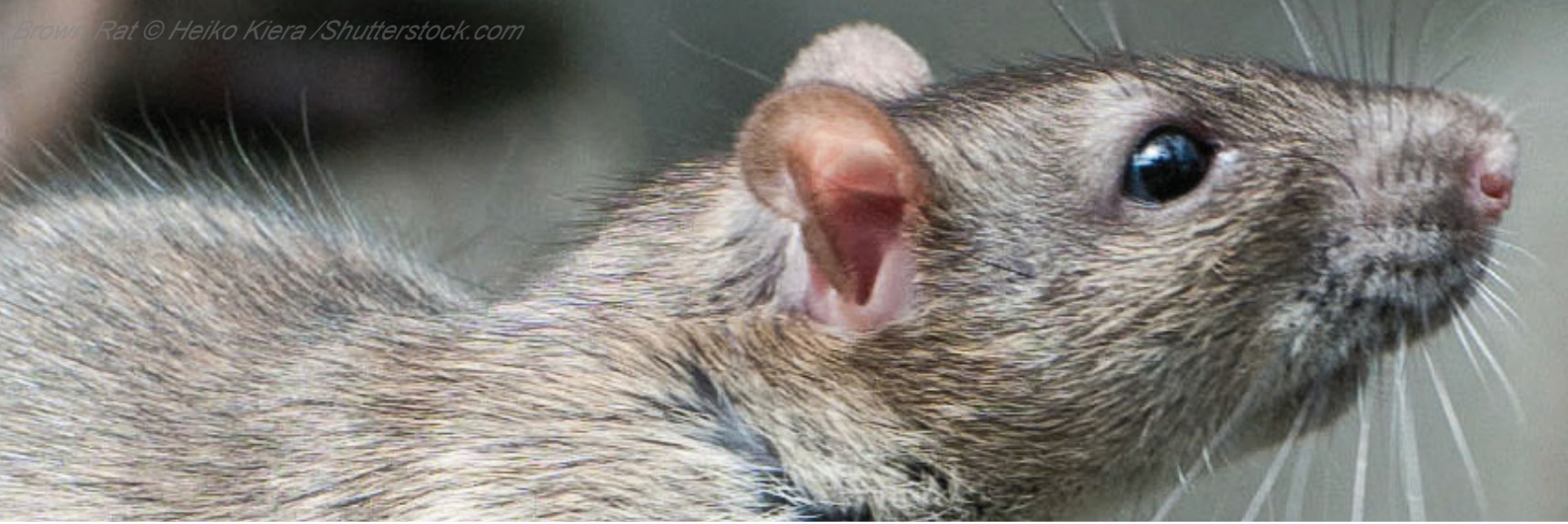


Pesticide Usage in Scotland

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A National Statistics Publication for Scotland



Rodenticides on Arable Farms 2022

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Executive summary

This report presents the results of a survey of rodenticide use on 298 arable farms in Scotland in 2022, collectively growing eight per cent of the 2022 arable crop area. Data from this sample were used to estimate total Scottish rodenticide use in this crop sector.

Rodenticides were used on an estimated 52 per cent of all arable farms in 2022, decreasing from 61 per cent reported in 2020 and 55 per cent reported in 2018. Farmers conducted the baiting on 46 per cent of holdings using rodenticides and applied 32 per cent of rodenticides by weight, almost halving their share of bait laid by weight compared to 2020. The remainder was applied by pest control professionals (PCPs). In 2022, arable farms used an estimated 40 tonnes of rodenticide products, a 35 per cent decrease since 2020 and 18 per cent decrease since 2018. The products used contained ca. 2.8 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 (90 per cent by weight), although the percentage of farms using brodifacoum increased significantly compared to 2020 (16 per cent compared to seven per cent in 2020 and from three per cent to 10 per cent by weight).

Forty-six per cent of rodenticides were applied year round, either permanently or in multiple individual baiting operations. This is similar to 2020 (45 per cent) but a large decrease from 2018 (61 per cent). Most rodenticides were used in autumn and winter (59 per cent). As in previous years, grain-based baits were the most common product type (93 per cent) targeting mainly rats, either alone (40 per cent) or combined with mice (57 per cent). Forty-six per cent of farms that did not use rodenticides and 46 per cent of those that did, employed non-chemical rodent control; most commonly cats and traps.

Eighty per cent of farmers were aware of rodenticide stewardship, of these 43 per cent had completed stewardship compliant training and 30 per cent planned to in the future. As in previous surveys, all PCPs had completed training, and this was significantly greater than uptake by farmers. As in 2020, the majority of farmers and PCPs stated that they complied with all elements of best practice. In relation to farm operation, farmers that applied rodenticides were significantly more likely to be members of a quality assurance scheme, to have a grain store and to have livestock than farmers that did not use rodenticides.

This dataset is the fourth in this series since the industry led stewardship scheme was introduced in 2015. Despite an increase in rodenticide use and reduction in the use of PCPs in 2020, the 2022 survey resumed the downward trend in rodenticide usage reported in 2018 and 2016 and continued uptake of best practice which was likely to have been influenced by the introduction of stewardship and regulatory changes. However, use of non-chemical methods declined in 2022 compared to previous surveys. It remains possible that rat populations, farmer use of PCPs and, as a consequence, bait volumes were impacted by COVID-19 restrictions during 2020.

Introduction

The Scottish Government (SG) conducts post-approval surveillance of rodenticide use. This monitoring is conducted by the Pesticide Survey Unit and the Wildlife Management Team at SASA, a division of the Scottish Government's Agriculture and Rural Economy 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 2022. This is the 16th survey in this series carried out biennially since 1992.

An Accredited Official Statistics Publication for Scotland

These statistics are accredited official statistics. The Office for Statistics Regulation has independently reviewed and accredited these statistics as complying with the standards of trustworthiness, quality, and value in the Code of Practice for Statistics.



The Scottish Pesticide Usage reports have been [accredited official statistics since October 2014](#).

Accredited official statistics are called National Statistics in the [Statistics and Registration Service Act 2007](#).

Scottish Government statistics are regulated by the Office for Statistics Regulation (OSR). OSR sets the standards of trustworthiness, quality and value in the [Code of Practice for Statistics](#) that all producers of official statistics should adhere to.

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 Wildlife Management Team. Please email wildlifeunit@sasa.gov.scot or visit [our website](#).

