of cats and traps (68 and 22 per cent of all methods reported respectively). Shooting, dogs and use of an electronic scarer were also used to control rodents.

On holdings using rodenticides (n=211), 46 per cent reported that they used additional non-chemical methods of rodent control. Again, the most common methods used were cats and traps (45 and 25 per cent of all methods reported respectively) with lower use of dogs and shooting.

The number of farmers reporting that they employed non-chemical rodent control was greater in 2018 than in 2016 and 2014 on holdings where rodenticides were used (46, 26 and 10 per cent respectively). For holdings where no rodenticides were used the numbers reporting the use of non-chemical rodent control was similar in 2018 and 2016 (60 and 61 per cent respectively) but higher than that reported in 2014 (44 per cent).

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⁽⁷⁾ (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 72 farmers, representing 99 per cent of those farmers who conducted their own rodenticide baiting and 20 PCPs, representing 65 per cent of the contractors encountered during the survey. Where statistically significant differences in the response between farmers and PCPs were found these are noted.

Ninety-five per cent of PCPs and 36 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 94 per cent of farmers stated that they recorded the quantity and location of baits. All PCPs and 99 per cent of farmers stated that these baits were protected from non-target animals. Bait was reported to be regularly inspected by all PCPs and farmers.

Sixty-five per cent of PCPs and 75 per cent of farmers removed bait after targeted baiting periods.

All PCPs and 90 per cent of farmers stated that they searched for and removed rodent carcasses. Many respondents stated they rarely saw carcasses. However, those farmers who did encounter carcasses employed a range of disposal methods; primarily burying, but also landfill, incineration and disposal in dung heaps (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 2016 arable crop survey. In 2016, there was a significant difference in farmer and PCP response in relation to searching for rodent carcasses. However, in 2018 many more farmers reported searching and removing carcasses (90 per cent) which meant there was no significant difference between farmer and PCP response.

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 267 farmers, representing 98 per cent of the farms sampled overall.

The majority of respondents (94 per cent) were a member of a quality assurance scheme, similar to the 92 per cent recorded in 2016. 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 (96 per cent) than farms that did not use rodenticides (85 per cent) and this difference was significant (p-value 0.002).

Although all the farms surveyed grew arable crops, some were also mixed farms and 59 per cent of those surveyed kept livestock on their holding, compared to 53 per cent in 2016. Only two per cent of farms had a pig unit and one 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.

Lastly, 66 per cent of holdings surveyed had an on-farm grain store, and a significantly greater number of farms using rodenticides had a grain store (74 per cent) than farms that did not use rodenticides (37 per cent) ($p < 0.001$).

In 2018, as in 2016, 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, the 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)⁽⁷⁾, 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).

These changes may influence rodenticide usage patterns. It is possible, that decreased rodenticide usage (occurrence and weight applied) and increased adoption of non-chemical control reported in 2018 may have been influenced by the introduction of the stewardship scheme and increased uptake of best practice.

Farmers were asked a series of questions to investigate knowledge and participation in the rodenticide stewardship scheme (Table 5). Not all of those surveyed provided this data, responses were provided by 72 farmers, representing 99 per cent of those farmers who conducted their own rodenticide baiting.

Eighty six per cent of farmers were aware of the rodenticide stewardship scheme's existence in 2018. Twenty five 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, 21 per cent of farmers stated they intended to complete this training in future. In 2016, 68 per cent of farmers were aware of the scheme, nine per cent had completed stewardship compliant rodenticide use training and 51 per cent intended to complete training in the future. The difference in intention to complete stewardship training may be due to the fact that more farmers are now trained and that professional rodenticide products can now be purchased by membership of a compliant QA scheme. This arrangement was an interim measure at the time of the 2016 survey, therefore, the motivation to complete training may have decreased over time.

Farmers were also asked if they had purchased rodenticides after April 2016, when the product authorisations under stewardship had been implemented. Ninety per cent of farmers had purchased rodenticides (41 per cent in 2016); the majority (69 per cent of purchases) were made by demonstrating membership of a compliant quality assurance scheme. Followed by production of a stewardship compliant training certificate (17 per cent), purchase of amateur products (4 per cent of purchases) and purchasing non-stewardship products available until September 2016 (3 per cent).

