Guidelines for the Collection of Pesticide Usage Statistics within Agriculture and Horticulture

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Foreword

The OECD Pesticide Forum is printing these guidelines to assist OECD Member countries who wish to collect data on pesticide use for plant protection. The guidelines were developed by the Eurostat Pesticide Statistics Task Force, and were originally intended for use within Europe. At an early stage, however, Eurostat and the OECD Pesticide Forum agreed that the guidelines would also be helpful for other countries. The Pesticide Forum was therefore invited to review drafts of the guidelines and to distribute the final version.

OECD is printing the guidelines as approved by Eurostat and the OECD Pesticide Forum, without further editing. The guidelines can also be found on the Internet via OECD's Pesticide Risk Reduction Web page (httm://www.oecd.org/ehs/pest_rr.htm), under the heading "Risk Indicators".

OECD would like to express its appreciation to Miles R. Thomas who authored these guidelines on behalf of the Eurostat Pesticide Statistics Task Force. Questions can be directed to Dr. Thomas at the Ministry of Agriculture, Fisheries and Food, Central Science Laboratory, Sand Hutton, York, YO4 1LZ, UK.

Summary

During the last decade, there has been a growing requirement within the European Community for meaningful and accurate statistics on pesticide use. Furthermore, an important target of the European Commission's Fifth Environmental Action Programme is the reduction of pesticide risk, and this will be impossible to monitor without sound information on changes in use over time. Eurostat therefore commissioned a Task Force of European Union (EU) members with experience of undertaking specific surveys of pesticide use, to draw up guidelines for the collection of usage statistics within member states.

The original Task Force was set up to include representatives from the United Kingdom (UK), Sweden, France and the Netherlands, together with Eurostat, but at the request of the OECD the Task Force was expanded to include a representative of the United States (US). Their remit was to draw up guidelines for countries not already collecting usage statistics, which would illustrate the minimum data requirements necessary in order to provide data useful to Eurostat, the OECD and the many EU-wide projects currently underway.

The Task Force considered methods of collection already in use within the European Union and OECD members and discussed at length the minimum data requirements from a survey.

The following information related to pesticide use was considered important:

- crop treated
- area of crop grown
- product used
- amount used or rate of application (kg/ha)
- area of crop treated
- any biological control methods used
- timing of application.

The following guidelines describe in more detail the reasoning behind the collection of statistically valid usage data, the uses to which it can be put and a choice of methodologies deemed appropriate in the view of the Task Force.

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Introduction

During the last decade, there has been a growing requirement within the European Community for meaningful and accurate statistics on the use of plant protection products, or pesticides as they will be referred to in these guidelines. Eurostat first published data on sales of pesticides in the environmental statistics yearbook for 1991, and further work was undertaken as part of the Dobris report in 1995 (Europe's Environment: The Dobris Assessment Editors, David Stanners and Philippe Bourdeau) to produce a co-ordinated statistical appendix on pesticide use. Eurostat found however, that data were poorly available, with specific information obtainable only for certain active substances or countries. It was also found that, in most cases, data were not very accurate and different definitions of pesticides and their classification between countries made comparison difficult.

With the development of environmental indicators that would include pesticides and their impact on the environment, sound statistical information was clearly required, particularly if the impact of policy changes on pesticide use was to be assessed over time. Furthermore, an important target of the European Commission's Fifth Environmental Action Programme is the reduction of pesticide risk, and this will be impossible to monitor without sound information on changes in use over time.

Reductions explained only in volume applied are meaningless with regard to risk as many new active substances are applied at much lower rates per hectare than the older products they are replacing, bringing about significant reductions in the weight applied, without necessarily resulting in any reduction of use or risk. From this point of view, the accumulation of sales statistics, and the general trends of reductions in weight used which they frequently show, can be seen to fall a long way short of providing the type of data required to allow meaningful assessment of the impact of policy changes on pesticide use and their consequences for the environment.

Eurostat therefore commissioned a Task Force of EU members with experience of undertaking specific surveys of pesticide use, to draw up guidelines for the collection of usage statistics within member states. The original task force was set up to include representatives from the UK, Sweden, France, and the Netherlands, together with Eurostat. Their remit was to draw up guidelines for countries not already collecting usage statistics, which would illustrate the minimum data requirements necessary in order to provide useful data to Eurostat, the OECD and the many EU-wide projects currently under way. At the request of the OECD the Task Force was expanded to include a representative of the US.

It is hoped that these guidelines will not only assist in the establishment of methodologies within countries not already surveying pesticide use, but also illustrate the significant wider value to each country of developing an effective database of pesticide use.

They are intended to cover agricultural and horticultural uses of pesticides, including food storage, i.e. uses for plant protection, but excluding uses in forestry other than nursery production.

Non-agricultural uses of pesticides, both plant protection products and biocides, and agricultural uses of veterinary medicines are not intended to be covered.

