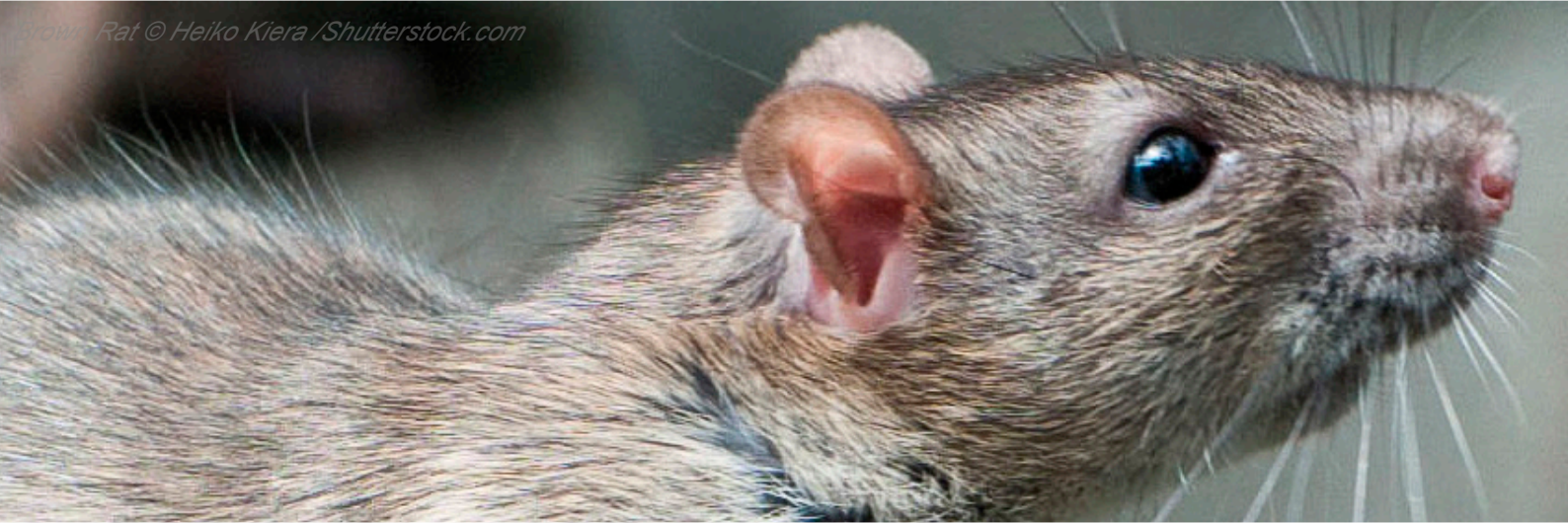


Pesticide Usage in Scotland

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A National Statistics Publication for Scotland



Rodenticides on Arable Farms 2016

Pesticide Usage in Scotland

Rodenticides on Arable Farms

2016

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Executive summary

This report presents the results of a survey of rodenticide use on farms growing arable crops in Scotland in 2016. Information was collected from 240 holdings, representing three per cent of arable farms, and was used to estimate total rodenticide use in Scottish arable agriculture.

It was estimated that rodenticides were used on 78 per cent of all arable farms in 2016, which is similar to that reported in previous surveys. Pest control professionals (PCPs) conducted the baiting on 40 per cent of holdings using rodenticides, and applied 48 per cent of rodenticides by weight.

An estimated 91 tonnes of rodenticide products were used in 2016, which was a decrease from the previous two surveys (30 and 19 per cent lower than 2012 and 2014 respectively). These products contained less than five kg of rodenticide active substance. Almost all rodenticides used were second generation anticoagulants. As in previous surveys, the most frequently used compounds were bromadiolone and difenacoum.

Just under half of farms (46 per cent) conducted rodenticide baiting throughout the year, with more rodenticides used in autumn and winter (64 per cent) than in spring and summer. Grain baits were the most common type of rodenticides encountered (86 per cent of total use) and the main targets were rats (58 per cent) or a combination of rats and mice (39 per cent).

Sixty one per cent of farms that did not use rodenticides, and 26 per cent of those that did, employed non-chemical rodent control. The most common methods were cats and traps, but dogs and shooting were also encountered.

Survey respondents were asked about their knowledge of rodenticide stewardship, training attainment, compliance with best practice and aspects of farm operation. Significantly more PCPs were aware of rodenticide stewardship than farmers (100 and 68 per cent respectively). As in previous surveys, significantly more PCPs had received rodenticide use training than farmers (100 and 11 per cent respectively). In relation to best practice, the majority of both farmers and PCPs stated that they complied with all elements identified. However, in a change from previous surveys, fewer PCPs stated that they practised permanent baiting in 2016 and, for the first time, there was no statistical difference between user groups in relation to this question. As in previous surveys, farmers were significantly less likely to search for and remove rodent carcasses than PCPs. 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 first to be produced since the industry led stewardship scheme was introduced in 2015 and subsequent HSE rodenticide product reauthorisations in 2016. Whilst some changes in use pattern and uptake of best practice have been encountered in this survey it is not possible to conclusively link these to stewardship and regulatory changes. However this data series will be useful to monitor changes which may occur in future.

Introduction

The Scottish Government (SG) conducts post-approval surveillance of rodenticide use. This monitoring is conducted by the Pesticide Survey Unit at Science and Advice for Scottish Agriculture (SASA), a division of the Scottish Government's Agriculture and Rural Economy Directorate. As part of this programme a survey of rodenticide use on farms growing arable crops was conducted in 2016. This is the 13th 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 receives survey specific statistical support from Biomathematics and Statistics Scotland ([BioSS](#)).

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

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

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

Structure of report and how to use these statistics

This report is intended to provide data in a useful format to a wide variety of data users. The results and comparison section presents the results from this survey in comparison with results from previous surveys in 2012⁽¹⁾ and 2014⁽²⁾.

Appendix 1 contains tables of results, 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 and survey response rates. Appendix 3 outlines the estimated financial burden to survey respondents. Appendix 4 defines the terms used throughout the report. Appendix 5 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 previous survey years are also outlined in Appendix 5.

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.

Data uses

The data collected by the Pesticide Survey Unit are used for a number of purposes including:

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

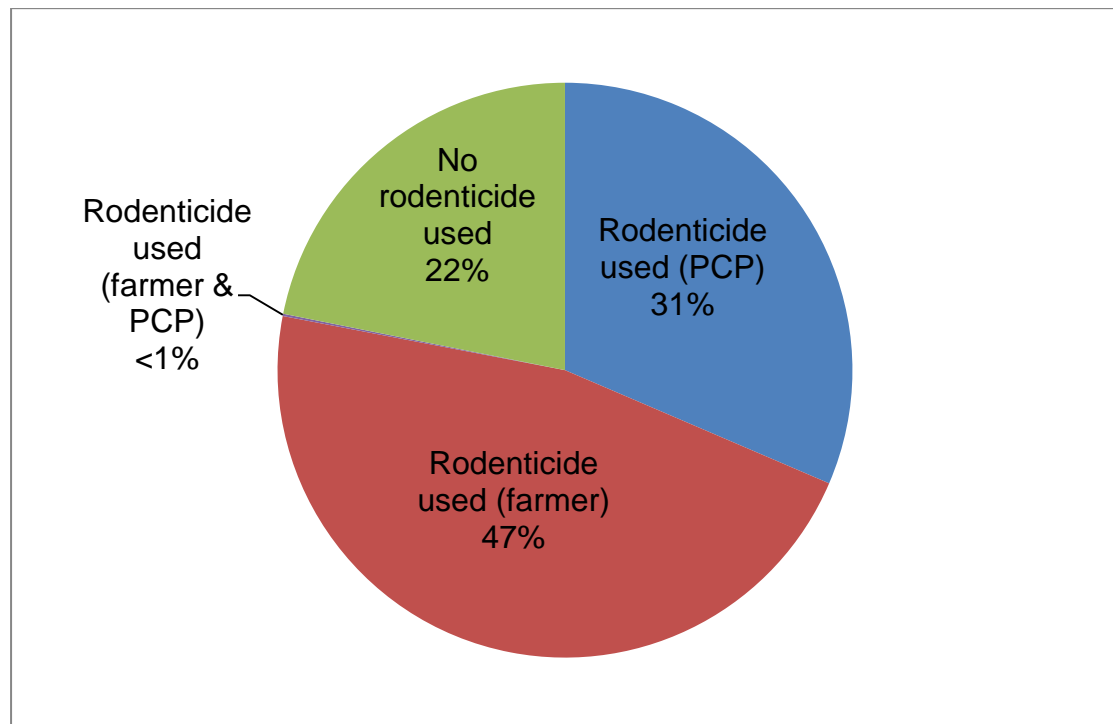
[Case studies](#) of how the Scottish dataset has been used are provided on the SASA webpage.

