

Pesticide Survey Unit – Methods of Data Collection, Statistical Estimation and Quality Assurance Procedures

Background

Estimation of plant protection usage information is a requirement under UK (Food and Environment Protection Act 1985) and EU (EC Regulation 1185/09) law. In the UK, collection of data on pesticide use is directed and overseen by the Working Party on Pesticide Usage Surveys (WPPUS). The WPPUS is a sub-group chaired by the Chemicals Regulation Directorate (CRD) that assists the Government's independent Advisory Committee on Pesticides (ACP).

In the UK pesticide usage information is collected by surveying a sample of farms and using that data to estimate total use. Pesticide use on the main agricultural crops is surveyed every two years (arable crops, potato stores, vegetable crops, soft fruit crops, top fruit crops and protected edible crops) and on grassland and fodder crops every four years.

The UK data are collected by three pesticide survey groups based in [England and Wales](#), [Northern Ireland](#) and [Scotland](#). The estimated pesticide use in [Scotland](#) and [Northern Ireland](#) are published in individual reports and are also combined with the data from England and Wales to produce [UK reports](#). Pesticide usage data collection and statistical estimation in each geographic area are therefore conducted according to standard techniques to allow collation and comparison of data.

The method used to estimate total pesticide use is ratio raising of data collected from a stratified random sample of farms. This is a standard statistical technique for producing estimates from a survey and has been used for over 30 years of pesticides surveying, allowing comparability of data over time. There are no alternative methods of pesticide usage estimation that could attain greater precision within the resource available. A copy of the Eurostat guidance on the principles behind the production process for pesticide usage statistics can be found on [Fera's website](#).

Rodenticide usage on arable and grassland farms in Scotland is estimated using the same method as for plant protection products. Rodenticide use is currently only surveyed by the Scottish PSU although historically it was also collected in [England and Wales](#).

Detailed descriptions of the methods used in each survey type, including any modifications or changes from previous reports, are included in the Scottish [reports](#).

The Scottish Pesticide Usage reports have been designated as Official Statistics since August 2012 and as National Statistics since October 2014. The Chief

Statistician (Roger Halliday) acts as the statistics Head of Profession for the Scottish Government and has overall responsibility for the quality, format, content and timing of all Scottish Government national statistics publications, including the pesticide usage reports. As well as working closely with Scottish Government statisticians, SASA receive survey specific statistical support from Biomathematics and Statistics Scotland ([BioSS](#)).

All reports are produced according to a published timetable. The reports are produced without political interference. For all 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](#).