Role of Usage Statistics

The collection of a reliable set of usage statistics has value in many areas of research, legislation and agricultural support, and should not be seen as a simple statistical exercise in its own right. Within the UK, pesticide use has been surveyed on all crops cyclically for over 30 years and the usefulness and availability of the data generated far outweigh their cost of collection. Areas of use fall into eight main categories, described below, of which the first two are of most importance to Eurostat and the OECD:

Provision of annual usage statistics

In their simplest form, usage statistics provide information on national and regional levels of pesticide inputs to individual crops. Thus the total amount of any one pesticide used annually should be available, together with the areas treated and the range of crops to which it has been applied. Additionally, information on the total inputs of all pesticides to any one crop would also be available. Both these may be broken down to provide a seasonal profile of use, as dates of application should also be available. Such data are required at several levels:

- **At a national level, to inform government of the current status of pesticide use.** Following a number of recently reported "pesticide scares" appearing in the press concerning carcinogenic, neurological or other undesirable effects of specific pesticides, it is vital that ministers have up-to-date information on their usage. This includes data on the product range in which they occur, the crops on which they are used and the extent to which those crops are treated, ultimately yielding information on likely exposure of the population to the purported hazard. Without these data, governments could find themselves embarrassed in being unable to defend the results of their own legislation. Indeed, it is written into UK legislation (Food and Environment Protection Act 1985), that the government shall monitor the post-registration use of pesticides. Data are also freely passed to universities, pressure groups such as Greenpeace, Friends of the Earth and the WorldWide Fund for Nature, and members of the general public.

- **Within the EU,** where Eurostat are trying to compile meaningful and comparative statistics across member states, partly in fulfilment of the EU's Fifth Environmental Action Programme, which sets a target for the year 2000 of "the significant reduction of pesticide use per unit of land under production…." The success of this can only be monitored by collating reliable usage data over time.

- **Within the OECD,** where the members of the Pesticide Forum have expressed a need for reliable usage statistics.

- **Internationally,** where the Food and Agriculture Organization of the United Nations (FAO) attempt to compile annual statistics across all countries under Article 1, para. 1 of the FAO Constitution, which stipulates that "the Organisation shall compile, analyse and disseminate information relating to nutrition, food and agriculture."

Providing data sets for the development of indicators of environmental impact

Usage data are critical for the development of indicators of the effects of pesticides on the environment, and data sets over time are required in order to monitor the effects that policy changes may have on that impact. Programmes within the EU (Sectoral Infrastructure Projects in the Context of Environmental Indicators and Green Accounting) and OECD (Pesticide Forum: Pesticide Risk Reduction Project) are acutely aware of the need for sound usage data over time in order to develop such indicators. It is partly in response to this work that the current Task Force was established.

Monitoring changes over time

Once the collection of a regular set of usage statistics has been established, changes over time in use on particular crops, or of particular pesticides, can be monitored. These changes may result from several factors, some or all of which may interact to give annual variations in use:

- **Annual differences in the weather,** influencing the range of pest, disease and weed problems requiring control, or affecting the ability of the farmer to apply the pesticide under suitable conditions;

- **The introduction of new molecules** which may replace older, less active pesticides, and may additionally be applied at much lower rates per hectare;

- **Changes in the price of, or support level to, crops,** thereby altering margins and making the use of pesticides more or less economic;

Providing information as part of the review process of existing pesticides

An essential part of the review process of a pesticide, currently underway for all existing pesticides within the EU, is a knowledge of the local and national uses and requirements for that pesticide. If monitoring suggests that growers cannot compete without a particular pesticide, and no alternatives are available, this must be borne in mind during its review. Reliable usage data are fundamental to such appraisals and are a suitable means of quantifying the effect of withdrawal. Alternatively, the demonstrated lack of use of a particular pesticide, coupled with the availability and uptake of safer or more benign alternatives, may hasten a pesticide's withdrawal. Furthermore, within the US, in response to the Food Quality Protection Act (1996) the Environmental Protection Agency has developed a "Risk Cup" whereby the total area of a crop is assumed to be treated at full label-recommended rate. This is then applied to the tolerance level and the exposure risk calculated. If the risk cup is not full, further registration is allowed. If the cup is full, however, exposure risk is recalculated using actual estimates of area treated and rates of use from survey data. Without such data, the continued approval of products may be significantly affected.

Providing information as part of the approvals process of new pesticides

During the approval of new active substances, usage data may provide a clear indication of the likely uptake of a new pesticide, knowing what pesticide(s) it is likely to replace and the current extent of their use. Furthermore, such data allow an evaluation of likely operator exposure, as realistic work rates can be derived from the data collected, such as average field size, area sprayed per operator per day, amount of pesticide handled per day, etc. All these factors are vital in developing predicted operator exposure models.