Results and comparison with previous surveys

Proportion of farms using rodenticides and type of user

It was estimated that 78 per cent of Scottish arable farms used rodenticides in 2016 (Figure 1). On farms where rodenticides were used, it was estimated that farmers applied rodenticides on 60 per cent of holdings and Pest Control Professionals (PCPs) conducted the baiting on the remaining 40 per cent. However, despite the fact that on the majority of farms baiting was conducted by farmers; it was estimated that farmers and PCPs used similar amounts of rodenticides overall (52 and 48 per cent of total use by weight respectively).

Figure 1 Number of arable farms using rodenticides and type of user 2016



Note: in previous reports farmer and PCP use was based on sample data rather than an estimation of the pattern in the total population (refer to Appendix 5)

The estimated percentage of farms using rodenticides, and associated user type, in the previous two surveys (2012 and 2014) is presented in Figure 2. The percentage of farms using rodenticides in 2016 was similar to that reported in 2012 and 2014 (78 and 71 per cent respectively), with a majority of arable holdings employing chemical rodent control throughout this period.

The proportion of holdings using rodenticides on which farmers conducted baiting in 2016 (60 per cent) was similar to that encountered in previous surveys (57 and 54 per cent in 2012 and 2014 respectively). However, perhaps unsurprisingly as PCPs are more likely to be used in the case of heavy rodent infestations, PCPs applied the same or more rodenticides in total than farmers. PCPs applied 59, 62 and 48 per cent of rodenticides by weight in 2012, 2014 and 2016 respectively (Figure 3).

Figure 2 Pattern of rodenticide use, and type of user conducting baiting, on arable farms in Scotland 2012 to 2016

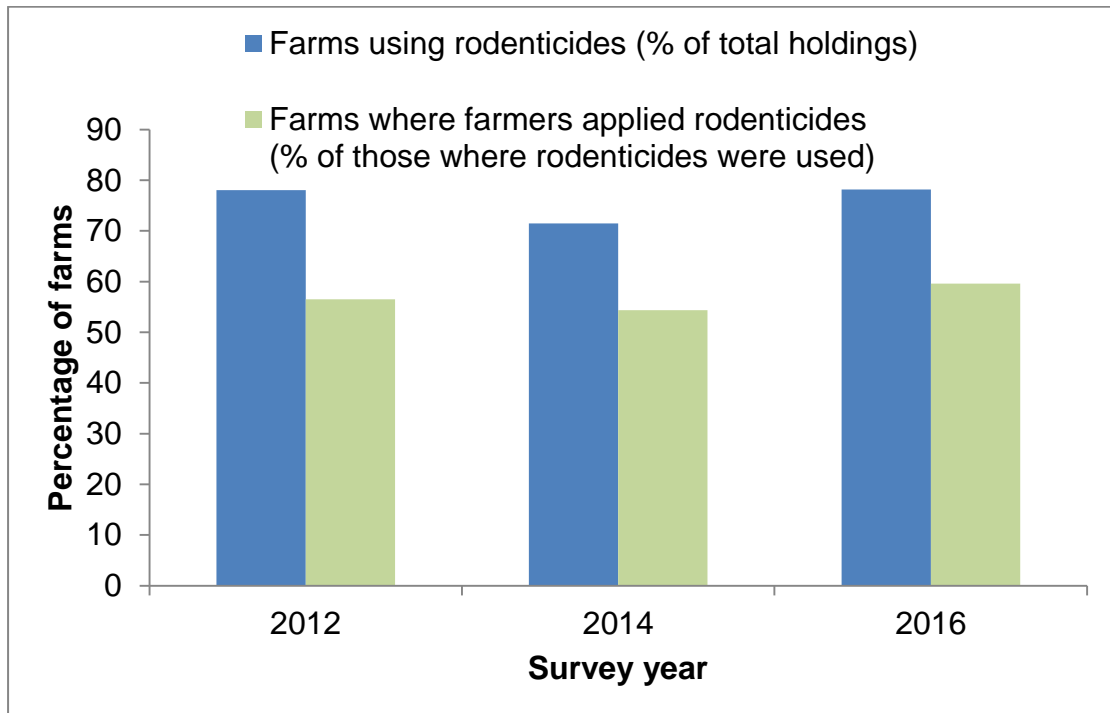
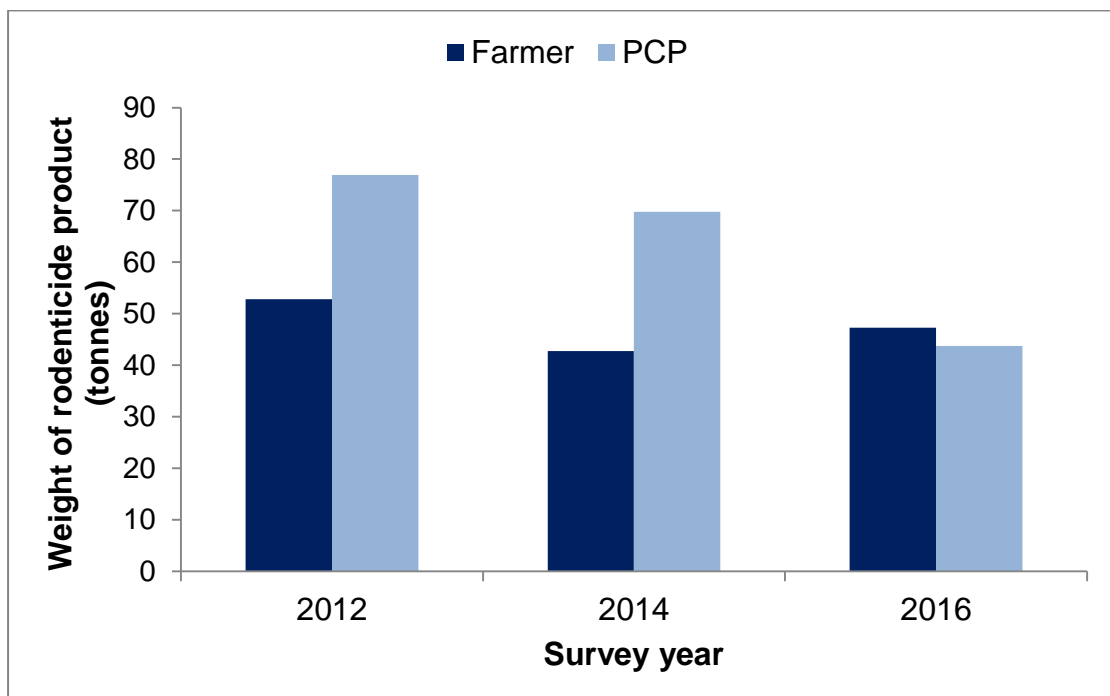


Figure 3 Weight of rodenticides applied, to arable holdings, by farmers and PCPs in Scotland 2012 to 2016

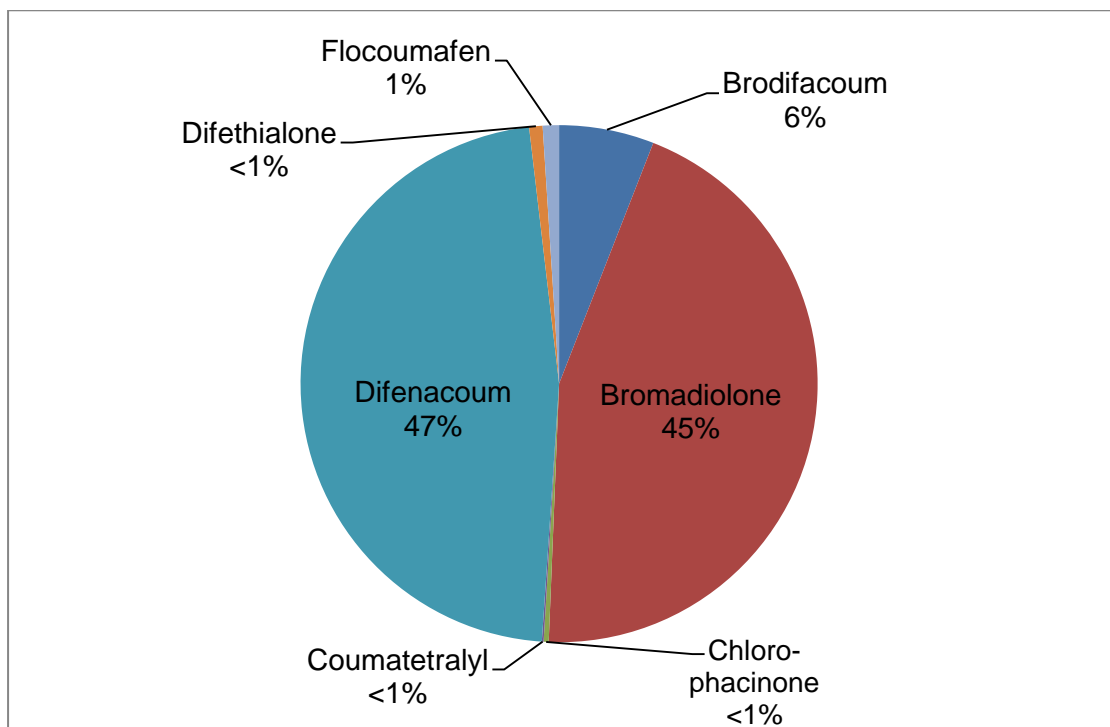


Rodenticides encountered and their estimated occurrence

During this survey product information was recorded for 96 per cent of all occurrences of rodenticide use. For the remaining four 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 records of the product used or PCPs not responding to requests for details of use. The following sections only discuss specified use of rodenticides.