Appendix 1 - Estimated rodenticide use and supplementary data tables

Table 1 Total estimated occurrence of rodenticide use on arable farms in Scotland - 2018

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

Formulation	Number of occurrences	Percentage of total specified occurrences
Alphachloralose ⁽¹⁾	41	<1
Brodifacoum	364	6
Bromadiolone	3,209	57
Coumatetralyl ⁽¹⁾	27	<1
Difenacoum	1,844	33
Difethialone ⁽¹⁾	94	2
Warfarin ⁽¹⁾	26	<1
Unspecified Rodenticide ⁽²⁾	827	
Total (excluding unspecified use)	5,606	
FGARs ⁽³⁾	53	1
SGARs ⁽⁴⁾	5,511	98
Non-anticoagulant ⁽⁵⁾	41	<1

(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

(3) First generation anticoagulant compounds: coumatetralyl, warfarin

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

(5) Non-anticoagulant rodenticide compounds: alphachloralose

Table 2 Total estimated weight of rodenticides used on arable farms in Scotland – 2018

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	Percentage of total specified use
Alphachloralose ⁽¹⁾	3.23	81	<1
Brodifacoum	0.07	1,395	3
Bromadiolone	1.76	35,258	72
Coumatetralyl ⁽¹⁾	0.09	230	<1
Difenacoum	0.55	11,020	23
Difethialone ⁽¹⁾	0.02	629	1
Warfarin ⁽¹⁾	0.04	79	<1
Total⁽²⁾	5.75	48,691	
FGARs ⁽³⁾	0.13	309	<1
SGARs ⁽⁴⁾	2.39	48,302	99
Non-anticoagulant ⁽⁵⁾	3.23	81	<1

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

(2) Not including unspecified rodenticides

(3) First generation anticoagulant compounds: coumatetralyl, warfarin

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

(5) Non-anticoagulant rodenticide compounds: alphachloralose

Table 3 Farmer and PCP response to training and compliance questions - 2018

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=72) ⁽¹⁾	PCPs (n=20) ⁽²⁾
1) Have you attended a training course on rodenticide use? ⁽³⁾	*36	*95
2) Are quantity and location of baits recorded?	94	100
3) Are bait points protected from non-target animals?	99	100
4) Is bait regularly inspected?	100	100
5) Is bait removed after targeted baiting periods?	75	65
6) Are rodent carcasses searched for and removed? ⁽⁴⁾	90	100

(1) Not all farmers returned compliance data. These farmers represent 99% of the 73 farmers who conducted their own rodenticide baiting during this survey

(2) Not all PCPs returned compliance data. These 20 PCPs represented 65 per cent of the contractors encountered during this survey and collectively conducted baiting on 52 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) 58 farmers gave a response in relation to carcass disposal method. The most common method was burying (48 per cent), others included landfill (26 per cent), incineration (24 per cent) and disposal in dung middens (2 per cent). Carcass disposal methods were not collected from PCPs

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

Table 4 Farmer response to farm operation questions - 2018

Question	Percentage yes response		
	All farms (n=267) ⁽¹⁾	Farms using rodenticides (n=207) ⁽¹⁾	Farms not using rodenticides (n=60) ⁽¹⁾
1) Is your farm a member of a quality assurance scheme	94	*96	*85
2) Is livestock kept on your farm?	59	62	47
3) Do you have a pig unit on your farm?	2	2	0
4) Do you have a poultry unit on your farm?	1	1	2
5) Do you have a grain store?	66	*74	*37

(1) Not all farmers returned farm operation data. These data represent 98 per cent of the farms sampled overall, 98 per cent of those using rodenticide and 100 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<0.002)

Table 5 Farmer response to rodenticide stewardship questions - 2018

Question	Percentage yes response (n=72) ⁽¹⁾
1) Are you aware of the rodenticide stewardship scheme?	86
2a) Have you completed a stewardship compliant training course?	25
2b) If no, do you intend to complete a stewardship compliant training course in the future?	21
3) Have you purchased any rodenticides since April 2016 ⁽²⁾	90

(1) Not all farmers responded to stewardship questions. These farmers represent 99% of the 73 farmers who conducted their own rodenticide baiting during this survey

(2) The farmers who purchased rodenticides post April 2016 (90% 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 (69 per cent of purchases), followed by production of a stewardship compliant training certificate (17 per cent), purchase of amateur products (4 per cent) and purchasing non-stewardship products (3 per cent, these were available until September 2016).