Monitoring the potential movement of pesticides into water

Data on pesticide usage can be used to assist in the monitoring of pesticide contamination in surface and ground waters. For example, the EU aims to protect drinking water and groundwater through legislation, leading to widespread monitoring of pesticide residues in order to comply with these directives. Within the UK, usage data are used within a complex geographical information system, containing maps of soil and groundwater, rivers and other waterways and water abstraction points. This is overlaid with current cropping and pesticide usage patterns, both geographically and seasonally, and, together with a database of pesticide properties and models of movement through different soils, is used to predict the likely appearance of pesticides at abstraction points to facilitate the monitoring of pesticides in water. By so doing, it is hoped to avoid unnecessary monitoring for pesticides which are unlikely to appear at a specific point or time within a given water body. It is important to note, however, that such methods can only be used to direct monitoring rather than substitute for it.

Monitoring farmer practice to highlight areas where use may be optimised

Data on farmers' actual use of pesticides may be examined to see how their current practices may be improved or optimised. For example, within the UK, the comprehensive database of farmer practice with regard to fungicide and insecticide use on winter wheat is being examined to identify where farmers may be using pesticide application programmes inappropriately. This is being examined particularly with regard to under-utilising varietal resistance or inappropriately timed pesticide applications. Furthermore, there would appear to be some scope for reducing pesticide applications under certain circumstances. It is hoped that areas where clear savings can be made will be identified and targeted for further advice, in an effort to reduce inputs of pesticides to those crops. The technique should be applicable to many crops.

Providing information for residue monitoring programmes of fresh fruit, vegetables, etc.

Usage data have provided the foundation for the development of residue monitoring suites for a wide range of domestically-grown produce within the UK to monitor compliance with Maximum Residue Levels (MRLs).

- **Where new monitoring programmes are being undertaken,** usage data will illustrate the range of pesticides currently used on the crops to be monitored and allow the analytical suite to be tailored to consider only those pesticides likely to be encountered.

- **Where unusual or unexpected residues are found,** usage data can confirm the results or invoke alternative methods to corroborate or invalidate the findings. For example, analysis of plums by HPLC with UV diode array detection indicated that 50% of samples contained residues of diflubenzuron, whereas usage data suggested that only 5% of the crop had been treated. These survey results prompted alternative analysis by LC-MS which revealed that suspected residues were artefacts. In contrast, residues of chlorothalonil in lettuce, a non-approved use within the UK, were corroborated by survey data where such misuse had been encountered in the field. EU-wide surveys would allow Member States to tailor their monitoring programmes for imported produce as well as home-grown foodstuffs.

The members of the Task Force who drew up the following Guidelines are listed in Appendix I and will be happy to deal with any questions relating to this document.

Guidelines for the Collection of Pesticide Usage Statistics

1. Methods of collection

The Task Force considered methods of collection already in use within the European Union and OECD members. Four broad methodologies for collecting usage data are available requiring differing levels of input and organisation. In addition, the Task Force considered the utility of statistics on pesticide sales. Countries should select that methodology most suitable to their resourcing and requirements:

- Personal visits to a representative sample of farmers and growers to collect information on what they have used;
- Telephone interviews with a representative sample of farmers and growers;
- Postal surveys of a representative sample of farmers and growers;
- Compulsory returns of pesticide use from all farmers and growers;
- Sales statistics.

Personal visits

Personal visits are currently used in the UK, France, Sweden and the US. Information is collected on the pesticides applied to specific crops over the previous growing season or year from a statistically derived, representative sample of farmers and growers.

Such surveys have the advantage of accuracy, particularly where trained personnel are used to collect the data, as the surveyor can go through all the potential uses which might have occurred, ensuring that the grower does not omit or forget anything important. For example, in the worst case, many growers consider pesticides to include only insecticides (those which kill insect pests) and may not include other groups such as fungicides, growth regulators or desiccants. Other areas which are often not considered by growers include seed treatments and molluscicides applied at drilling. Pre-drilling and pre- and post-harvest treatments to the land are also important and are often ignored by farmers if not specifically questioned about them.

A further advantage of personal visits is that it allows all the relevant crops to be surveyed on a single farm without over-complicating the survey. To cover only one crop or field at each visit would result in many more visits having to be undertaken to derive a statistically valid sample.

As with any survey, it is vital to have a well-structured form on which to record the data, and farmers should be forewarned of a visit to allow time for them to assemble their records and information.

Telephone interviews

Telephone surveys have been used in Sweden to reduce the cost of their survey programme and may be adopted as the only method in future surveys. They are similar in structure to personal interviews but avoid the time and cost of travel. However, they should not be over-complicated and it would be unwise to attempt to cover all the cropping on a farm within each call. Future surveys in Sweden will be conducted solely by telephone but cover only the largest field of each crop grown on the selected farm.

A letter giving some indication of the structure the interview will take should precede calls. It is also important to have trained personnel undertaking the calls using a structured questionnaire.

In Sweden, comparative studies in 1990 and 1992 have shown that the differences in results between personal visits and telephone interviews are statistically of little importance provided that the telephone interviews are performed by trained personnel, and the information required is not overly complex.