All seven active substances encountered during this survey (Table 1 & Figure 4) were anticoagulant rodenticides, which prevent the synthesis of blood clotting factors and result in death by haemorrhage. Five were second generation anticoagulant rodenticides (SGARs), and these compounds collectively accounted for more than 99 per cent of all occurrences of specified rodenticide use.

Figure 4 Estimated percentage occurrence of specified rodenticide active substances on arable farms in Scotland 2016



Note: as there were 10 or fewer occurrences of coumatetralyl, chlorophacinone, difethialone and flocoumafen in the sample, estimates of their use should be treated with caution

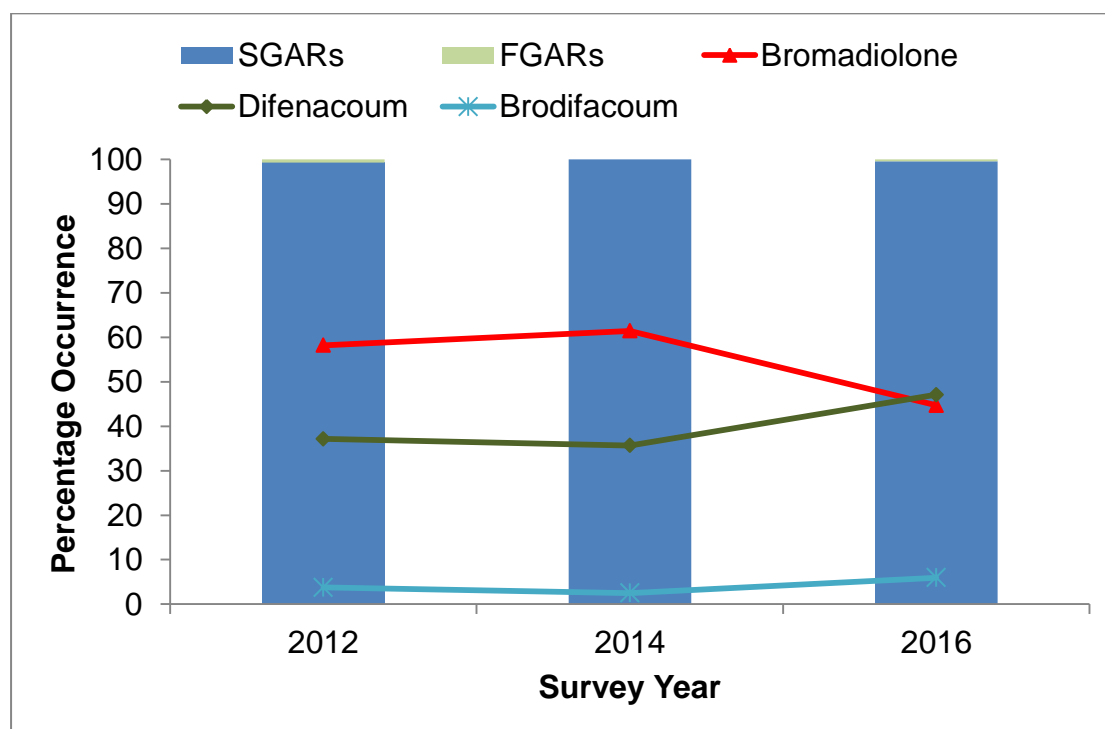
The most commonly encountered active substances were bromadiolone and difenacoum (45 and 47 per cent of all occurrences respectively). More limited use of brodifacoum, flocoumafen and difethialone was also recorded; accounting for six, one and <1 per cent of total occurrences respectively. The dominance of difenacoum and bromadiolone use reflects their being the most commonly available rodenticides. They currently account for 78 per cent of all rodenticide product approvals, 80 per cent of those approved outdoors and are the only SGAR compounds with approval for use in open areas⁽³⁾.

Of the two first generation anticoagulant rodenticides (FGARs), approved during the survey period (coumatetralyl and warfarin), only coumatetralyl was encountered (<1 per cent of occurrences). The survey also encountered a single unapproved occurrence of the withdrawn FGAR active substance chlorophacinone.

The percentage occurrence of rodenticide active substances on arable farms from 2012 to 2016 is presented in Figure 5. Over this time series rodenticide use has been almost exclusively composed of SGARs (99, 100 and >99 per cent in 2012, 2014 and 2016 respectively, no significant difference amongst years). In contrast, in 2000, FGAR compounds accounted for 20 per cent of total occurrence of use⁽⁴⁾.

The combined use of difenacoum and bromadiolone has changed little over time, accounting for 95, 97 and 92 per cent of rodenticide occurrences in 2012, 2014 and 2016 respectively. However, the relative proportions of these two compounds differed in 2016, with occurrences of difenacoum exceeding bromadiolone for the first survey since 2000⁽⁴⁾. Although it should be noted that bromadiolone use still exceeded difenacoum by weight (refer to next section).

Figure 5 Estimated percentage occurrence of anticoagulant rodenticides on arable farms in Scotland 2012 to 2016



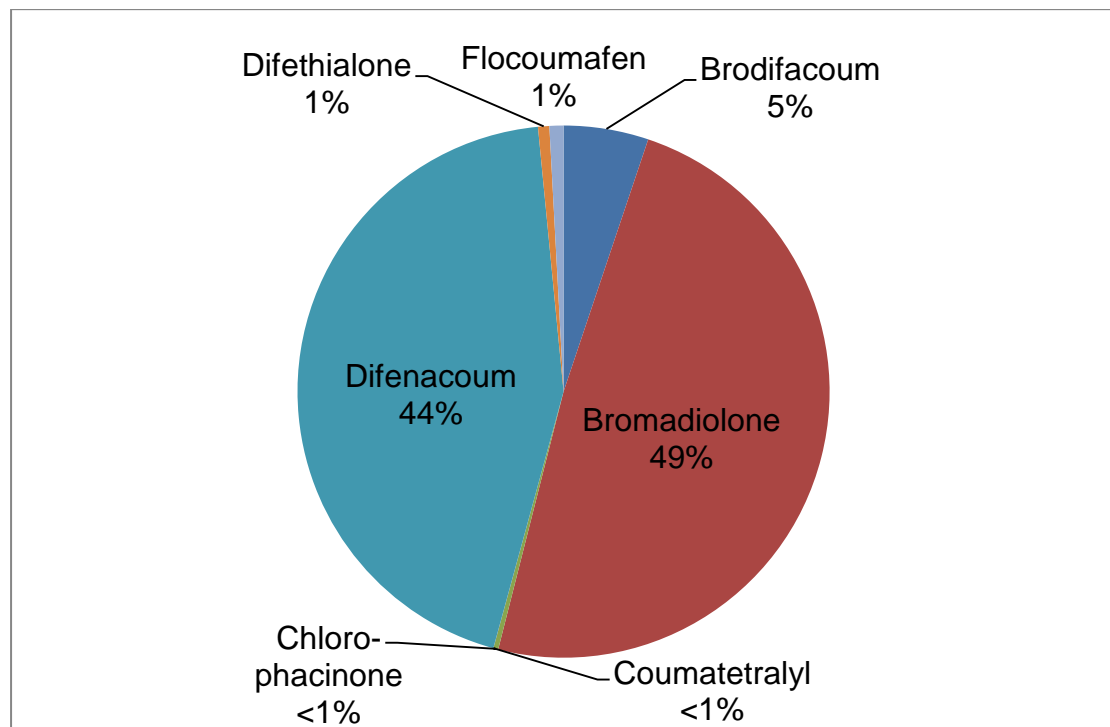
The use of brodifacoum, the third most commonly encountered rodenticide in this survey, has increased from one and three per cent of total occurrences in 2012 and 2014 respectively, to six per cent in 2016. Prior to 2016 all brodifacoum products, in addition to those containing difethialone and flocoumafen, were only authorised for use inside buildings. However, 2016

re-authorisations amended the approved location of use for many products containing these compounds. At the time of writing, the majority (96 per cent) of brodifacoum products are approved for use in and around buildings⁽³⁾. Whilst it is not possible to determine whether these changes in approval have influenced the increased occurrence of brodifacoum in the 2016 survey, they may affect future Scottish rodenticide use patterns.