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 2018⁽¹⁾ and 2020⁽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 Single Application Form (SAF, used in absence of the June 2022 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

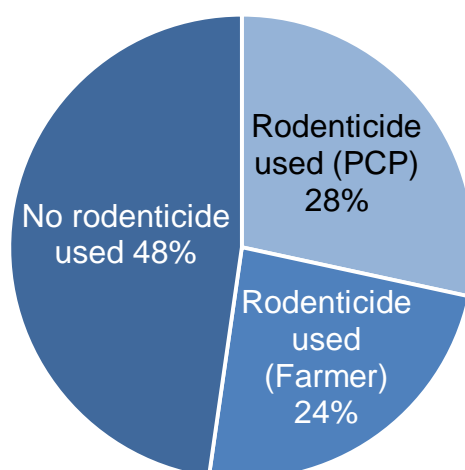
Rodenticide use data were collected from 298 arable holdings in Scotland in 2022. The farms surveyed represented four per cent of the total arable holdings in Scotland. These holdings collectively grew eight per cent of the 2022 arable crop area. The data collected from this sample were used to estimate rodenticide use on all Scottish arable farms in 2022.

Percentage of farms using rodenticides and type of user

It was estimated that approximately 52 per cent of Scottish arable farms used rodenticides in 2022 (Figure 1). Almost half of all baiting operations on farms using rodenticide (46 per cent) were implemented by farmers. Pest Control Professionals (PCPs) conducted baiting on the remainder of these farms.

Farmers were responsible for 32 per cent of the total use by weight of product. Indicating lower average use by weight than PCPs.

Figure 1 Percentage of arable farms using rodenticides and type of user – 2022

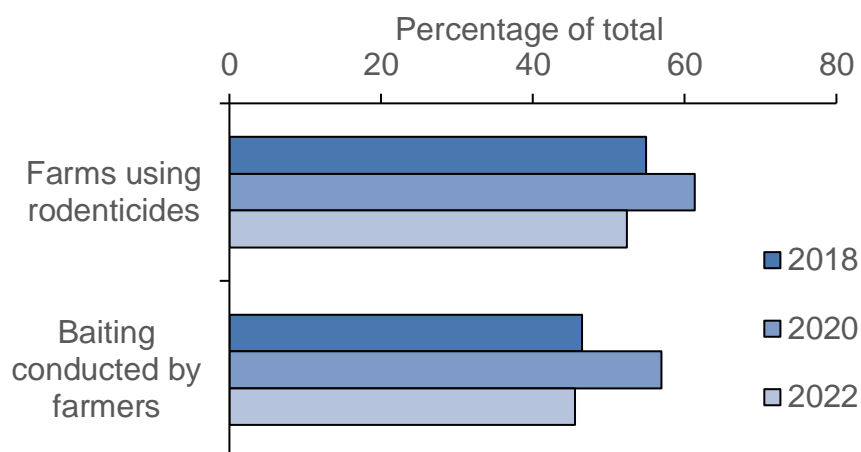


The estimated percentage of farms using rodenticides, and associated user type, in the previous two surveys (2018 and 2020) is presented in Figure 2. The proportion of arable farms using rodenticides in 2022 (52 per cent) was significantly lower (p-value 0.042) to that in 2020 (61 per cent) but there was no significant change between 2022, 2020 and 2018 when compared together (p-value 0.121).

In 2022, on farms where rodenticides were used, the proportion applied by PCPs (54 per cent) was significantly higher than in 2020 (43 per cent, (p-value 0.021)), but similar to 2018 (54 per cent). Recent surveys, since the introduction of the Rodenticide Stewardship Scheme, have shown a trend of an increasing proportion of farms using PCPs to apply rodenticides. It is

possible the decline in use of PCPs in 2020 was influenced by COVID-19 and the subsequent lockdown, and that use of PCPs is now returning to pre-pandemic levels. Although pest management was classed as an essential sector during the pandemic some farmers may have preferred to conduct their own baiting rather than using external contractors, which may also have influenced the amount of rodenticides used in 2020.

Figure 2 Percentage of arable farms using rodenticides and type of user – 2018 to 2022



Note: The number of farms using rodenticide decreased significantly between 2020 and 2022. The proportion of baiting conducted by farmers also significantly decreased between 2020 and 2022 (p-value 0.021), returning to pre-pandemic levels.

Rodenticides encountered and their estimated occurrence

During this survey, product information was recorded for 95 per cent of all occurrences of rodenticide use. This is an increase from 2020, when products were specified in only 78 per cent of cases and from 2018, where 87 per cent of products were specified. For the remaining 5 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 2020 was over 4 times higher than encountered in 2022 and was almost double that encountered in the 2018 survey (13 per cent). The spike in unspecified rodenticides in the previous survey may have been influenced by the higher proportion of farmers conducting baiting in 2020 due to the pandemic, as farmer responses are sometimes less detailed. 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

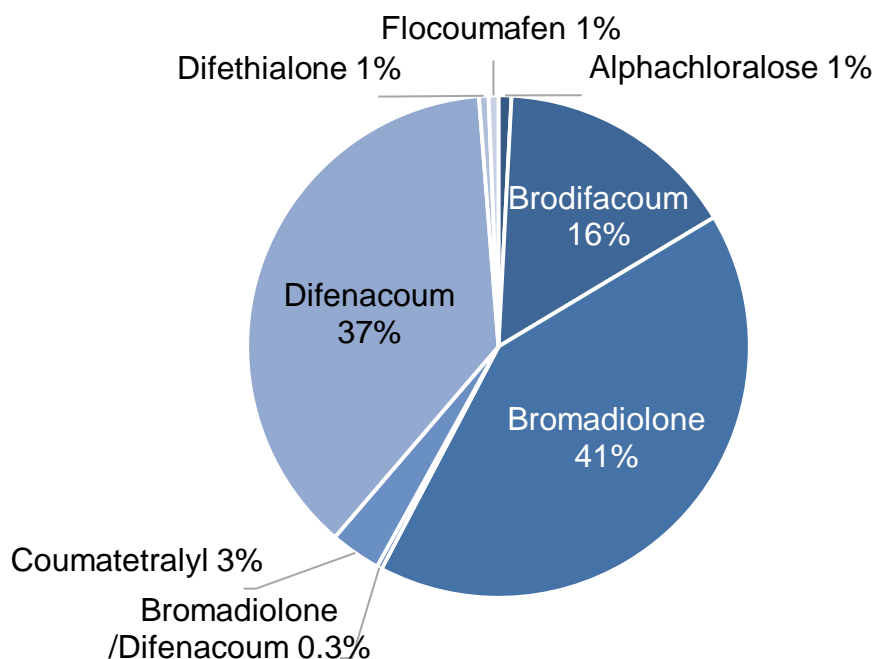
product) is encountered. Multiple uses of the same formulation at the same holding are counted as a single occurrence (refer to Appendix 3 for further explanation of these definitions).