Postal surveys

Postal surveys have been used in the Netherlands to obtain information on pesticide use for specific crops grown on selected farms. Postal surveys are considerably less expensive than visit surveys but can usually expect a return of up to only 30%. However, experience in the Netherlands suggests that this does not bias the sample in any way towards those farmers who are more conscientious or are more likely to carry out "good farming practice". Survey numbers can be increased to account for the reduction in participation in order to achieve the desired number of responses. For example, if results from 1,000 farms are needed and the response rate is known to be no better than 28%, a minimum of 3,570 farms should be included in the initial sample.

Postal surveys need to be less complex than surveys undertaken by personal visits or telephone interviews, exemplified by the surveys undertaken in the Netherlands, where only one crop per farm is surveyed. However, this allows survey forms to be tailored to each crop, and statistical validity is maintained simply by increasing the sample size.

Postal surveys may be open to abuse, in that respondents may only include what they want the enquirer to know, thereby overlooking or omitting known misuse. Furthermore, they are particularly open to misinterpretation, with respondents potentially missing out specific uses that they might think excluded from the survey, or not even considering part of the survey. However, just as visit and telephone surveys require trained personnel, so the staff involved in checking the returned questionnaires will need to be experienced in understanding what is likely to be used on a crop at a particular time. Further checks may also be included in the questionnaire and, as with other survey methods, many error-checking routines may be built into the data entry programmes and any obvious omissions can be followed up and checked with the grower.

Additionally, postal surveys can be structured such that questionnaires are sent out at several times through the year after important periods during the husbandry of the crop when pesticide applications are likely to have occurred. This will remind the grower to fill in the form at a time when the information required is fresh in his memory and reduce the burden of filling in a form with all details at the end of the growing year.

In the Netherlands, before the survey begins farmers are asked by post if they still grow the crop being surveyed, and whether they will participate in the survey. If they agree, at the beginning of each month they are sent a questionnaire tailored to that crop which reflects the practices likely to be undertaken over the next month.

All the most important crops are covered in each survey, but surveys are only undertaken every two or three years. This has the advantage of providing a complete picture of use of any one active substance but reduces the burden on individual farmers. Farmers who participated in the last survey are also excluded from selection for the next survey.

Compulsory returns of spraying records from all users of pesticides

At present, it is thought that compulsory returns from all pesticide users of all their spraying activities are only required in the state of California. These take the form of monthly returns by post. The overheads involved in handling the vast amount of data generated by such a comprehensive system are very high and the administration and computing are complicated to set up initially. However, the Californian experience appears to illustrate the usefulness of such a comprehensive database once established. This methodology may well be particularly appropriate to small countries.

Alternatives to surveys of usage - collation of sales statistics

Where countries do not immediately have the resources to undertake surveys of pesticide use using one of the methods outlined above, some useful information can be obtained from the collation of sales statistics, though this in no way substitutes adequately for statistically reliable surveys. Some of the advantages and disadvantages are listed below, together with a description of the process currently used in Sweden, where returns of sales figures by manufacturers is compulsory.

Advantages

There are advantages to using sales statistics as a basis for providing simple statistics on pesticide use.

- They are relatively inexpensive, as they are generally compiled by agrochemical organisations, or the state, directly from company returns. In Sweden, where collection of sales data is required by law and a data register of all approved products is available, the compilation of the data and processing of the statistics in tables costs around £2,600 (US$4,000).

- They are theoretically accurate, as chemical companies are likely to know with some degree of precision how much of each product they have sold.

- They are therefore quick to produce, as companies should be able to supply quarterly returns, or at worst annual figures, which may be processed within weeks of receipt.

- The data may be used as a check for usage statistics when sold quantities differ. Thus, statistics on sold quantities may be used to adjust and improve surveys on use of pesticides.

- The data may be used to provide estimates for years when surveys are not undertaken.

Disadvantages

- Where agrochemical organisations are involved in the collation of data, unless all the companies within a country are members of that organisation, the statistics will only represent a part of total sales. For example, the British Agrochemicals Association is comprised of approximately 30 major pesticide producers but almost 200 chemical companies have pesticides registered for use in the UK. In the Netherlands, Nefyto (the Dutch Foundation of Phytopharmacy) has published yearly sales figures since 1984, but represents only 90% of the whole producer population. However, since 1993 the Dutch government has also received figures from the non-members.

- Where products are unique to single companies, commercially sensitive sales data are unlikely to be released at product level.

- The above, together with the work involved in separating all individual active substances, may result in a degree of aggregation of data. For example, all fungicides or organophosphates may be grouped, thereby masking use of specific actives or usage on individual crops.

- Sales figures do not represent usage accurately where there is any lag within the chain from sales by producer through distributor to end-user, and these may be exacerbated by any stock-piling within the distribution network or by users. Data within the UK would suggest that most growers buy only what they intend to use, but the statistics for a single year may be distorted if farmers are hoarding pesticides, e.g. due to expected price changes. Stocking at the user end of the chain occurs infrequently and only within the smaller producers of minor horticultural crops, particularly where annual requirements are less than pack size.