Estimated weight of rodenticide used

Approximately 91 tonnes of rodenticidal products are estimated to have been used on Scottish arable farms in 2016 (Table 2). In line with the occurrence data, more than 99 per cent of the total weight used was of SGAR containing products (Figure 6). Products containing bromadiolone were the most commonly used (ca. 44 tonnes), accounting for 49 per cent of total rodenticide use by weight. Difenacoum products were the second most commonly used (ca. 40 tonnes) accounting for 44 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 91 tonnes of rodenticide used on arable farms in 2016 contained less than five kg of active substance, the remainder primarily being food bait used to attract rodents.

Figure 6 Estimated percentage weight of rodenticide product used on arable farms in Scotland 2016

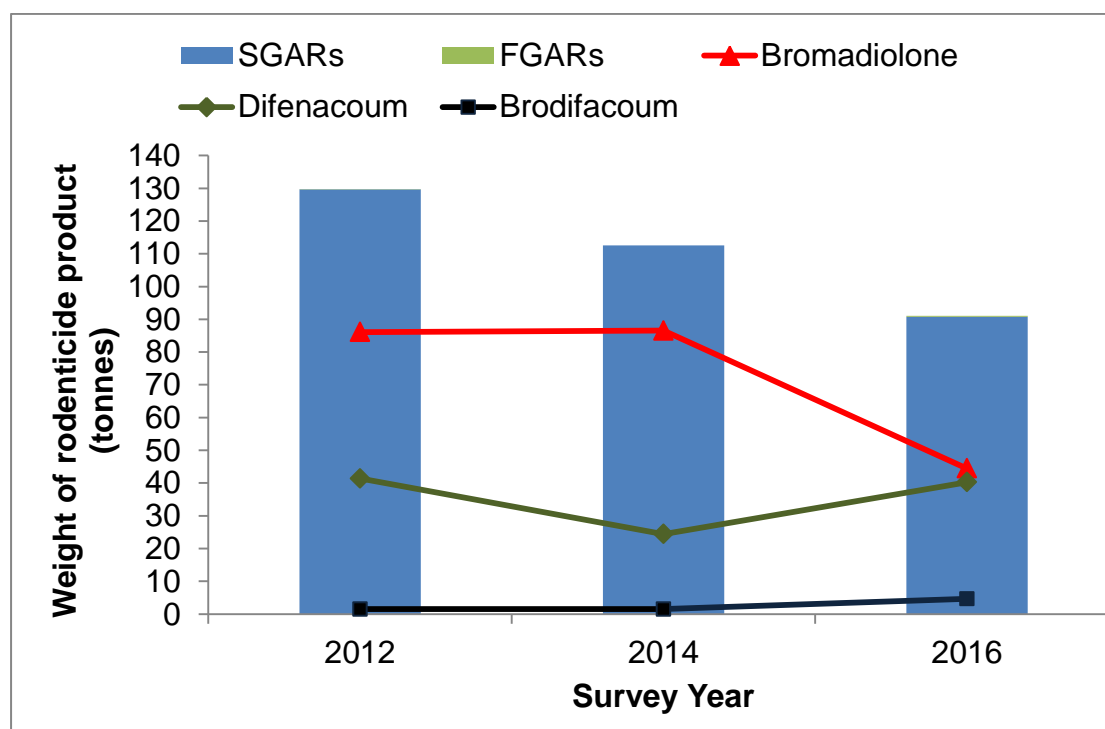


Note: as there were 10 or fewer occurrences of chlorophacinone, coumatetralyl, difethialone and flocoumafen in the sample, estimates of their use should be treated with caution

The estimated weight of rodenticides used on arable farms from 2012 to 2016 is presented in Figure 7. There has been a decrease in weight applied over these three surveys. Rodenticidal product use in 2016 (ca. 91 tonnes) was 19 per cent lower than in 2014 (ca. 113 tonnes) and 30 per cent lower than in 2012 (ca. 130 tonnes). This decline appears to be a continuation of a longer term trend of decreasing use in arable agriculture. The estimated use reported in this survey is 37 per cent lower than reported in 2000 (ca. 144 tonnes)⁽⁴⁾ despite little change in the proportion of farms on which baiting is conducted (76 and 78 per cent in 2000 and 2016 respectively).

The reason for this apparent decline in quantity of rodenticide use is unclear, and it should be noted that rodent populations, and thus rodenticide use, fluctuate over time. However, declines may also have been influenced by the creation of the Campaign for Responsible Rodenticide Usage (CRRU) and their guidance for best practice in 2005 and, in relation to the 2016 data, by the 2015 launch of the UK industry led rodenticide stewardship scheme⁽⁵⁾.

Figure 7 Estimated weight of anticoagulant rodenticide products used on arable farms in Scotland 2012 to 2016



The majority of rodenticides applied by weight over the last three surveys have been bromadiolone and difenacoum, accounting for 98, 99 and 93 per cent of bait applied in 2012, 2014 and 2016 respectively. As with the occurrence data, the relative proportions of these two compounds have changed since the last survey (bromadiolone decreasing by 49 per cent, and difenacoum increasing by 65 per cent). Brodifacoum use has also increased more than threefold since the previous survey (1,497 kg and 4,696 kg in 2014 and 2016 respectively) representing one per cent of total product weight applied in 2014 and five per cent in 2016.

The reasons for the differences in use pattern of difenacoum and bromadiolone in 2016 are also unclear. 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 South West Scotland⁽⁶⁾. It may also simply represent a response to differences in the range of products available, and their marketing strategies over time.

In relation to brodifacoum usage, it is possible that the increase in 2016 may be influenced by the recent changes in approved use locations discussed in the previous section, particularly in areas where resistance to difenacoum and bromadiolone is an issue. However, it should also be noted that the volume of brodifacoum use in 2016 is not unprecedented, with similar levels recorded in 2004 and 2010⁽⁴⁾.

Seasonal use of anticoagulant rodenticides

Season of use was specified for 95 per cent of all rodenticides surveyed (Figure 8). 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 a lower proportion than in both 2012 and 2014, when it was reported that 65 and 51 per cent of anticoagulant rodenticide use occurred throughout the year. When the weight used, including year-round use, is separated into season, the greatest use was in winter (39 per cent) with use decreasing during autumn, spring and summer. This is the same pattern reported in 2014 and 2012 (Figure 9).

Figure 8 Seasonal use of anticoagulant rodenticides on arable farms in Scotland 2016 (percentage of total weight)