Seven active substances were recorded on arable farms in 2022; alphachloralose, brodifacoum, bromadiolone, coumatetralyl, difenacoum, difethialone and flocoumafen (Figure 3, Table 1). One active substance, alphachloralose, is a non-anticoagulant rodenticide licenced for use against mouse infestations only. The remaining six rodenticides encountered were anticoagulants, which prevent the synthesis of blood clotting factors and cause rodent death by haemorrhage. One of the active substances was a first generation anticoagulant rodenticide (FGAR; coumatetralyl). The other five anticoagulants were second generation anticoagulant rodenticides (SGARs) and these SGARs collectively accounted for 96 per cent of all occurrences of specified rodenticide use in 2022. This is lower than the previous two surveys, where rodenticide use was almost exclusively composed of SGARs (>98 and >99 per cent in 2018 and 2020 respectively). This difference between the proportion of SGAR use in 2022 and 2020 was strongly significant (p-value 0.004).

The most commonly encountered formulations were bromadiolone and difenacoum (41 and 37 per cent of occurrences respectively). Other formulations recorded were brodifacoum (16 per cent of occurrences), coumatetralyl (three per cent), difethialone, flocoumafen and alphachloralose (all one per cent) and bromadiolone/difenacoum (less than one per cent).

In past surveys, bromadiolone and difenacoum have been identified as the most commonly available rodenticides in terms of products available⁽³⁾. However, as the number of products containing brodifacoum has increased this situation has changed, and at the time of writing bromadiolone, difenacoum and brodifacoum containing products accounted for 21, 35 and 35 per cent respectively of all currently authorised rodenticide products. Bromadiolone and difenacoum accounted for all but one product authorised for use in open areas (the other being cholecalciferol)⁽⁴⁾.

Figure 3 Percentage occurrence of rodenticide formulations on arable farms – 2022

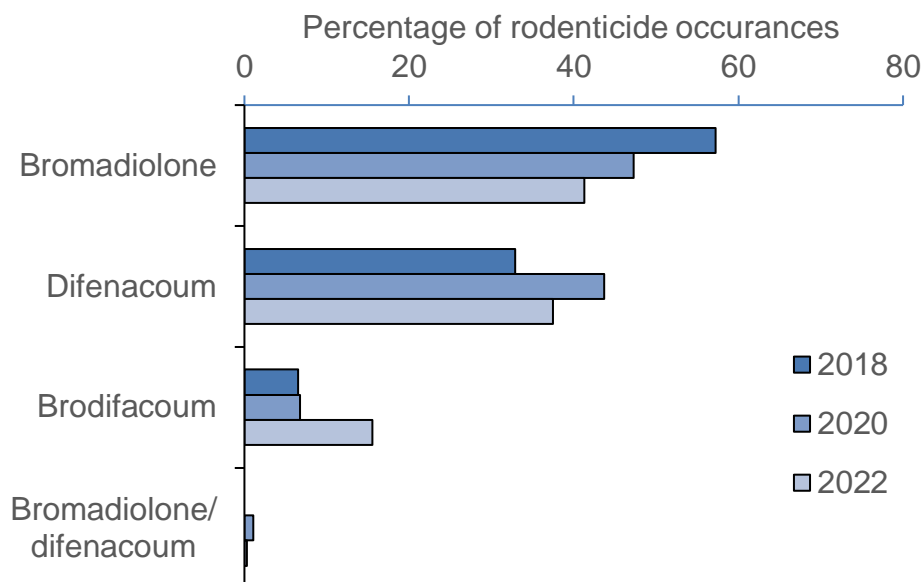


The combined use of bromadiolone and difenacoum fell to 79 per cent in 2022, after having changed little over previous surveys, this combination accounted for 90 and 92 per cent of rodenticide occurrences in 2018 and 2020 respectively. This change is largely due to an increase in use of brodifacoum and, to a lesser extent, coumatetralyl in 2022. The combined use of bromadiolone, difenacoum and brodifacoum accounted for 94 per cent of rodenticide occurrences in 2022. In 2022, the number of farms using bromadiolone was not significantly different compared to 2020 (p-value 0.144) but there was strong evidence of an overall decline across the years 2018, 2020 and 2022 (p-value <0.001). There was no evidence of a change in difenacoum use between 2020 and 2022 (p-value 0.142). However, considering 2018, 2020 and 2022 together, there was some evidence of a significant difference between the years, with more farms using difenacoum in 2020 (p-value 0.032).

There was a significant increase in use of brodifacoum between 2020 and 2022 (p-value 0.001) and strong evidence of an increase across the last three surveys (p<0.001) (Figure 4), brodifacoum use (16 per cent of farms) was more than double that recorded in 2020 and 2018 (7 and 6 per cent respectively), continuing a post-stewardship trend of increases. The mixed formulation bromadiolone/difenacoum was found at very low levels of use, accounting for less than one per cent of all specified occurrences in 2022, 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; such as resistance to both difenacoum and bromadiolone which have both been

reported in Scotland⁽⁵⁾. It may also represent a response to differences in the range of approved products available and their marketing strategies over time.

Figure 4 Percentage occurrence of rodenticides on arable farms – 2018 to 2022



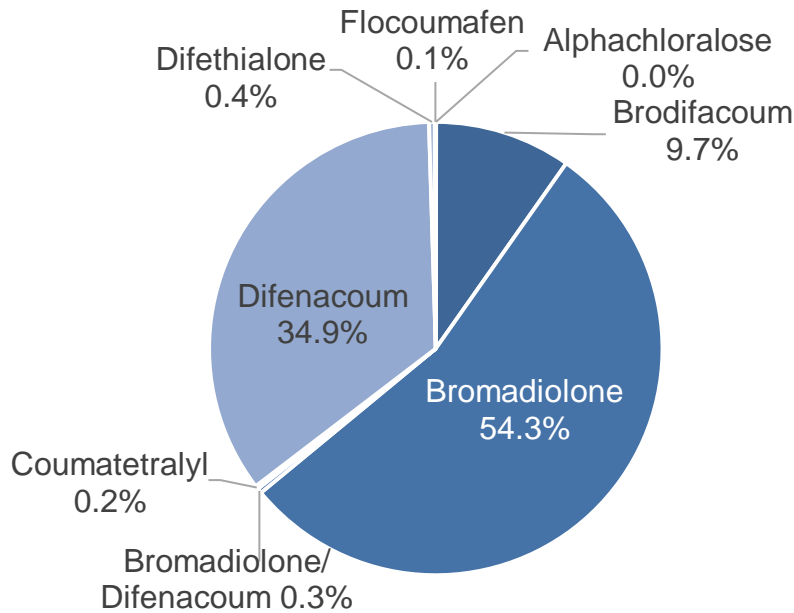
Note: there was no statistically significant change in the number of farms using bromadiolone (p-value 0.144) or difenacoum (p-value 0.142) between 2020 and 2022. In contrast, the number of farms using brodifacoum more than doubled between 2020 and 2022 (p-value 0.001).