Appendix 2 - Survey statistics

Census and sample information

Table 6 Distribution of arable holdings sampled in Scotland - 2018

Size Group (ha)	H & I and C & O	Moray Firth	Aberdeen	Angus	East Fife & Lothian	Central Lowlands	TV, SU & Solway	Scotland
0.01 – 19.99	6	1	4	1	2	4	4	22
20.00 – 49.99	2	3	9	5	4	7	6	36
50.00 – 99.99	2	6	16	10	12	6	7	59
100.00 – 149.99	3	6	17	12	12	4	15	69
150.00 +	0	11	11	21	20	10	13	86
Total	13	27	57	49	50	31	45	272

Table 7 Census distribution of arable holdings in Scotland - 2018

Size Group (ha)	H & I and C & O	Moray Firth	Aberdeen	Angus	East Fife & Lothian	Central Lowlands	TV, SU & Solway	Scotland
0.01 - 19.99	1,369	364	840	272	202	506	439	3,992
20.00 - 49.99	132	227	561	313	185	282	283	1,983
50.00 - 99.99	*	157	423	286	228	184	175	1,496
100.00 - 149.99	*	81	154	152	153	*	107	724
150.00 +	*	80	146	184	160	*	156	793
Total	1,564	909	2,124	1,207	928	1,096	1,160	8,988

* To prevent disclosure of information about individual holdings, entries relating to fewer than five holdings are not reported
H&I=Highlands & Islands, C&O=Caithness & Orkney, TV=Tweed Valley, SU=Southern Uplands

Raising factors

Table 8 Raising and adjustment factors for arable holdings - 2018

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	228.1667	66.0000	21.5000	5.3333		1.0026
Moray Firth	364.0000	75.6667	26.1667	13.5000	7.2727	1.0000
Aberdeen	210.0000	62.3333	26.4375	9.0588	13.2727	1.0000
Angus	272.0000	62.6000	28.6000	12.6667	8.7619	1.0000
East Fife & Lothian	101.0000	46.2500	19.0000	12.7500	8.0000	1.0000
Central Lowlands	126.5000	40.2857	30.6667	15.2500	6.3000	1.0000
Southern Uplands, Tweed Valley & Solway	109.7500	47.1667	25.0000	7.1333	12.0000	1.0000

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 9.0588(raising factor) and 1.00 (adjustment factor) to give an estimated rodenticide use in that region and size group of 90.59 kg.

Survey response rates

Table 9 Response rate for arable rodenticide survey - 2018

	2018	Percentage of total
Target sample	350	
Total achieved	272	78
Total number of farms approached	563	
Total number of refusals/non-contact	291	

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 2018 rodenticide use on arable farms survey placed on those providing the information, farmers were asked to estimate the time that they spent providing data. 90 per cent of the farmers surveyed provided this information. The median time taken was two minutes.

In addition, PCPs were also asked to estimate how long they took to provide information. 95 per cent of the PCPs supplying data provided this information. The median time taken was 15 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 £14.48⁽⁹⁾)

It is estimated that the total financial burden to respondents for the 2018 arable crop rodenticide survey was £203.69.

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. 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 2018 survey period were: FGARs (coumatetralyl and warfarin), SGARs (brodifacoum, bromadiolone, difenacoum, difethialone and flocoumafen) and non-anticoagulant rodenticides (alphachloralose, aluminium phosphide, carbon dioxide and hydrogen cyanide). The **rodenticides encountered** in this survey were; alphachloralose, brodifacoum, bromadiolone, coumatetralyl, difenacoum, difethialone 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, arable farms are defined as farms growing combinable and/or potato crops. These farms may also grow other crop types and/or have livestock in addition to arable 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 2014⁽¹⁾ and 2016⁽²⁾ surveys of rodenticide use on arable farms are provided for comparison with the estimates from arable farms 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**⁽¹⁰⁾ 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**⁽⁸⁾ 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 2018 Agricultural Census⁽¹⁰⁾, a sample was drawn representing arable cultivation in Scotland. The country was divided into 11 land-use regions (Figure 11). Each sample was stratified by these land-use regions and according to holding size. The holding size groups were based on the total area of arable crops grown. The sampling fractions used within both regions and size groups were based on the areas of relevant crops grown rather than number of holdings, so that smaller holdings would not dominate the sample.