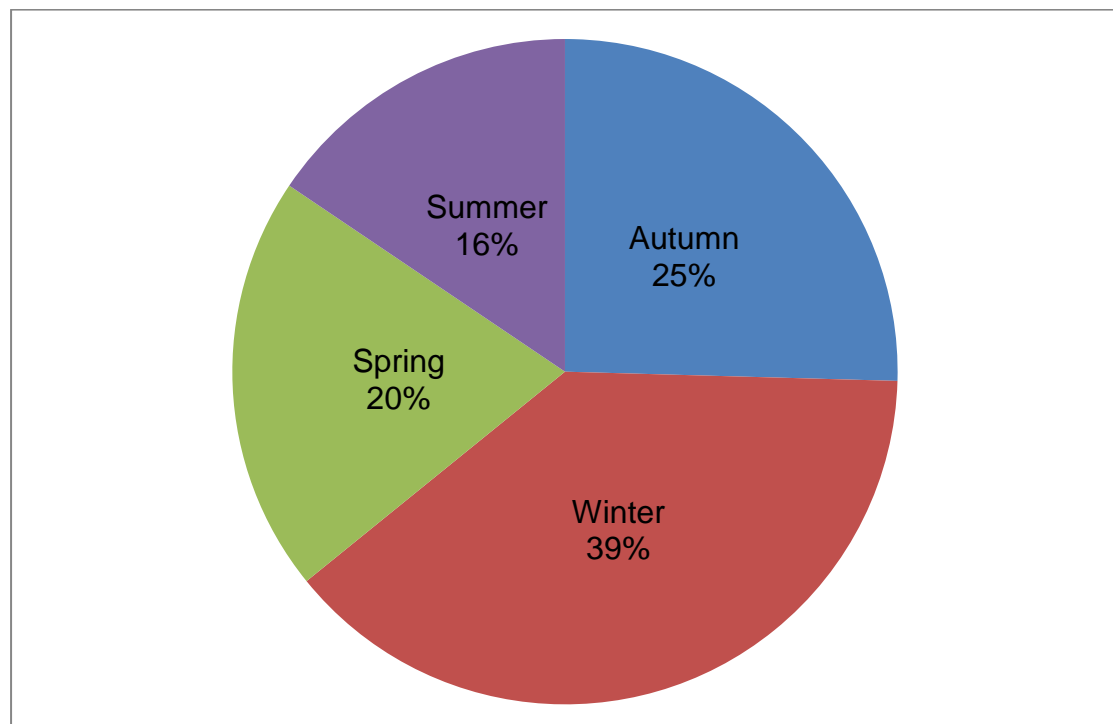
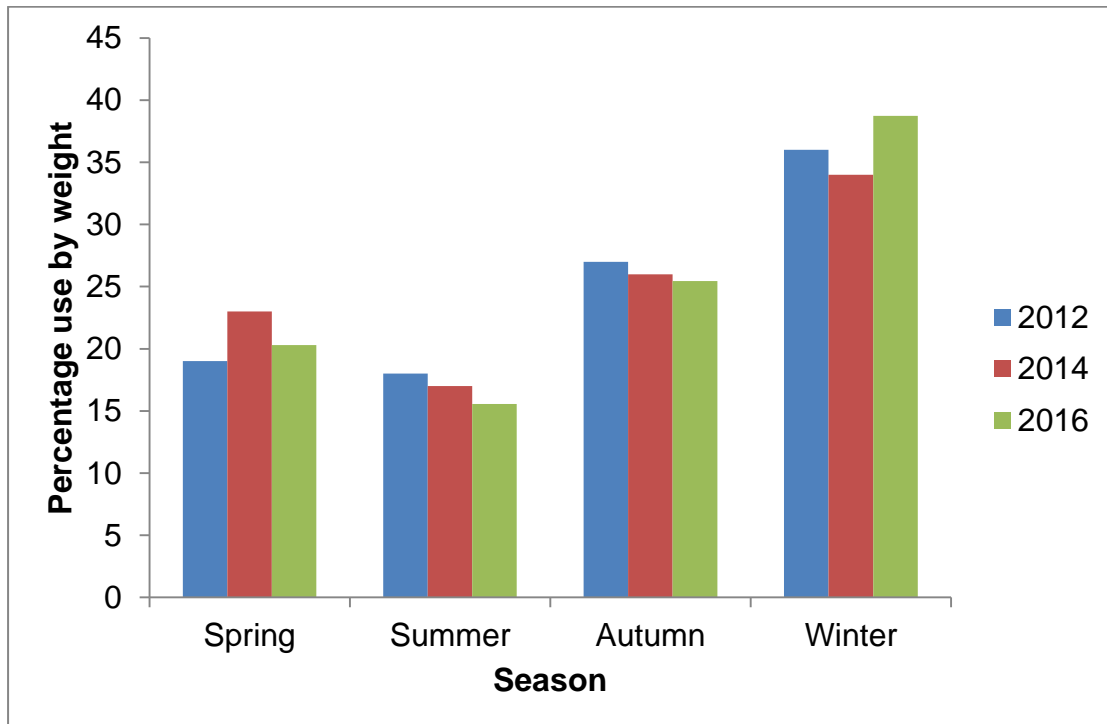


Figure 9 Seasonal use of anticoagulant rodenticides on arable farms in Scotland 2012 to 2016



Rodenticide bait type and target of baiting

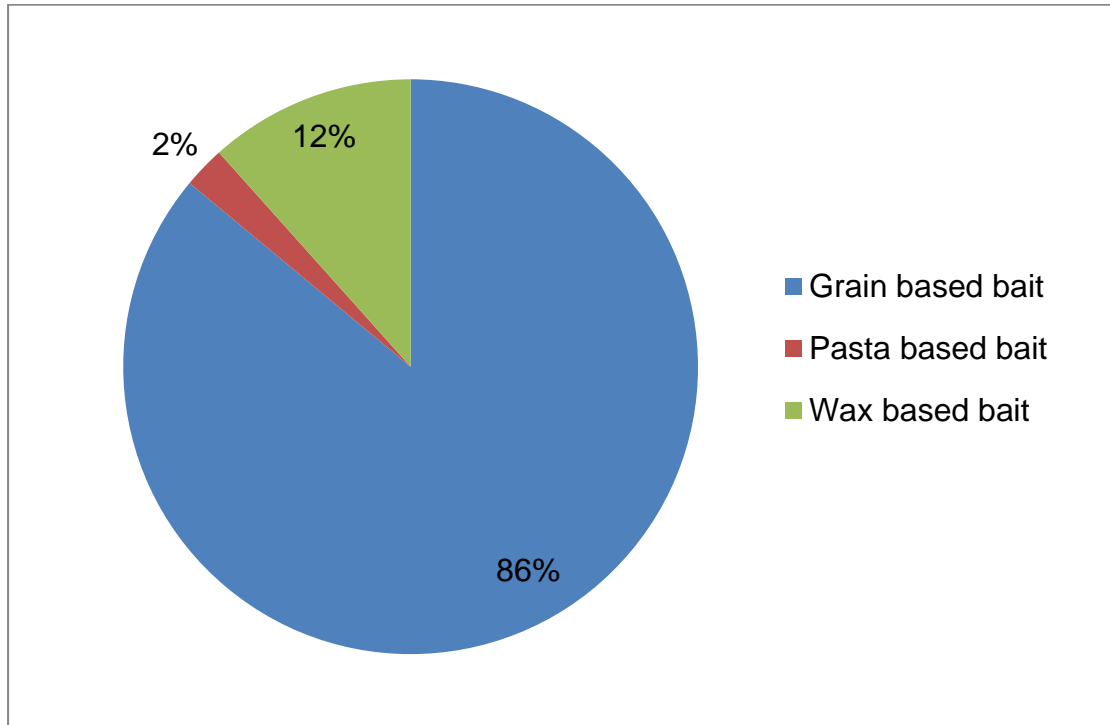
Baits formulated with grain were the most commonly encountered in this survey accounting for 86 per cent of use by weight (Figure 10). These baits were primarily loose grain and place packs containing grain, but also included a small amount of grain based paste and pelletized grain (less than one per cent of total grain baits).

The other types of rodenticide products encountered were wax baits which accounted for 12 per cent of use. All of the wax formulations were solid wax blocks. The next most frequently used type of rodenticide product was pasta based bait, contributing two per cent of total use. For the first time in this survey series, a foam rodenticide product was also encountered, this product was a contact rodenticide rather than bait, which is ingested by grooming.

Similar proportions of bait types were encountered in the previous two surveys (Figure 11). Grain baits made up 89, 93 and 86 per cent of rodenticidal baits used in 2012, 2014 and 2016 respectively.

Survey respondents were also asked to state the target of their rodenticide use (Figure 12). Where reason data were supplied the most common target was rats (58 per cent) followed by a combination of rats and mice (39 per cent). Only three per cent of use was targeted at mice alone. This is very similar to the targets reported in 2014 (60, 38 and two per cent for rats, rats/mice and mice respectively). Target data were not collected prior to 2014.

Figure 10 Type of rodenticide bait used on arable farms 2016 (percentage of total weight)



Note: There was one occurrence of a foam rodenticide product which is a contact rodenticide rather than bait; therefore it is not included in the above chart