Weight of rodenticides used

Just under 40 tonnes of rodenticidal products are estimated to have been used on Scottish arable farms in 2022 (Figure 5, Table 2), compared to around 62 tonnes in 2020. More than 99 per cent of the total weight used was SGAR products. Products containing bromadiolone were most frequently used (ca.22 tonnes), accounting for 54 per cent of total rodenticide use by weight. This was followed by difenacoum products (ca. 14 tonnes) accounting for 35 per cent of total use. The use of products containing Brodifacoum (ca. 4 tonnes) doubled compared to 2020 (ca. 2 tonnes). Alphachloralose, bromadiolone/difenacoum, coumatetralyl, difethialone and flocoumafen combined accounted for less than one tonne. 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. 40 tonnes of rodenticide product used on arable farms in 2022 contained only ca. 2.8 kg of active substance, the remainder of the product weight is almost exclusively food bait used to attract rodents. This is similar to the estimated weight of active substance reported in 2020 (3.1 kg), despite an approximate 35 per cent decrease in the weight of rodenticide product. This may have been influenced by the amount of unspecified rodenticide recorded during 2020 but also that alphachloralose

was recorded in 2022 but not in 2020. Alphachloralose products contain much higher levels of active substance (four per cent weight/weight (w/w)) compared with anticoagulants (ca. 0.005 per cent w/w).

Figure 5 Percentage weight of rodenticide product used on arable farms – 2022

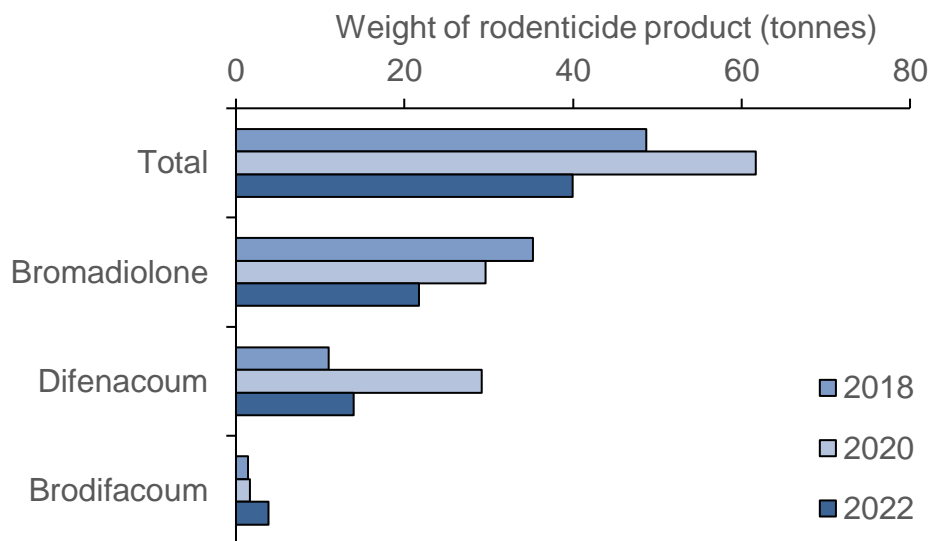


The estimated weights of the three main rodenticides recorded in the 2018, 2020 and 2022 arable crop surveys are presented in Figure 6. Overall rodenticide use in 2022 (ca. 40 tonnes) was 35 per cent lower than in 2020 (ca. 62 tonnes). However, the 2020 figure was itself an increase in use, the first for many years following a longer-term decline in rodenticide use in arable agriculture, and the reduction in 2022 may mark a return to that trend. Rodenticide use in 2022 was 18 per cent lower than in 2018 (ca. 49 tonnes) and 72 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 52 per cent in 2000 and 2022 respectively), It may also have been influenced by the greater use of PCPs (35 and 54 per cent of farms undertaking baiting in 2000 and 2022 respectively) and an increased awareness and application of best practice following the introduction of the rodenticide stewardship scheme from 2015.

At active substance level there was a 53 per cent decrease in the use of difenacoum in 2022 compared with 2020. However, the 2020 figure was considerably higher than the 2018 figure and difenacoum use in 2022 is still higher than in 2018 (by 26 per cent). The use of bromadiolone decreased by 27 per cent in 2022 compared with 2020 and by 39 per cent compared with 2018. In contrast, the use of brodifacoum in 2022 was more than double that recorded in both 2020 and 2018 (increasing by 165 per cent and 188 percent

over these respectively). There is no consistent trend in use of the three main rodenticides over the last three surveys, although over a longer period the trend appears to be declining use of bromadiolone and difenacoum and an increase in brodifacoum. The reasons for the fluctuation in difenacoum in 2020 are unclear and it should be noted that rodent populations, and thus rodenticide use, fluctuate over time. The longer term decline in rodenticide use and increased use of PCPs, which were detected in both arable and grass and fodder crop systems, are 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⁾. The increase in difenacoum use recorded in 2020 and the slightly lower use of PCPs may be a one-off exception to this trend influenced by the impact of the COVID-19 pandemic. It is not possible at this time to establish the impact of COVID-19 on farmer baiting operations and to indicate whether the 2020 data is an outlier, however, the 2022 data appears to indicate a possible return to the long-term trend. Further surveys may help to confirm this. The CRRU Code of Best Practice was revised and published in 2021 following a number of changes relating to the regulation and permitted practical uses of professional rodenticides and more recently CRRU announced further changes regarding the use of baits in open areas ⁽⁹⁾ (see rodenticide approval and stewardship section for further details). These changes could influence future rodenticide use.

Figure 6 Weight of rodenticide product used on arable farms – 2018 to 2022



Note mixed bromadiolone/difenacoum formulated products are included in total.

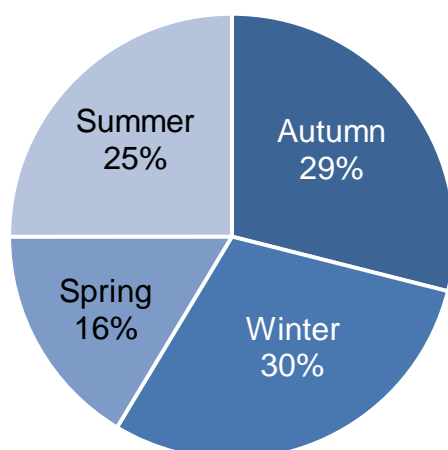
Seasonal use of rodenticides

The season in which rodenticides were used was specified for over 99 per cent of the rodenticides encountered in this survey. Forty-six 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 similar to the level reported in 2020 (45 per cent used all year round) but lower than 2018 in which 61 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 46 per cent in 2016.

When the weight used, including year-round use, is separated into constituent seasons, the greatest use was in winter (30 per cent) and autumn (29 per cent), slightly lower use in summer (25 per cent) and lowest use in spring (16 per cent) (Figure 7). Summer use was lower in previous surveys (ranging from 13 per cent to 18 per cent from 2014 to 2020).