- Most chemicals are not specific to single crops and sales data are therefore useless for anything more sophisticated than total usage figures.

- Sales figures often provide little, if any, information on regional differences in use.

- Total sales may include sales into sectors outside agriculture, for example weed control in industry or on public areas (roads, pavements, parks, etc.), sports grounds, homes and gardens.

- Data on weights sold cannot be converted accurately to area treated. For example, many farmers within the UK now invariably apply pesticides at well below the recommended rate, leading to grossly underestimated areas treated if they were to be calculated from the weight applied simply divided by recommended rate. Furthermore, experience in the UK indicates that farmer uptake of reduced rates appears regionally variable and is definitely influenced by enterprise size, therefore complicating any attempt to predict area treated.

- Finally, unless sales data have been collected using the same classification system for pesticides, they will be impossible to interpret meaningfully.

A description of the utilisation of sales statistics, as provided by the Swedish Chemicals Inspectorate

Collection of sales data can be used to substitute for survey of usage data. One of the obvious advantages is that it is much cheaper to collect and can therefore be performed annually. It is, however, an advantage if such sales statistics are regularly followed up by a survey on usage to verify and clarify sales data. In Sweden, the provision of sales figures by industry is compulsory.

Data may be collected by the competent authority with the help of a statutory obligation, which requests the manufacturer and/or importer that holds registration in a country to provide the competent authority with the requested data.

Other ways of collection are through agrochemical organisations or retailers. In such cases it is important to know what coverage such an organisation has.

Examples of what such information could state:

- Quantity of the product transferred by national manufacturers and importers for purposes other than export (i.e. into domestic sales), and quantity of the product used by themselves (e.g. for seed treatments applied by the manufacturer or other distributor). Confounding factors may be private imports or where the registration holder does not know the full extent of imports.

- Estimated distribution of the use between agriculture, forestry, commercial fruit growing, gardening and industry, as well as household consumption.

- Information with regard to quantity shall refer to the product in unpackaged condition and shall be given in litres or kilograms in accordance with instructions.

As the pesticide approval authority has all data on contents in these pesticides the product data can easily be converted to amounts sold of individual active ingredients, and also compiled in different ways.

Possible presentation of data on sold quantities of pesticides:

- classified as very toxic, toxic or harmful (N.B. this is only provided for organophosphates in the Netherlands)
- by type of product (herbicide, fungicide, etc.)
- by type of use category (agriculture, forestry, households, etc.)
- by each active ingredient (may be classified business information if few (less than 3) registration holders sell that active ingredient – e.g. individual data on only 20-25 active substances is allowed to be published in the Netherlands)
- by dividing the pesticides into chemical classes (organophosphates, triazines, etc.)
- by area treated, assuming dosage statistics based on label
- may be used within simple risk indicators, as currently available in Sweden

2. Defining the crops to be surveyed

These guidelines are designed to allow assessment of pesticide usage within the widest fields of agriculture and horticulture, including usage in food storage practice. For these purposes, agricultural crops include all the major arable crops, grassland and fodder crops (see Appendix II). Horticultural crops include fruit, vegetables, protected crops, hops, mushrooms, bulbs, flowers and hardy nursery stock. A full listing of the crops included within the UK, Netherlands and the US for each of these horticultural sectors is also given in Appendix II.

These sectors should not include use in homes and gardens of amateur products, or use of professional products by industry, in amenity situations, on roads, railways or other sectors of the transport industry. They are also not intended to cover use of wood preservatives, anti-fouling paints or pesticides used in public hygiene situations, such as insect control in buildings, etc.

Ideally, all agricultural and horticultural sectors should be surveyed, as this will not only account for all pesticide use, thereby satisfying the requirements listed in the introduction, but also it is more often in the minor sectors or uses where problems may occur. However, this may be too expensive for some countries and crops should be selected which represent the majority of pesticide use, both in absolute terms and in terms of rates of application.

From Table 1a it can be seen that the most important crops in the UK representing, for example, 90% of the area grown (sum of ranks 1 to 7) account for only 73% of the area treated (Table 1b – sum of ranks 1, 2, 4, 7, 8 & 11) and only 40% of the weight applied (Table 1c sum of ranks 2, 4, 7, 8, 9 & 10). Moreover, they account for none of the crops where the highest rates of application are found (Table 1d), while the 15 crops receiving the highest rates of application account for 45% of the total weight applied.

Crops should be selected sensibly within each country, therefore, which represent those grown most plus those receiving the most treatments, by area treated, weight applied and rate of application.

It is sometimes within those crops subjected to the highest rates of pesticide application where problems resulting from pesticide use may occur, and having some high inputs they may belong to the politically most interesting group, for which large reductions in usage may be stipulated.