Figure 11 Type of rodenticide bait used on arable farms 2012 to 2016

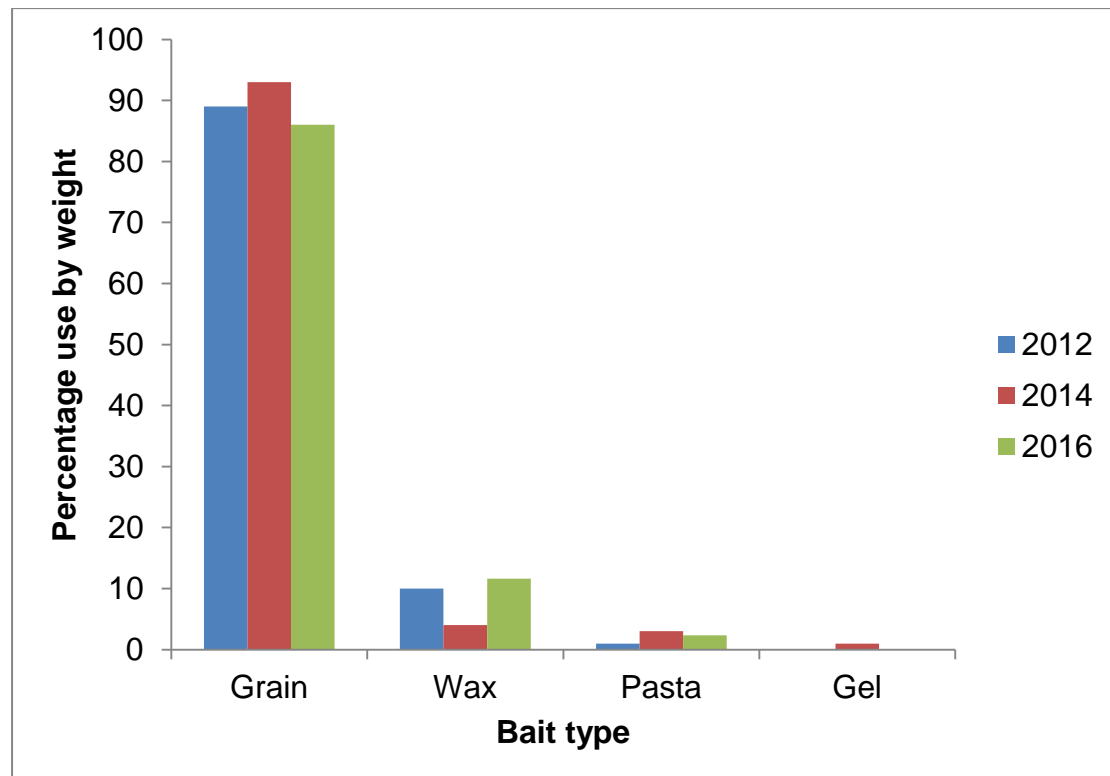
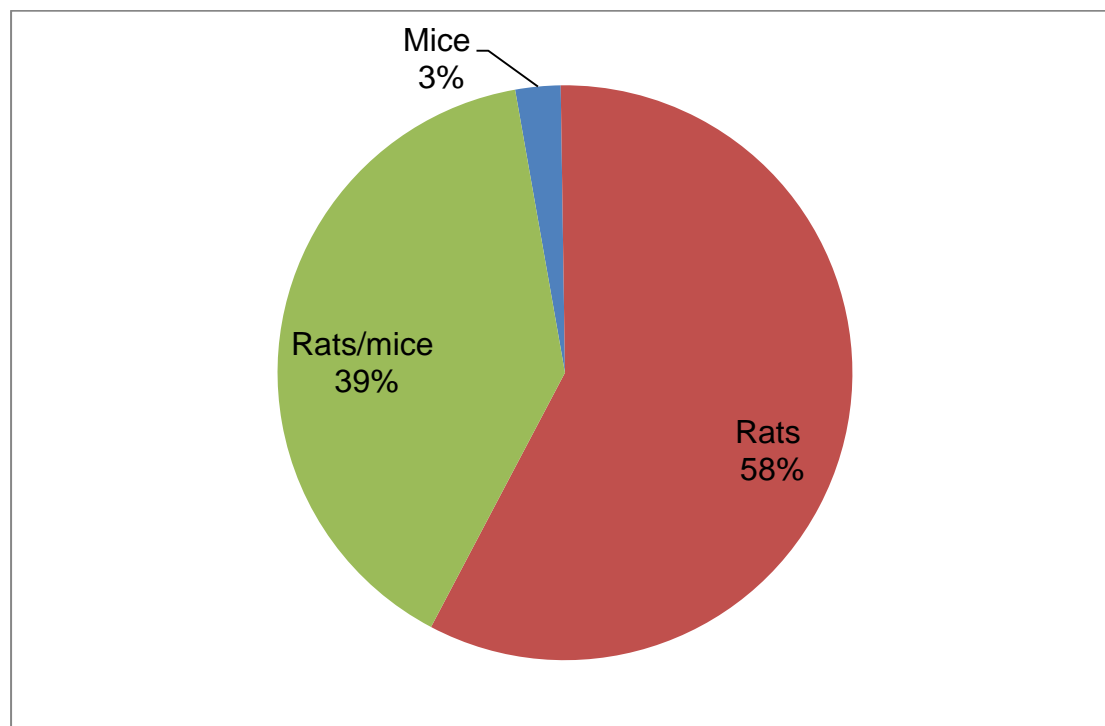


Figure 12 Target of rodenticide use on arable farms 2016 (percentage of total weight)



Non-chemical rodent control

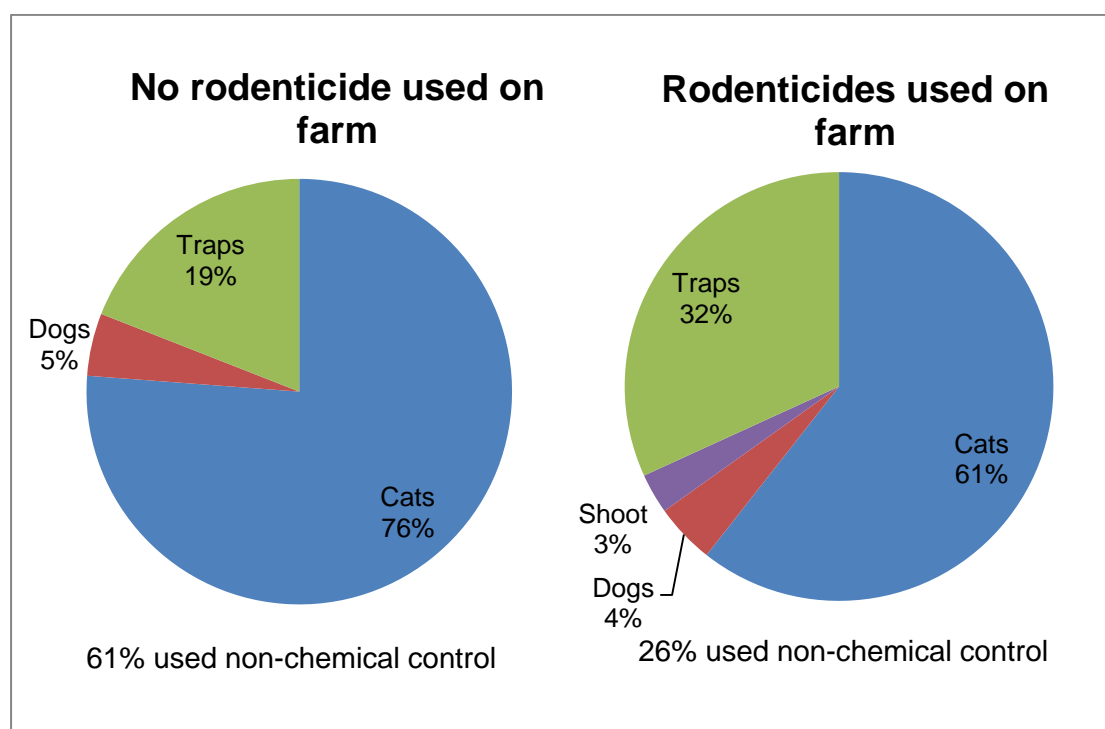
Farmers were asked about non-chemical methods employed for rodent control (Figure 13). A range of measures were conducted, with some farmers employing more than one method.

On holdings on which rodenticides were not used (n=31), 61 per cent of the farmers reported using one or more non-chemical controls. The most commonly encountered method was use of cats (76 per cent of all methods reported). These farmers also reported that they used traps (19 per cent) and dogs (5 per cent) to control rodents.

On holdings using rodenticides (n=209), a lower proportion of farmers (26 per cent) reported that they used additional non-chemical methods of rodent control. Again, the most common methods used were cats (61 per cent of all methods reported) or traps (32 per cent), with lower use of dogs and shooting (four and three per cent respectively).

Two farmers, one who used rodenticides and one who did not, commented that predation by owls also reduced rodent numbers on their farms.

Figure 13 Non-chemical control methods used on arable farms 2016



The number of farmers reporting that they employed non-chemical rodent control was greater in 2016 than in 2014. In 2014, 44 per cent of farmers who didn't use rodenticides, and 10 per cent of those who did, reported that they used non-chemical rodent control methods. The range of measures employed was similar to those encountered in the current survey. Uptake of non-chemical control was not collected prior to 2014.

Compliance with rodenticide best practice

All farmers and PCPs who were responsible for rodenticide baiting on the surveyed farms were provided with a questionnaire relating to their training history and their compliance with the principles of best practice of rodenticide use⁽⁷⁾ (Table 3).

Ninety nine per cent of farmers who conducted their own baiting (n=92) provided responses to the compliance questions. Seventy four per cent of the PCPs (n=23) also provided responses. These 23 PCP respondents were collectively responsible for baiting on 62 per cent of the farms (n=116) which used a contractor during this survey.

These data are expressed as percentage of respondents giving a positive answer to each question, where statistically significant differences in the response between farmers and PCPs were found these are noted.

All PCPs and 11 per cent of farmers had attended a training course on rodenticide use. The uptake of training was significantly different between farmers and PCPs (P<0.01).

All PCPs and 96 per cent of farmers stated that they recorded the quantity and location of baits, and all PCPs and farmers stated that these baits were protected from non-target animals. Bait was reported to be regularly inspected by all PCPs and 99 per cent of farmers.

Sixty one per cent of PCPs and sixty two per cent of farmers removed bait after targeted baiting periods.

All PCPs and 68 per cent of farmers stated that they searched for and removed rodent carcasses. Compliance with this element of best practice was significantly different between farmers and PCPs ($P < 0.01$). Most respondents stated that they rarely saw carcasses. However, those who did employed a range of disposal methods including; incineration, burying, landfill and disposal in dung heaps and slurry pits.