Figure 7 Seasonal use of rodenticides on arable farms (percentage of total weight) - 2022



Rodenticide bait type and target

As with the previous survey, baits formulated with grain were the most commonly encountered in this survey, accounting for 93 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 (<1 per cent of total grain baits).

The other types of rodenticide products encountered included wax-based baits, which accounted for 5 per cent of use. Seventy-four per cent of wax baits were solid wax baits and 26 per cent were soft waxes. Pasta based bait contributed two per cent of total use, foam 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. No gel rodenticides were encountered in 2022.

Grain baits also accounted for the majority of rodenticides used in the previous two arable surveys in 2020 (82 per cent) and 2018 (90 per cent).

Survey respondents were asked to state the target of their rodenticide baiting regimes (Figure 9) and this information was supplied for all estimated use by weight. The most common target was a combination of rats and mice (57 per cent), followed by rats (40 per cent). Only three per cent of rodenticide use was targeted at mice alone. In the previous surveys in 2020 and 2018 the principal target was also a combination of rats and mice (51 per cent and 52 per cent respectively).

Figure 8 Type of rodenticide bait used on arable farms (percentage of total weight) - 2022

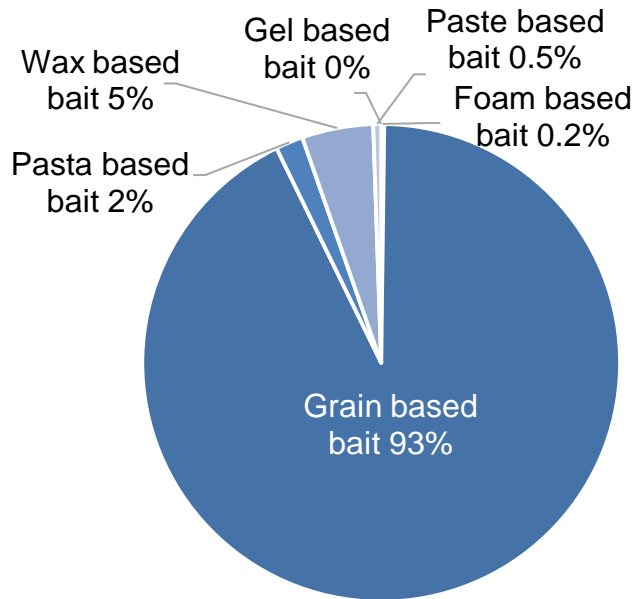
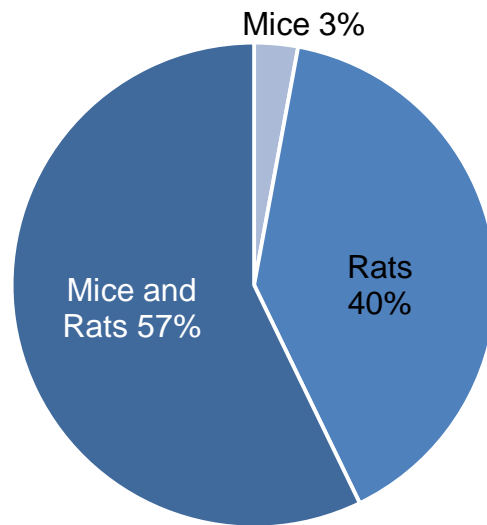


Figure 9 Target of rodenticide use on arable farms (percentage of total weight) - 2022



Supplementary data

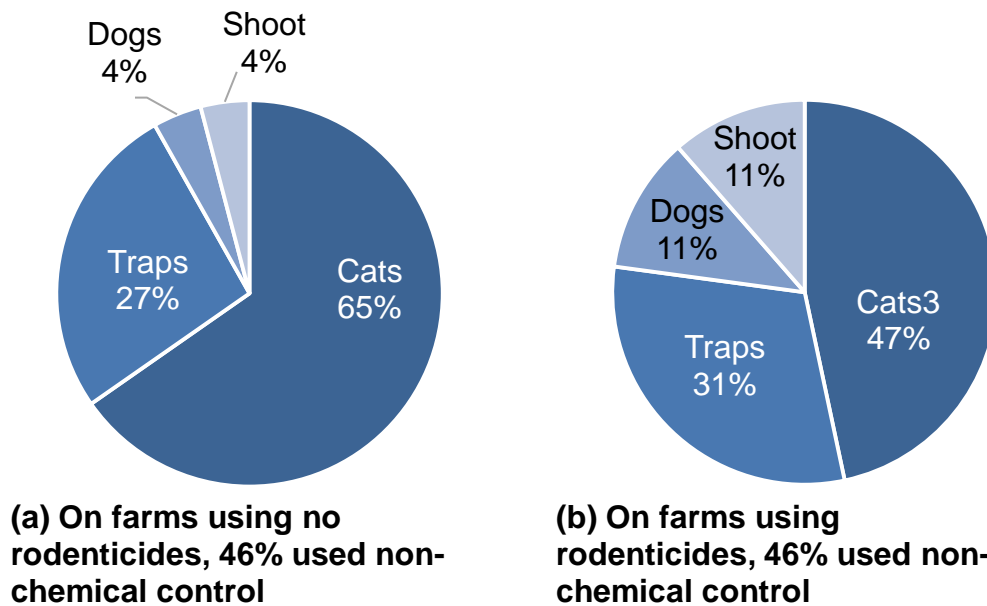
In addition to the collection of rodenticide usage data, farmers were also asked a series of supplementary questions relating to aspects of their farm operation, their use of non-chemical rodent control, rodenticide stewardship and their compliance with best practice in rodenticide use.

In contrast to the rodenticide usage data presented in the previous sections of this report, this information is not raised to provide national estimates and 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) – 2022



On holdings on which rodenticides were not used (n=99), 46 per cent of the farmers reported using one or more non-chemical controls. The most commonly encountered methods were use of cats and traps (65 and 27 per cent of all methods reported respectively). Shooting and dogs were also used to control rodents.

On holdings using rodenticides (n=199), 46 per cent reported that they used additional non-chemical methods of rodent control. Again, the most common methods used were cats and traps (47 and 31 per cent of all methods reported respectively) with lower use of dogs or shooting.

Most of the traps reported across both farms using and not using rodenticide were concussive (spring or ‘snap’ traps) (85 per cent of those who specified trap type) but cage trap and glue traps were also used (19 and five per cent of trap users respectively).

The number of farmers reporting that they employed non-chemical rodent control was lower in 2022 than in 2020 but similar to 2018 on holdings where rodenticides were used (46, 52 and 46 per cent respectively). For holdings where no rodenticides were used the numbers reporting the use of non-chemical rodent control was slightly lower in 2022 than in 2020 and 2018 (46, 51 and 60 per cent respectively).