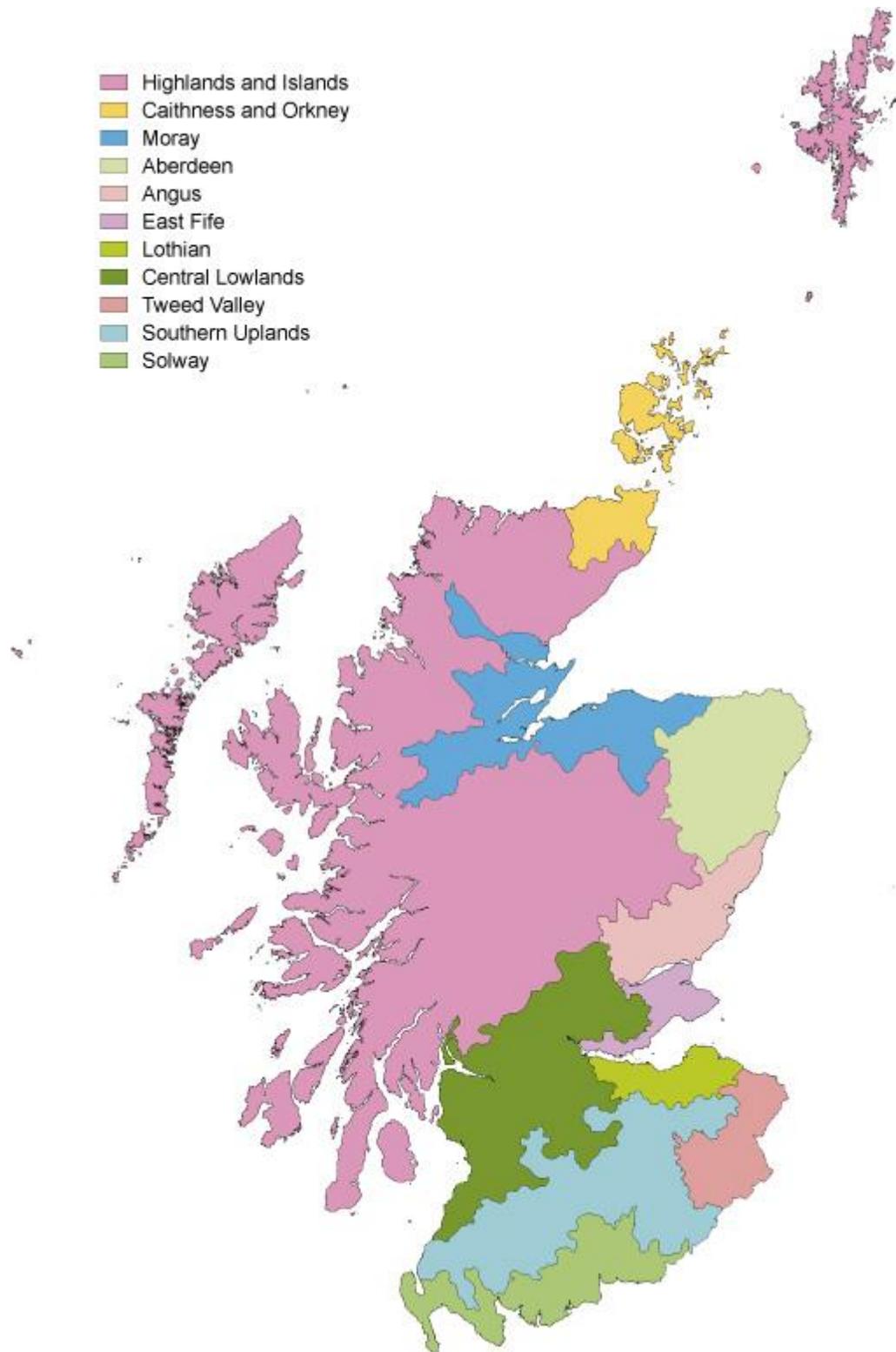
A summary of the methodology is included below:

Sample selection

Using the Scottish June Agricultural Census, a sample of holdings growing the target crops is selected (for rodenticide surveys this relates to the crops grown on the target farms, e.g. arable or fodder and grass crops).

To ensure a representative distribution of holdings is selected, the sample is stratified geographically (11 land-use regions, see Figure 1) and by farm size group (based on the total area of the target crops grown on the holding). Sample holdings are chosen at random within each of the size groups, with the number of holdings selected being proportional to the total area of crops grown. Sampling within size groups is based on area rather than numbers of holdings, so that smaller size groups are not over-represented in the sample.

Figure 1 Land use regions of Scotland



Data Collection

Farmers and growers are contacted by letter explaining the purpose of the survey and then subsequently contacted again by telephone call to arrange a method for data collection. Data collection may be by phone, email, fax, personal visit or a combination of these methods and all data collection is conducted by trained members of the pesticide survey team. Where necessary, information is also collected from consultant agronomists, contractors and seed merchants.

The dataset collected is comprised of the area of crops grown, selected agronomic information and a record of the area and quantity of all pesticide applications. For rodenticide surveys the data include the quantity of all rodenticides used and information on compliance with best practice in the use of rodenticides.

Holdings that are not willing, or are not able to, provide data are replaced with alternative reserve holdings from the same region and size group.

Data Checking

The dataset undergoes several validation processes before it is used for estimation of Scottish pesticide use and sent to [Fera](#) for inclusion in the UK report.

Data are checked for any obvious errors upon receipt. They are then entered into a database which includes an internal validation procedure that checks usage rates against the maximum approval rate and also prompts the user to validate any use pattern that has not been encountered previously. Finally, the entered data are 100% cross checked against the raw data by two members of staff.

Where inconsistencies are found these are checked against the records and with the farmer if necessary.

Statistical Estimation Process

National pesticide use is estimated by ratio raising. This is a standard statistical technique for producing estimates from a sample. It is the same methodology used by the other UK survey teams and has been used for all historical datasets produced by the PSU allowing comparability over time.

The sample data are multiplied by raising factors. These factors are calculated by comparing the sampled area in each region and size group to the areas recorded in the Agricultural Census. Further adjustments to the estimate are made to take into account differences in crop distribution between the sample and the census and also to account for minor crops that may not have been encountered in the sample for

each region but are present in the population. All raising and adjustment factors for each survey are included in the individual survey [reports](#).