The responses to these questions in 2016 are very similar to those provided in 2014 and 2012. The only notable difference is that in the past two surveys significantly more farmers (59 per cent in 2012 and 69 per cent in 2014, $P < 0.01$) removed bait after targeted baiting periods than did PCPs (14 per cent and 26 per cent respectively). In 2016 the response to this question was very similar between the two groups, with a greater number of PCPs stating that they removed bait at the end of the baiting period (61 per cent) and thus complying with best practice.

Farm operation data

Farmers were asked to respond to a series of questions relating to aspects of farm operation which might affect rodenticide use pattern (Table 4). Ninety two per cent ($n=240$) of the farms surveyed provided this information; this represented 98 per cent of farms that used rodenticides and 87 per cent of those that did not.

The majority of respondents (92 per cent) were a member of a quality assurance scheme. 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 permitted purchase and use of rodenticide products authorised under stewardship conditions from April 2016 onwards during this survey. More farms that practised rodenticide baiting were members of a quality assurance scheme (97 per cent) than farms that did not use rodenticides (85 per cent) and this was significantly different ($P < 0.01$).

Although all of the farms surveyed grew arable crops, some were also mixed farms and 53 three per cent of those surveyed kept livestock on their holdings, compared to 62 per cent in 2014. Very few of these farms reared pigs or poultry and those that did, did so on a small scale (these livestock sectors are particularly vulnerable to rodent infestations and so tend to be greater users of rodenticides). Farms that used rodenticides were not

significantly more likely to have livestock than those that did not use rodenticides (57 and 41 per cent respectively).

Lastly, 62 per cent of holdings had an on-farm grain store, and a significantly greater number of farms using rodenticides had a grain store (68 per cent) than farms that did not use rodenticides (33 per cent) ($P < 0.01$).

In 2014, unlike in 2016, there was no significant difference in quality assurance membership uptake between those farmers using or not using rodenticides. However, significantly more farmers who used rodenticides in 2014 had livestock on their farm, and had a grain store, than those that did not use rodenticides.

Rodenticide approval and stewardship

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

In order to be able to re-authorise these rodenticides for use outdoors, Government must be assured that the risks will be properly managed to preclude unacceptable effects to non-target species. This is being addressed by an industry led stewardship scheme, managed by the Campaign for Responsible Rodenticide Use (CRRU)⁽⁵⁾ which was launched in 2015.

With the launch of the stewardship scheme providing environmental risk mitigation measures for rodenticide use, HSE has, during 2016, 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 future rodenticide usage patterns, and indeed the increase in brodifacoum use in this survey may indicate that users are already reacting to the changes in authorisation. It is also possible, although too early to state conclusively, that the decreased rodenticide use, increased number of PCPs using targeted baiting periods and increased adoption of non-chemical control reported in 2016 may also have been influenced by introduction of the stewardship scheme and increased uptake of best practice.

Some additional questions were included in the 2016 survey to investigate knowledge and participation in the rodenticide stewardship scheme (Table 5). All PCPs and 68 per cent of farmers were aware of the rodenticide stewardship scheme's existence. The response to this question was significantly different between farmers and PCPs ($P < 0.01$).

Nine 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, 51 per cent of farmers stated they intended to complete this training in future.

Farmers were also asked if they had purchased rodenticides after April 2016, when the product authorisations under stewardship had been implemented. Of the 38 farmers who purchased rodenticides post April 2016, the majority (29) did so by demonstrating membership of a compliant quality assurance scheme. Five purchased non-professional rodenticide products and three purchased non-stewardship products (which were available until September 2016).

Appendix 1 - Estimated Application Tables

Table 1 Total estimated occurrence of rodenticide use on arable farms in Scotland 2016

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

Formulation	No. occurrences	Percentage of total specified occurrences
Brodifacoum	508	6
Bromadiolone	3,821	45
Chlorophacinone ⁽¹⁾	27	<1
Coumatetralyl ⁽¹⁾	9	<1
Difenacoum	4,024	47
Difethialone ⁽¹⁾	72	<1
Flocoumafen ⁽¹⁾	87	1
Unspecified Rodenticide ⁽²⁾	393	
Total (excluding unspecified use)	8,547	
Total first generation anticoagulants ⁽³⁾	36	<1
Total second generation anticoagulants ⁽⁴⁾	8,511	>99

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

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

(3) First generation anticoagulant compounds: chlorophacinone (unapproved use), coumatetralyl

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

Table 2 Total estimated weight of rodenticides used on arable farms in Scotland 2016

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

Formulation	Formulation (kg)	Product	
		(kg)	Percentage of total use
Brodifacoum	0.23	4,696	5
Bromadiolone	2.22	44,448	49
Chlorophacinone ⁽¹⁾	0.02	269	<1
Coumatetralyl ⁽¹⁾	0.02	5	<1
Difenacoum	2.01	40,271	44
Difethialone ⁽¹⁾	0.02	624	<1
Flocoumafen ⁽¹⁾	0.04	774	<1
Total⁽²⁾	4.56	91,087	100
Total first generation anticoagulants ⁽³⁾	0.04	274	<1
Total second generation anticoagulant ⁽⁴⁾	4.53	90,813	>99

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

(2) Not including unspecified rodenticides

(3) First generation anticoagulant compounds: chlorophacinone (unapproved use), coumatetralyl

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

Table 3 Response to training and compliance questions

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=92) ⁽¹⁾	Pest control professional (n=23) ⁽²⁾
1) Have you attended a training course on rodenticide use?	11*	100*
2) Are quantity and location of baits recorded?	96	100
3) Are bait points protected from non-target animals?	100	100
4) Is bait regularly inspected?	99	100
5) Is bait removed after targeted baiting periods?	62	61
6) Are rodent carcasses searched for and removed? ⁽³⁾	68*	100*

(1) This represented 99% of farmers who conducted their own baiting during this survey

(2) This represented 74 per cent of the contractors encountered during this survey. These 23 PCPs collectively conducted baiting on 62 per cent (n=116) of those farms using a PCP

(3) Most respondents stated that they rarely saw carcasses. However, those who did employ a range of disposal methods including; incineration, burying, landfill and disposal in dung heaps and in slurry pits

* Responses marked with an asterisk are significantly different between farmers and PCPs (P<0.01)

Table 4 **Response to farm operation questions**

Question	Percentage yes response		
	All farms (n=240) ⁽¹⁾	Farms using rodenticides (n=209) ⁽¹⁾	Farms not using rodenticides (n=31) ⁽¹⁾
1) Is your farm a member of a quality assurance scheme	92	97*	85*
2) Is livestock kept on your farm?	53	57	41
3) Are pigs kept on your farm?	1	1	4
4) Is poultry kept on your farm?	2	1	4
6) Do you have a grain store?	62	68*	33*

(1) These data represent 92 per cent of the farms sampled overall, 98 per cent of those using rodenticide and 87 per cent of those not using rodenticides

* Responses marked with an asterisk are significantly different between those farms that did and did not use rodenticides in 2016 (P<0.01)

Table 5 Response to rodenticide stewardship questions

Question	Percentage yes response	
	Farmer (n=92) ⁽¹⁾	Pest control professional (n=23) ⁽²⁾
1) Are you aware of the rodenticide stewardship scheme?	68*	100*
2a) Have you completed a stewardship compliant training course?	9	N/A
2b) If no, do you intend to complete a stewardship compliant training course in the future?	51	N/A
3) Have you purchased any rodenticides since April 2016 ⁽³⁾	41	N/A

(1) This represented 99% of farmers who conducted their own baiting during this survey

(2) This represented 74 per cent of the contractors encountered during this survey. These 23 PCPs collectively conducted baiting on 62 per cent (n=116) of those farms using a PCP

(3) Of the 38 farmers who purchased rodenticides post April 2016 (41% of respondents), the majority (29) did so by demonstrating membership of a compliant quality assurance scheme. Five purchased non-professional rodenticides and three purchased non-stewardship products which were available until September 2016

N/A (not applicable) - PCP training is compliant with rodenticide stewardship (via grandfather rights or new certification)

* Significantly different between farmers and PCPs (P<0.01)

Appendix 2 - Survey statistics

Census and sample information

Table 6 Distribution of arable holdings sampled in Scotland 2016

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	7	2	5	2	0	2	1	19
20.00 - 49.99	3	4	12	5	4	7	6	41
50.00 - 99.99	3	6	16	11	6	9	5	56
100.00 - 149.99	1	4	13	9	10	3	6	46
150.00 +	1	8	15	19	12	10	13	78
Total	15	24	61	46	32	31	31	240

H&I=Highlands & Islands, C&O=Caithness & Orkney, TV=Tweed Valley, SU=Southern Uplands

Table 7 Census distribution of arable holdings in Scotland 2016

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	1,351	375	888	288	199	574	515	4,190
20.00 - 49.99	131	244	600	304	185	334	294	2,092
50.00 - 99.99	52	156	431	317	240	198	183	1,577
100.00 - 149.99	13	78	166	163	145	62	117	744
150.00 +	2	75	135	174	168	61	155	770
Total	1,549	928	2,220	1,246	937	1,229	1,264	9,373