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. Responses were provided by 69 farmers, representing 97 per cent of those farmers who conducted their own rodenticide baiting and 23 PCPs, representing 92 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.

All PCPs and 43 per cent of farmers had attended a training course on rodenticide use. The uptake of training was significantly different between farmers and PCPs (p -value <0.001).

All PCPs and 97 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. One hundred per cent of PCPs and 80 per cent of farmers removed bait after targeted baiting periods. There was a significant difference between farmers and PCPs removing bait (p -value 0.032). Levels of permanent baiting are lower than those recorded in 2020 and 2018, when 64 per cent and 65 per cent of PCPs respectively, and 65 per cent and 75 per cent of farmers respectively removed bait after targeted baiting periods. The CRRU UK Rodenticide Stewardship regime published updated permanent baiting guidance in July 2019⁽¹⁰⁾ following changes to make the rules around permanent baiting more prescriptive.

Ninety-one per cent of PCPs and 99 per cent of farmers stated that they searched for and removed rodent carcasses, with no evidence of a significant difference (p -value 0.15). Many respondents stated that they rarely saw carcasses. However, those farmers who did encounter carcasses employed a range of disposal methods; primarily burying and landfill, but also incineration (refer to table 3 for details).

Thirty-six per cent of PCPs and six per cent of farmers used non-toxic indicator baits to monitor rodent activity on farm. This use of indicator baits was significantly different between farmers and PCPs (p -value <0.001).

The pattern of responses to these questions, both by farmers and PCPs, are very similar to those provided in the 2020 and 2018 arable crop surveys. The level of training and use of non-toxic indicator baits were the only questions where there was a significant difference between farmer and PCP response.

Farmers were asked if they had ever encountered or suspected resistance to rodenticides. Of the 69 farmers who responded to this question five (seven per cent) answered confirmed that they had. Three of the five farmers responded to their concerns by changing the bait formulation used.

Farm operation data

Farmers were asked a series of questions relating to aspects of farm operation which might affect rodenticide use pattern (Table 4). Responses were provided by all 298 farms sampled.

The majority of respondents (95 per cent) were a member of a quality assurance scheme, similar to the 96 per cent recorded in 2020. 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 (98 per cent) than farms that did not use rodenticides (87 per cent) and this difference was significant (p-value <0.001).

Although all the farms surveyed grew arable crops, some were also mixed farms and 49 per cent of those surveyed kept livestock on their holding, lower than the 55 per cent observed in 2020. Only three per cent of farms had a pig unit and just 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.

Lastly, 40 per cent of holdings surveyed had an on-farm grain store, and a significantly greater number of farms using rodenticides had a grain store (48 per cent) than farms that did not use rodenticides (23 per cent) (p<0.001).

In 2022, as in 2020 and 2018, statistically significant differences between those farmers using and not using rodenticides were found in relation to quality assurance membership uptake and presence of a grain store. However, unlike the previous two surveys, in 2022 there was also strong evidence that a significantly greater number of farms using rodenticides also kept livestock (p-value <0.001). There was weak evidence that a greater number kept pigs (p-value 0.059), but this was based on a very small sample size.

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 from 2016, re-approved anticoagulant rodenticide product authorisations. As part of this re-authorisation the approval conditions for some products were amended, notably in relation to the outdoor use (around buildings only) of active substances that were previously restricted to use inside buildings (brodifacoum, flocoumafen and difethialone). Since the introduction of the scheme CRRU has continued to consider ways to strengthen the regime. The CRRU Code of Best Practice was revised in September 2021 to take into account further changes in permitted practical uses of professional rodenticides. For example, in the updated code, rodenticide use for permanent, pulsed or burrow baiting, or in covered and protected bait stations, is now only legal if the product label permits these 'non-standard' scenarios specifically. The updated code also includes new information about two active substances returning to the UK market, cholecalciferol and hydrogen cyanide, including their roles in rodenticide resistance management. When first published in 2015, the code's legal status was guidance. Since then, the Biocidal Products Regulation governing rodenticide authorisations has determined that "biocidal products shall be used in compliance with the terms and conditions of authorisation". These are summarised on product labels, thereby placing a legal obligation on pest controllers, farmers and gamekeepers. The 2021 Code of Best Practice also contains new details for using a risk hierarchy to plan effective rodent control at minimum risk to people, non-target animals and the environment. Pre-control environmental risk assessments are also recommended. Further changes due to take effect by the end of 2024 will end the authorised use of all SGAR compounds for open area baiting (i.e. away from buildings)⁹.

Changes to the Code of Best Practice may influence rodenticide usage patterns. As discussed earlier, it is possible that decreased rodenticide usage and increased adoption of non-chemical control reported in most surveys from 2016 onwards may have been influenced by the introduction of the stewardship scheme and increased adherence to best practice. The slight increase in rodenticide usage and similar levels of non-chemical control reported during 2020 may be an anomaly related to other factors such as the influence of COVID-19 pandemic restrictions.

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 69 farmers, representing 97 per cent of those farmers who conducted their own rodenticide baiting. All percentages given in the following two paragraphs are based on these 69 respondents.

Eighty per cent of farmers were aware of the rodenticide stewardship scheme's existence in 2022. Forty three per cent of the farmers responding had attended a training course and 30 per cent stated that they intended to complete training in future. Only 28 per cent had attended a stewardship compliant training course which provided certification acceptable for point of

sale purchase of professional rodenticide products. In 2020, 87 per cent of farmers were aware of the scheme, 28 per cent had completed stewardship compliant rodenticide use training and nine per cent intended to complete training in the future. The proportion of farmers that were stewardship trained has not increased in this survey, although considerably more now say they intend to undertake training. The static proportion who are stewardship trained may reflect the fact that it is not considered a priority due to the ability to obtain and use rodenticides under QA scheme membership.

Farmers were also asked how they last purchased rodenticides. Of those answering, the majority (78 per cent) obtained rodenticides by demonstrating membership of a stewardship compliant quality assurance scheme (72 per cent in 2020), 20 per cent produced a stewardship compliant training certificate, compared 26 per cent in 2020. Three per cent of farmers reported either buying amateur products, or in the case of one farmer, still using product purchased pre-stewardship. (there were no farms using these latter two methods in 2020).

Appendix 1 - Estimated rodenticide use and supplementary data tables

Table 1 Total estimated occurrence of rodenticide use on arable farms in Scotland - 2022

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

Formulation	Number of occurrences	Percentage of total specified occurrences
Alphachloralose ⁽¹⁾	43	<1
Brodifacoum	810	16
Bromadiolone	2150	41
Bromadiolone/Difenacoum ⁽¹⁾	17	<1
Coumatetralyl	170	3
Difenacoum	1950	37
Difethialone ⁽¹⁾	32	<1
Flocoumafen ⁽¹⁾	33	<1
Unspecified Rodenticide ⁽²⁾	302	
Total (excluding unspecified use)	5,205	
FGARs ⁽³⁾	170	3
SGARs ⁽⁴⁾	4,992	96
Non-anticoagulant rodenticides ⁽⁵⁾	43	<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.