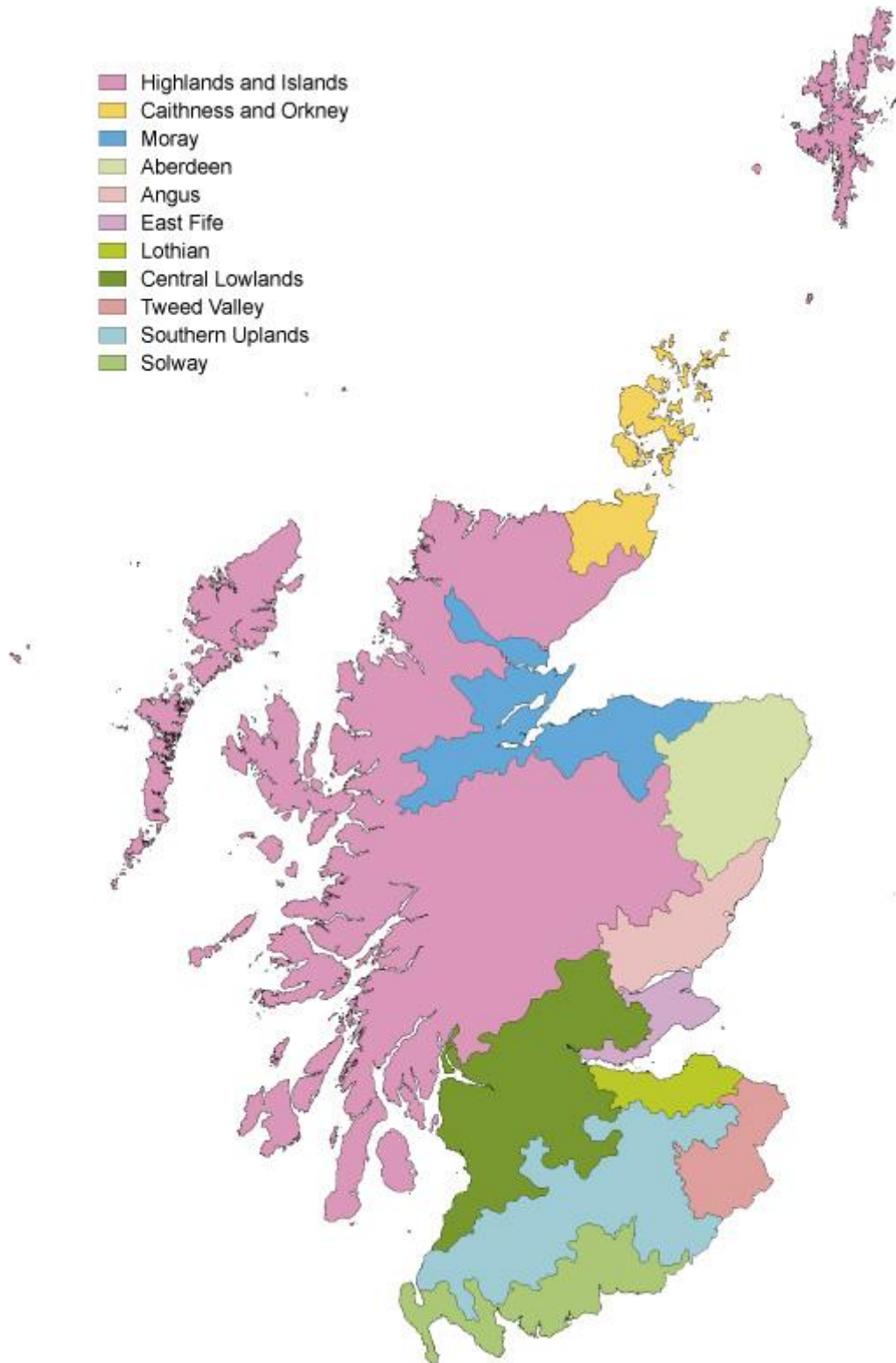
The survey covered rodenticide use during the 12 month period January to December 2018. Following an introductory letter and telephone call, data were collected by personal interview, telephone interview, email or post. When rodenticides were applied by a pest control professional (PCP) the data were obtained from either the farm rodent control record book or by post/telephone interview from the contractor. If it was recorded that rodenticides were used but product data were not obtainable this was recorded as unspecified rodenticide use.

In total, information was collected from 272 holdings (Table 6). These 272 holdings represent three per cent of the total arable holdings in Scotland (Table 7). The data collected were; who conducted the baiting, 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, their self-reported compliance with best use practice for rodenticides and their knowledge of rodenticide stewardship. Farmers were also asked to provide operation details about their farm, such as whether they kept livestock or had a grain store, to allow comparison in farm operation in relation to whether they used rodenticides.

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⁽¹¹⁾



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 Table 8.

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

There were no changes in method used from the previous survey in 2016.

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.

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