H&I=Highlands & Islands, C&O=Caithness & Orkney, TV=Tweed Valley, SU=Southern Uplands

Table 8 Raising and adjustment factors for arable holdings

Region	Size Group (ha)					Adjustment factor
	0-19.9	20-49.9	50-99.9	100-149.9	150 +	
Caithness & Orkney and Highlands & Islands	193.00	43.67	17.33	13.00	2.00	1.0000
Moray Firth	187.50	61.00	26.00	19.50	9.38	1.0000
Aberdeen	177.60	50.00	26.94	12.77	9.00	1.0000
Angus	144.00	60.80	28.82	18.11	9.16	1.0000
East Fife & Lothian	0.00	58.72	50.79	18.41	17.78	1.2696
Central Lowlands	287.00	47.71	22.00	20.67	6.10	1.0000
Solway, Southern Uplands & Tweed Valley	515.00	49.00	36.60	19.50	11.92	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 5 for description of statistical estimation process). For example, a total recorded rodenticide use of 10 kg on 100-149.9 ha sized farms in Aberdeen would be multiplied by 12.77 (raising factor) and 1.00 (adjustment factor) to give an estimated rodenticide use in that region and size group of 127.7 kg

Survey response rates

Table 9 Response rates for rodenticide survey

	2016	Percentage of total
Target sample	350	
Total number of farms approached	451	
Achieved rodenticide responses	240	53
Total number of refusals/non-contact	211	

Appendix 3 - Financial burden of rodenticides on arable farms survey

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

To determine the total burden that the 2016 rodenticide use on arable farms Survey placed on those providing the information, the surveyors recorded the time that 139 farmers spent providing the data during the survey. This sample represents 58 per cent of farmers surveyed. Information was recorded from all strata of the sample to ensure that the overall estimate of burden was representative. The median time farmers took to provide the information was three minutes.

In addition, 19 PCPs who provided rodenticide use data and four PCPs who provided compliance data were asked to estimate how long they took to provide information. The median time taken for the PCPs providing rodenticide use data was 15 minutes and for those providing compliance data was three and a half minutes.

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

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

(* using median “full Time Gross” hourly pay for Scotland of £13.48⁽⁸⁾)

The total financial burden to respondents for the 2016 rodenticide survey was £336.77.

Appendix 4 - 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 an active substance refers to a substance which has a detrimental effect on rodents.
- 3) The term **product** is used to describe a marketed rodenticide product which contains active substances, bait and other co-formulants.
- 4) The term **formulation(s)** is used to describe an active substance or mixture of active substances formulated together in a product. In this survey all products encountered contained a single active ingredient.
- 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 broken down further into first and second generation compounds (**FGARs** and **SGARs** respectively). The FGARs, which were the first anticoagulant compounds to be developed, are generally less acutely toxic than SGARs.
- 6) The **rodenticides approved for use** in the UK during the 2016 survey period were: FGARs (coumatetralyl and warfarin), SGARs (brodifacoum, bromadiolone, difenacoum, difethialone and flocoumafen) and non-anticoagulant rodenticides (alphachloralose, aluminium phosphide and powdered corn cob). The **rodenticides encountered** in this survey were; brodifacoum, bromadiolone, chlorophacinone, coumatetralyl, difenacoum, difethialone and flocoumafen. The chlorophacinone use encountered in this survey was a single unapproved occurrence of use of a withdrawn product. No non-anticoagulant rodenticides were encountered in this survey.
- 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** (encountered on 10 or less holdings) are marked with an asterisk 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 2012 and 2014 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**⁽⁹⁾ is conducted annually by the Scottish Government's Rural and Environmental Science Analytical Services (RESAS). The June Agricultural Census collects data on land use, crop areas, livestock and the number of people working on agricultural holdings. For this report the Census was used to draw a sample of farms growing the relevant crops to participate in the survey.

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

Appendix 5 - Survey methodology

Sampling and data collection

Using the June 2016 Agricultural Census⁽⁹⁾, a sample was drawn representing arable cultivation in Scotland. The country was divided into 11 land-use regions (Figure 14). 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.

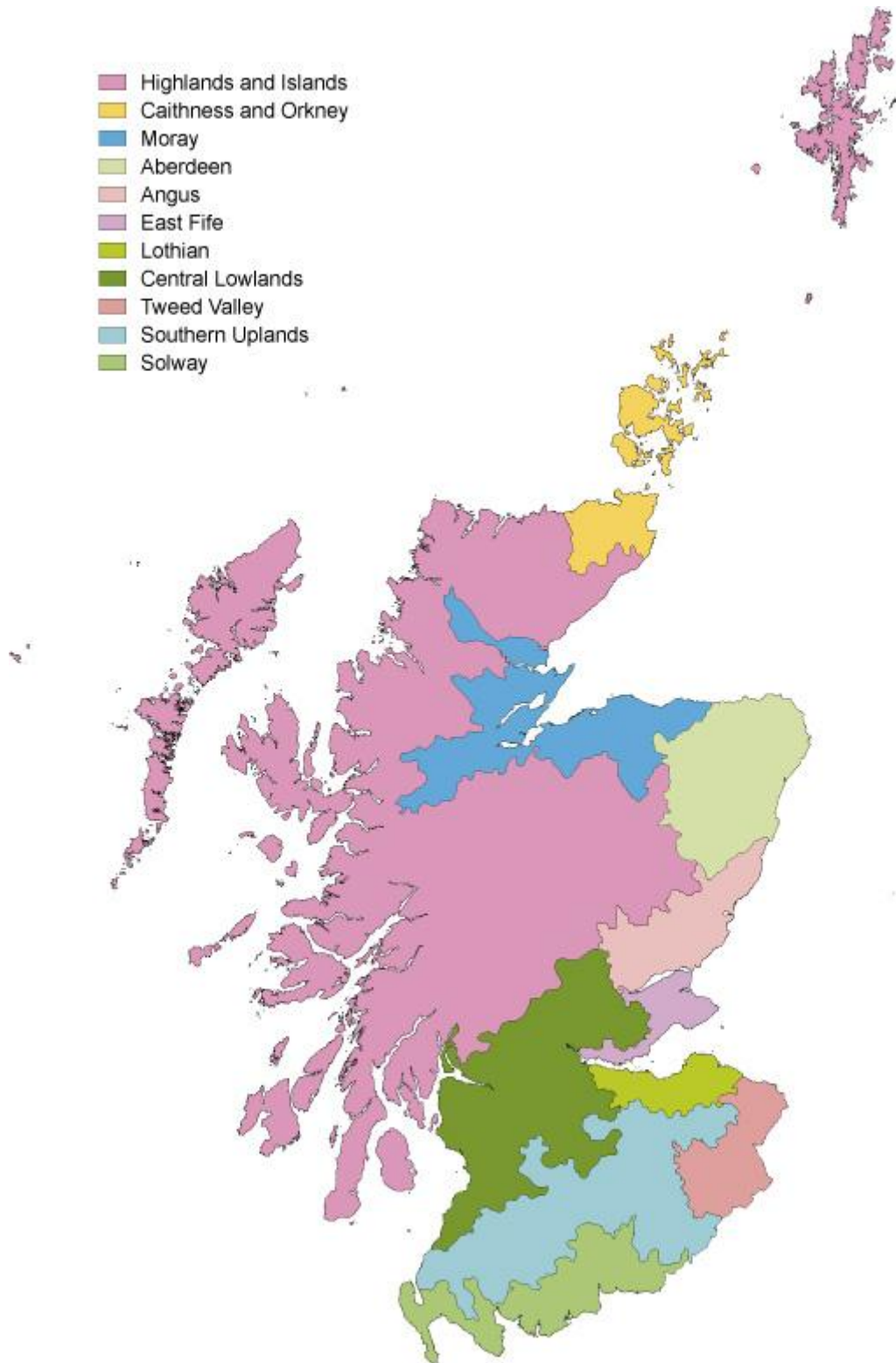
The survey covered rodenticide use during the 12 month period January to December 2016. Following an introductory letter and telephone call, data were collected by personal interview, telephone interview, email or post. When rodenticides were applied by a pest control professional (PCP) the data were 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 240 holdings (Table 6). These 240 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 14 Land use regions of Scotland⁽¹⁰⁾



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

Changes from previous years

In previous reports in this series, data about the type of rodenticide user (i.e. farmer or PCP) were based on the proportions encountered in the sample surveyed. Whilst this was made clear in the reports, it was in contrast to the weight and occurrence data presented, which were estimates of use in the total population of arable farms. Due to improvements in our database, population estimates of user type are now available and replace the sample data in this report for both 2016 and historical data. This has resulted in differences in 2012 and 2014 user data presented in this report and in the original reports.

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

Statistical analyses

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

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

Data quality assurance

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

Main sources of bias

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

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

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