For example, from the data presented in Tables 1a-d, it would be sensible to include at least the following crops:

Crop	**Importance derived from Table:**			
Permanent grass	1a		1c	
Wheat	1a	1b	1c	
Grass < 5 years old	1a	1b	1c	
Winter barley	1a	1b	1c	
Set-aside	1a	1b	1c	
Spring barley	1a	1b	1c	
Oilseed rape		1b	1c	
Sugar beet		1b	1c	
Ware potatoes		1b		1d
Peas		1b	1c	
Beans		1b	1c	
Mushrooms				1d
Edible protected crops				1d
Seed potatoes				1d

Rough grazing is omitted because it is not listed as important in any of the tables concerning pesticide use (Tables 1b-d). Marrows and flower crops are omitted because of the very small areas grown. For flower crops, this would not be the case in the Netherlands where they form a significant part of national horticulture.

Table 1a Variation in importance of crop by area grown

Rank	Crop	Area grown (ha)	% of total area grown	Cumulative % of area grown
1	Permanent grass	4,555,472	29.4	29.4
2	Rough grazing	4,409,099	28.5	57.9
3	Wheat	1,967,270	12.7	70.6
4	Grass < 5 years old	1,358,717	8.8	79.4
5	Winter barley	740,876	4.8	84.2
6	Set aside	506,217	3.3	87.5
7	Spring barley	491,211	3.2	90.6
8	Oilseed rape	355,845	2.3	92.9
9	Sugar beet	198,778	1.3	94.2
10	Ware potatoes	152,776	1.0	95.2
11	Beans	99,937	0.6	95.9
12	Oats	93,446	0.6	96.5
13	Peas	79,526	0.5	97.0
14	Maize	72,894	0.5	97.4
15	Linseed	65,007	0.4	97.9

Table 1b Variation in importance of crop by area treated[1]

Rank	Crop	Area grown (ha)	% of total area treated	Cumulative % of area treated
1	Wheat	20,473,107	48.7	48.7
2	Winter barley	5,875,182	14.0	62.7
3	Oilseed rape	2,456,420	5.8	68.5
4	Spring barley	2,381,206	5.7	74.2
5	Sugar beet	2,262,552	5.4	79.6
6	Ware potatoes	2,084,754	5.0	84.6
7	Set aside	670,348	1.6	86.2
8	Grass < 5 years old	618,984	1.5	87.6
9	Peas	586,188	1.4	89.0
10	Beans	523,661	1.2	90.3
11	Permanent grass	467,342	1.1	91.4
12	Oats	463,724	1.1	92.5
13	Linseed	246,778	0.6	93.1
14	Maize	241,787	0.6	93.6
15	Dessert apples (Cox)	239,317	0.6	94.2

[1] note that the area treated for a crop may exceed the area grown, as this is the sum of all applications made to that crop (e.g. one hectare of wheat sprayed six times has an area treated of 6 spray hectares).

Table 1c Variation in importance of crop by weight of pesticide applied

Rank	Crop	Weight applied (t)	% of total weight applied	Cumulative % of weight applied
1	Ware potatoes	11,448	32.2	32.2
2	Wheat	9,458	26.6	58.8
3	Seed potatoes	3,678	10.4	69.2
4	Winter barley	2,645	7.4	76.6
5	Sugar beet	1,109	3.1	79.8
6	Oilseed rape	827	2.3	82.1
7	Permanent grass	749	2.1	84.2
8	Spring barley	735	2.1	86.3
9	Grass < 5 years old	564	1.6	87.9
10	Set aside	355	1.0	88.9
11	Peas	310	0.9	89.7
12	Beans	273	0.8	90.5
13	Mushrooms	244	0.7	91.2
14	Oats	241	0.7	91.9
15	Hops	235	0.7	92.5

Table 1d Variation in importance of crop by average rate of pesticide use

Rank	Crop	Average rate of pesticide use (kg/treated ha)	% of total weight applied	Cumulative % of weight applied
1	Mushrooms	90.9	0.7	0.7
2	Minor vegetables (protected)	21.5	< 0.1	0.7
3	Seed potatoes	16.3	10.4	11.1
4	Flowers & foliage (protected)	10.6	< 0.1	11.1
5	Marrows	8.2	< 0.1	11.1
6	Lettuce (protected)	6.6	0.1	11.2
7	Narcissi	6.3	0.6	11.9
8	Ware potatoes	5.5	32.4	44.2
9	Alstroemeria	4.5	< 0.1	44.2
10	Chrysanthemums (protected)	4.0	0.1	44.3
11	Strawberries (outdoor)	3.3	0.6	44.9
12	Chrysanthemums (outdoor)	3.0	< 0.1	44.9
13	Shrubs (nursery production)	2.9	0.1	45.0
14	Beans – runner	2.9	< 0.1	45.0
15	Flowers for cutting (outdoor)	2.9	< 0.1	45.0

3. Frequency of surveys

Although surveys should ideally be undertaken annually, it is currently unrealistic to expect all countries to initiate annual surveys of all crops. Even in the UK, where monitoring is, perhaps, at its most sophisticated, arable crops, which represent around 86-90% of usage, are only surveyed biennially, while all other crops are surveyed every four years. It is recommended that, if annual surveys are not possible, important crops (as outlined above) should be surveyed at least biennially, though an annual programme should be followed for those crops where usage is most important.