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

(5) Non-anticoagulant rodenticides: alphachloralose.

Table 2 Total estimated weight of rodenticides used on arable farms in Scotland – 2022

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

Rodenticide	Formulation (kg)	Product (kg)	Product Percentage of total use
Alphachloralose ⁽¹⁾	0.49	12	0.03
Brodifacoum	0.19	3891	9.74
Bromadiolone	1.08	21682	54.26
Bromadiolone/Difenacoum ⁽¹⁾	0.01	138	0.35
Coumatetralyl ⁽¹⁾	0.34	97	0.24
Difenacoum	0.69	13948	34.90
Difethialone ⁽¹⁾	0.00	171	0.43
Flocoumafen ⁽¹⁾	0.00	21	0.05
Total ⁽²⁾	2.81	39962	100
FGARs ⁽³⁾	0.34	97	0.24
SGARs ⁽⁴⁾	1.98	39853	99.73
Non-anticoagulant rodenticides ⁽⁵⁾	0.49	12	0.03

(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.

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

(5) Non-anticoagulant rodenticides: alphachloralose.

Table 3 Farmer and PCP response to training and compliance questions - 2022

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=69) ⁽¹⁾	PCPs (n=23) ⁽²⁾
1) Have you attended a training course on rodenticide use? ⁽³⁾	*43	*100
2) Are quantity and location of baits recorded?	97	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?	*80	*100
6) Are rodent carcasses searched for and removed? ⁽⁴⁾	99	91
7) Did you use non-toxic indicator baits in the last year to monitor	6	36

(1) Not all farmers returned compliance data. These farmers represent 97 per cent of the 71 farmers who conducted their own rodenticide baiting during this survey.

(2) Not all PCPs returned compliance data. These 23 PCPs represented 92 per cent of the contractors encountered during this survey and collectively conducted baiting on 80 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) Sixty six farmers gave a response in relation to carcass disposal method. The most common methods were burying (65 per cent), landfill (30 per cent) and incineration (11 per cent), 18 PCPs gave a response in relation to carcass disposal method. The most common method was burying (44 per cent), collection by a waste contractor (28 per cent) incineration (22 per cent), and landfill (six 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 - 2022

Question	Percentage yes response		
	All farms (n=298)	Farms using rodenticides (n=199)	Farms not using rodenticides (n=99) ⁽¹⁾
1) Is your farm a member of a quality assurance scheme	95	*98	*87
2) Is livestock kept on your farm?	49	*56	*33
3) Do you have a pig unit on your farm?	3	5	0
4) Do you have a poultry unit on your farm?	2	4	0
5) Do you have a grain store?	40	*48	*23

* 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 - 2022

Question	Percentage yes (n=69) ⁽¹⁾
1) Are you aware of the rodenticide stewardship scheme?	80
2a) Have you completed a stewardship compliant training course?	28
2b) If no, do you intend to complete a stewardship compliant training course in the future?	30
3) When you last purchased rodenticides did you ⁽²⁾	
3a) Show a certificate of competence/training in rodenticide use	20
3b) Demonstrate membership of a compliant quality assurance scheme	78
3c) Purchase non-professional/amateur rodenticides (<1.5 kg pack) ⁽³⁾	1.5
3d) Still using product using product purchased pre-stewardship	1.5

(1) Not all farmers responded to stewardship questions. These farmers represent 97 per cent of the 69 farmers who conducted their own rodenticide baiting during this survey.

(2) Some farmers gave two methods in response; these responses have been evenly split between the relevant options.

Appendix 2 - Survey statistics

Single Application Form and sample information

Table 6 Distribution of arable holdings sampled in Scotland - 2022

Group Size (ha)	0.01 to 19.99	20.00 to 49.99	50.00 to 99.99	100.00 to 149.99	150.00 +	Total
H&I and C&O	5	3	5	1	0	14
Moray Firth	2	6	7	5	12	32
Aberdeen	3	11	17	13	22	66
Angus	0	6	15	9	18	48
East Fife & Lothian	2	5	13	11	32	63
Central Lowlands	3	7	8	6	5	29
TV, SU & Solway	4	9	8	10	15	46
Scotland	19	47	73	55	104	298

Table 7 SAF distribution of arable holdings in Scotland - 2022

Group Size (ha)	0.01 to 19.99	20.00 to 49.99	50.00 to 99.99	100.00 to 149.99	150.00 +	Total
H&I and C&O	738	122	49	14	8	931
Moray Firth	250	212	160	75	81	778
Aberdeen	619	494	397	160	166	1836
Angus	180	269	269	136	194	1048
East Fife & Lothian	115	168	207	130	170	790
Central Lowlands	384	278	179	63	64	968
TV, SU & Solway	402	270	176	108	157	1113
Scotland	2688	1813	1437	686	840	7464

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 - 2022

Region	Size group (ha)					Adjustment factor
	0.01–19.99	20.00–49.99	50.00–99.99	100.00-149.99	150 +	
H & I and C & O	147.60	40.67	9.80	14.00	N/A	1.0087
Moray Firth	125.00	35.33	22.86	15.00	6.75	1.0000
Aberdeen	206.33	44.91	23.35	12.31	7.55	1.0000
Angus	N/A	44.83	17.93	15.11	10.78	1.2074
East Fife & Lothian	57.50	33.60	15.92	11.82	5.31	1.0000
Central Lowlands	128.00	39.71	22.38	10.50	12.80	1.0000
TV, SU & Solway	100.50	30.00	22.00	10.80	10.47	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 100-149.99 ha sized farms in Aberdeen would be multiplied by 12.31 (raising factor) and 1.00 (adjustment factor) to give an estimated rodenticide use in that region and size group of 123.1 kg. NA = not applicable. H&I=Highlands & Islands, C&O=Caithness & Orkney, TV=Tweed Valley, SU=Southern Uplands

Survey response rates

Table 9 Response rate for arable rodenticide survey - 2022

Response rate	2022	Percentage of total
Target sample	350	100
Total achieved	298	85
Total number of farms approached	506	
Total number of refusals/non-contact	208	

Financial burden to survey respondents

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

To determine the total burden that the 2022 rodenticide use on arable farms survey placed on those providing the information, farmers were asked to estimate the time spent providing data. One hundred per cent of the farmers surveyed provided this information. The median time taken was one minute.

In addition, PCPs were also asked to estimate how long they took to provide information. Ninety one per cent of the PCPs supplying data provided this information. The median time taken was 30 minutes.