Rodenticide data are raised to the number of holdings in each stratum instead of crop area as area is less relevant in relation to rodenticide use in farm buildings than it is to use of plant protection products on crops.

Statistical Precision

The figures presented in the pesticide usage reports are produced from surveying a sample of holdings rather than a census of all the holdings in Scotland. Therefore the figures are estimates of the total pesticide use for Scotland and should not be interpreted as exact. To give an idea of the precision of estimates, the field crop reports include relative standard errors.

Standard errors are produced using the raising factors. An overall variance is calculated by summing the variance estimates for individual strata (region and size groups) multiplied by the square of their raising factors. These variance estimates include a finite population correction. The overall standard error is calculated from the overall variance by taking its square root. This method of standard estimation was implemented as it is both relatively straightforward and has advantages over ratio estimator methods when within-strata sample sizes are small.

Standard errors are expressed as percentage relative standard errors (RSE) for both total pesticide use by area treated and for weight applied. Larger RSEs mean that the estimates are less precise. An RSE of 0 per cent would be achieved by a census. An RSE of 100 per cent indicates that the error in the survey is of the same order as the measurement. Relative standard errors may be reduced by increasing sample sizes and in general terms, a lower standard error indicates that the estimate is more precise. Total estimates of pesticide use for crop groups have lower standard errors than those for their constituent crops as sample sizes are greater.

Survey sample size

The size of the target sample varies with the survey and is related to the total quantity of pesticide use in each survey, i.e. greater sampling effort is made in the survey types in which most pesticide is used.

This method for setting target sample sizes is designed to optimise sample distribution/sampling effort between the surveys and is a compromise between attempting to target a fixed standard error (for the weight of total pesticide applied)

and targeting a fixed relative standard error. This results in output from surveys of larger more agriculturally important crop groups tending to have smaller relative standard errors than those of more minor crops as the standard error decreases approximately in proportion to the square root of the sample size. Therefore this method of sample setting results in more robust estimates of pesticide use in the crop types which use the greatest quantity of pesticides and therefore a more robust estimate of overall Scottish pesticide use.

Comparability of surveys over time

In general, data from the two previous surveys are provided for comparison purposes in each report and many data users compare estimates over longer time series. Such comparisons over time are possible as the general principles of sample number setting, distribution of the sample within strata and the statistical estimation process remain the same throughout the data series.

There are two main issues which should be taken into account when comparing surveys over time. The first is the precision of the survey; as discussed in the previous two sections sampling effort varies among surveys with greater sample sizes in those surveys where most pesticide is used, resulting in greater statistical precision which is reflected in lower RSEs. Therefore in those surveys where precision is greater there will be less variability and more confidence can be placed in comparisons over time.

The other issue which should be taken into account is interpretation of the factors that may influence changes in estimated pesticide use. This may include differences in sample size achieved, the composition of crops encountered in the sample, changes in the types of crop grown over time or in the way that crop areas are calculated or grouped by the census branch.

In recent reports we have endeavoured to aid interpretation of data comparison over time for the data user. We have included relative standard errors for overall use and for each crop group, this allows an indication of the robustness of the estimate, and consequently reflects the limitations of the sample, allowing users to make informed comparisons between surveys. In addition, when comparing use between surveys the reports express use in relation to the area of crop grown as well as an absolute. We have also included a section in each report, titled changes from previous years, which details any differences from previous surveys such as changes in methodology or the range of crops surveyed, which may affect the estimate. This aims to make data users aware of the limitations and factors affecting temporal comparison, within each report.

Quality Assurance

The Scottish survey reports have been designated as Official Statistics since 2012 (including the 2011 reports published in September 2012). In addition, the Scottish pesticide survey unit is accredited to ISO 9001:2008. All survey related processes are documented in Standard Operating Procedures (SOPs) and our output is audited against these SOPs by internal auditors annually and by external auditors every three years.

Additional quality assurance is provided by sending reports to members of the Working Party on Pesticide Usage Surveys and other agricultural experts for critical review before publication.

Acknowledgement of potential sources of bias in the dataset

The pesticide survey may be subject to measurement bias as it is reliant on farmers recording data accurately. In addition, as this survey is not compulsory it may also be subject to non-response bias.