The most limiting factor is resource availability, and different countries currently undertaking surveys have established different cycles to satisfy their own requirements.

In Sweden, surveys of all important crops are undertaken biennially.

In the US, major arable crops are surveyed annually because the government wants to monitor how quickly new or alternative products replace chemicals that are being phased out. Fruit and vegetable crops are surveyed biennially on alternate years.

In the UK, arable crops are surveyed at least biennially because of the speed of introduction of new active substances, giving rise to a rapidly changing market of use. Furthermore, chemicals have a two-year period of wind-down following part-revocation, to allow safe disposal through normal channels of supply, sales and use. In order to monitor this effectively, it would be unwise to have a survey interval greater than the average wind-down period. The introduction of new products into the horticultural industry, however, is much slower. For example, captan, available for over 30 years, is still one of the most important fungicides used in apple production. Lack of resources does not allow horticultural surveys to be repeated more frequently than once every four years. Whilst this is not ideal, it is accommodated somewhat by the much slower introduction and turnover of new products.

In the Netherlands, surveys have been undertaken every three years, and while all major crops are included in each survey, the work involved precludes repetition more frequently than this.

Where surveys are not undertaken annually, it should be borne in mind that differences in weather patterns between years may have a greater effect on usage than changes for other reasons, particularly on crops where change is very conservative. Until a sequence of surveys has been undertaken it would be unwise to explain changes between two surveys as the result of any simple factor.

4. Data requirements

The complexity of data collection is dependent on the resources available to undertake the survey. The more data collected, the more areas outlined in the introduction will be furnished. However, there are a minimum number of parameters that need to be collected in order to make any survey worthwhile.

The following data are considered essential to collect for each crop to be surveyed. They include the crop and its area grown, the product applied and its timing and rate of application or amount used and the area treated. Other data, which may be collected if resources allow, are listed at the end of this section.

Crop

A record of the crop to which pesticide applications have been made is clearly vital to any realistic assessment of pesticide use. This should take the form of the crop name as defined by any available census data, or that defined by the Community Farm Structure Survey. It should additionally include whether this was a winter or spring crop, if this is not already part of the census definition (e.g. winter or spring wheat, barley, oilseed rape, linseed, etc.). A list of the crop definitions and the surveys under which they are covered in the UK, the Netherlands, the US and Sweden is given in Appendix II.

It would be unrealistic to attempt to survey pesticide use on all crops within one survey. The limits of the survey, with regard to the crops to be covered, need to be clearly defined at the outset. Some seemingly similar crops, or developmental stages of a crop, may be best covered in different surveys. For example, a survey of pesticide use on orchard crops may exclude trees under production within a nursery, as these may be covered in an alternative survey of all nursery stock. Similarly, peas grown for harvesting fresh for the frozen pea market, or carrots, which may be grown on arable farms in arable rotations, may be omitted from a survey of arable crops as they would be covered under a survey of vegetable crops. Peas for harvesting dry may be considered as combinable crops and would fit best in a survey of arable crops.

It is also necessary to define which developmental stages of a crop will be considered by which survey to avoid “double counting” of pesticide applications, thereby inflating the real amount of pesticide used on a crop. Difficulties like this may arise with crops such as lettuce and brassicas, which may be raised from seed under glass as small plants, often with quite high inputs of pesticide, then sold to be planted out, either under glass or outside. The seedling production stage and any applications to the subsequent crop if planted under glass may be covered by a survey of usage on protected crops, and care must be taken not to include any double counting of use. However, applications made to the crop once planted outdoors would be covered by a survey of outdoor vegetable crops and any seedling treatments should not be included with this if they are covered by a survey of protected crops.

The survey must therefore clearly define those crops to be included, and this, in part, may also be defined by the census data available. It is relatively easy to raise sample data to a known total area of a crop grown, but difficulties arise where no census data exist for a crop, though this is usually only applicable to minor crops.

Area grown

On each surveyed farm the area grown of each crop to be surveyed must be recorded. This will be used to raise data on pesticide inputs to national estimates of usage. Problems may arise with multiple cropping. Where the principal interest is in data for water quality studies, clearly any multiple cropping (e.g. taking several harvests from one field of alfalfa) will not influence the area grown being equal to the area planted. However, for studies more directed at food quality, the number of crops on a single piece of land must be taken into consideration. For example, for six crops of lettuce grown on one field in a year, the area treated should be taken as six times the area of the field. Failure to do this would result in the sum of all treatments on all six crops being attributed to just one crop of lettuce.