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

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

(* using median "Full Time Gross" hourly pay for Scotland of £16.69⁽¹¹⁾)

It is estimated that the total financial burden to respondents for the 2022 arable crop rodenticide survey was £258.14.

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 2022 survey period were: FGARs (coumatetralyl and warfarin), SGARs (brodifacoum, bromadiolone, difenacoum, difethialone and flocoumafen) and non-anticoagulant rodenticides (alphachloralose, cholecalciferol, aluminium phosphide, carbon dioxide and hydrogen cyanide). The **rodenticides encountered** in this survey were; alphachloralose, brodifacoum, bromadiolone, coumatetralyl, difenacoum, flocoumafen and difethialone.

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 coumatetralyl, bromadiolone, difenacoum and brodifacoum were encountered on more than 10 holdings.

11) Data from the 2018⁽¹⁾ and 2020⁽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** 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. In past reports the June census data was used to draw a sample of farms growing the relevant crops to participate in the survey, but for this report the May 2022 **Single Application Form (SAF)** data⁽¹²⁾ was used instead as the 2022 June census was paused (See Appendix 4 – changes from previous years for further information).

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 May 2022 Single Application Form (SAF) data ⁽¹²⁾, 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.

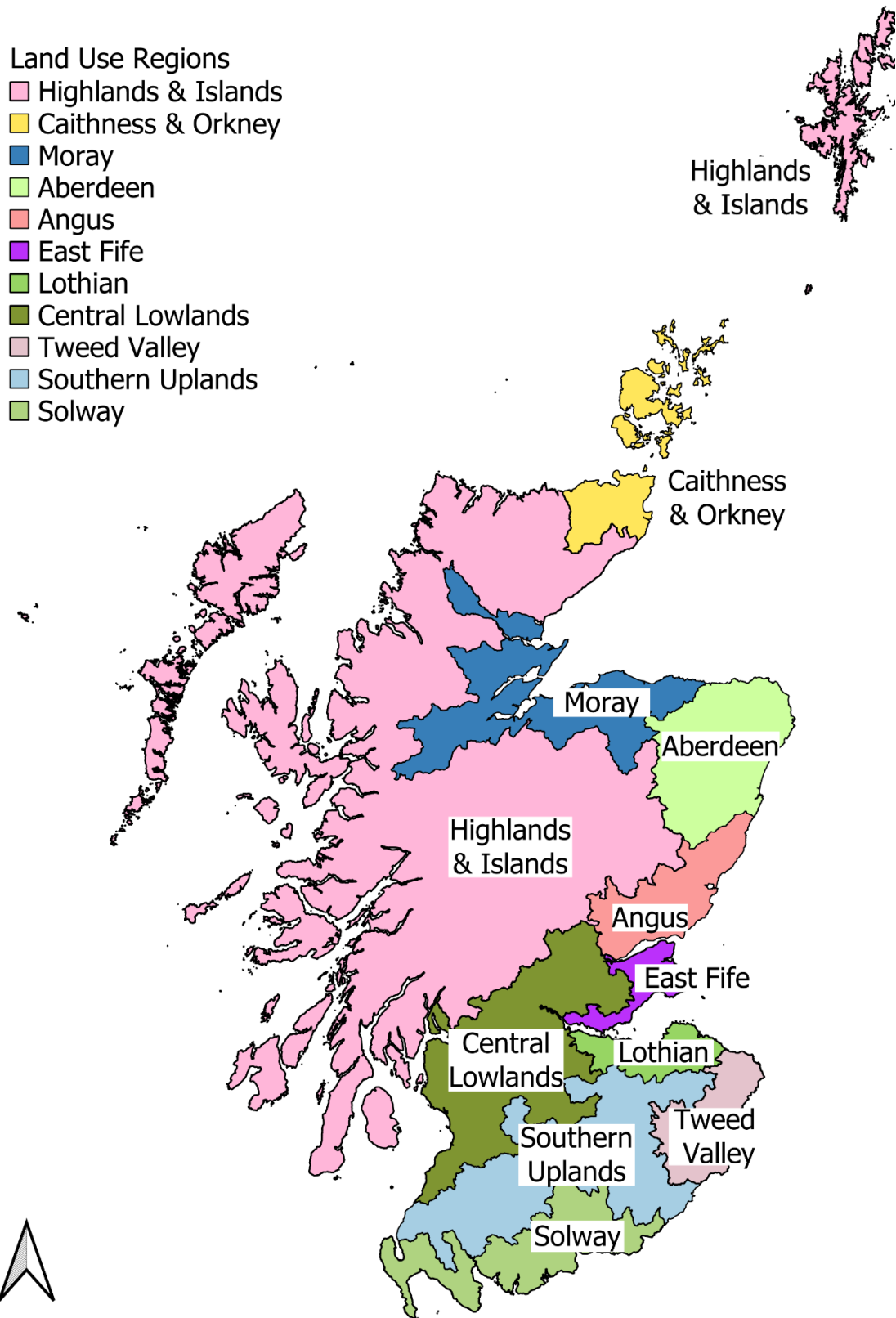
The survey covered rodenticide use during the 12 month period January to December 2022. Following an introductory letter and telephone call, data were collected by telephone interview, email or post. When rodenticides were applied by a pest control professional (PCP) the data were obtained from either 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 298 holdings (Table 6). These 298 holdings represent four per cent of the total arable holdings in Scotland, and eight per cent of the arable area (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⁽¹³⁾



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 SAF data 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

All data in 2020 had to be collected using non-visit methods such as by phone interview or by email due to restrictions imposed by the COVID-19 pandemic. In 2022, data were also primarily collected by non-visit methods in order to reduce burden on farmers. Every effort was made to achieve a robust sample.

For previous reports, the June Agricultural Census was used to draw a sample of farmers growing the relevant crops to participate in the survey. National rodenticide use was then estimated by ratio raising, by comparing the sampled numbers of holdings in each region and size group to the holding numbers recorded in the June Agricultural Census data.

To allow for the Agricultural Statistics Transformation Programme⁽¹²⁾, the June 2022 Agricultural Census was paused. This pause was agreed with the Office for Statistical Regulation and data users.

For this report, the May 2022 Single Application Form (SAF) data was used to draw the sample and estimate national pesticide use using the same methodology as previous surveys. The SAF is the form completed by farmers annually to claim a range of government payments, SAF data accounts for the majority of land area for arable crops. The sample drawn is based on area of crop grown, rather than number of holdings. As such, no attempt is made to account for holdings that are not captured by SAF returns. (Note: The difference in total Scottish arable area recorded between SAF 2022 and Agricultural Census 2021 was less than one per cent. The largest difference was biased towards the smaller size groups, less than five per cent of a difference).

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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