Product

The pesticide product actually used should, wherever possible, be recorded. This is vital in order to establish the active substance(s) being applied, and also their formulation. Different formulations of the same pesticide may have different impacts on human health or the environment, despite containing the same active substance(s).

In most instances, growers may only know what they have used by product name, which is ideal, but alternatively may know what they wanted to use only by its constituent active substance(s), and have not kept a record of the actual product used. This is often the case for chemicals such as cypermethrin, which is well known to farmers by its active substance and is frequently a constituent part of the product name in the UK, thereby allowing farmers to consider it generically (e.g. “Manufacturer’s name” Cypermethrin 10).

Care must be taken with prefixes and suffixes to product names, which often indicate very different constituents with small changes in name. For example, within the UK, Alto 100 SL, Alto Eco, Alto Elite, Alto Combi and Alto Major all contain cyproconazole but at different rates and with widely different additional fungicides (see Table 2). It is therefore important to collect the full name with as much detail as possible. To collect only “Alto” as the product used would lead to considerable confusion and misrepresentation.

Table 2 An example of variations in constituent active substances in products with similar names

Name	Active substance(s)
Alto 100 SL	Cyproconazole
Alto Eco	Cyproconazole + Mancozeb
Alto Elite	Cyproconazole + Chlorothalonil
Alto Combi	Cyproconazole + Carbendazim
Alto Major	Cyproconazole + Tridemorph

Seed treatments may not be known by the farmer and it may be necessary to obtain this information from the merchant or supplier.

Amount used or rate of application

The rate of application is crucial to estimating the total amount of pesticide used, and similarly, the total amount used and the area treated can be used to derive the rate of application. Either is acceptable. Experience in the UK has shown that it is not sufficient to assume that the farmer/grower has applied the chemical at the label-recommended rate. The average rate for applications of fungicide products to wheat in 1996 in the UK was, in fact, 0.51 of the label recommended rate. Assumptions that label rates were adhered to would therefore have over-estimated use by almost 100%.

The grower’s actual rate of application to the crop should be recorded, as litres or kilograms of product per hectare. Where the grower is unsure of the rate, a record of the actual amount used and the area treated will clearly allow for later calculation of rate. It would also be acceptable to record the grower’s known level of application, for example “½ or ¾ label recommended rate”. This will also allow calculation of a rate from a knowledge of the pesticide’s own label recommendations.

Area treated

The area treated with each pesticide application should be recorded, as this may not necessarily be the same as the area of crop grown. Part-field treatments to control specific localised weed or pest problems, applications only to headlands or to all parts of the field except headlands, are amongst the reasons why the whole of a crop may not be treated. Additionally, there may be enforced buffer zones applied to certain pesticides preventing application within a certain distance of a watercourse, hedge or other boundary.

Where spot treatment has occurred, for instance in grassland to control small patches of pernicious weeds, the grower should estimate the area treated if it is not already recorded. Where this is not possible, the area should be calculated from the amount used and the application rate.

Note that when the area treated for a given crop is summed, it will often exceed the area of crop grown. Care must be taken over definitions, for which no accepted standards are yet established. However, in order to define more precisely what is being referred to, a set of definitions have been proposed in Appendix III.

Biological control methods

Biological control methods include preparations of fungal, viral and bacterial agents, as well as introductions of natural predators and parasites. Biological control methods should be collected as if they were pesticide applications. Changes in the use of these, and potential increases in use at the expense of conventional pesticides, will be of importance to schemes which aim to monitor the conversion from current practices to methods of integrated pest control (such as within the Fifth Environmental Action Programme).

The area over which an introduction has been made (area of crop "treated") should be recorded for each introduction to give a record of the number of treatments made. There would seem to be little to be gained from recording the number or amount of agents introduced (e.g. five Encarsia per m^2), but this may be applicable in some situations.

The UK has been recording the use of biological control methods for over 10 years. Although almost all of them are not registered pesticides, by treating them in a similar way to any other product, an extremely useful amount of information can be recorded and analysed (see Table 3).

Table 3 Layout of data to illustrate the format for collection of biological control agents

Date	Product	Method of application	Rate/ha
5/1/96	*Encarsia formosa*	Biological control	-
15/1/96	*Encarsia formosa*	Biological control	-
25/1/96	*Encarsia formosa*	Biological control	-
27/1/96	*Amblyseius cucumeris*	Biological control	-
7/2/96	*Encarsia formosa*	Biological control	-

Timing (date of application)

The date of application of each pesticide should be collected. Timing is perhaps the least essential of the above data requirements but its collection can prove useful to many aspects of analysis. A record of timing will allow the number of sprays applied to a crop to be quantified more easily, as without timing, or some record of tank-mixing, it would not be possible to separate sprays applied on separate occasions from those applied together. More accurate data on the timing of applications assists with many of the aspects outlined in the role of usage statistics section in the Introduction. Timing data are particularly pertinent to monitoring potential movement into water, monitoring farmer practice with regard to ineffective or illegal timings, providing information on harvest interval for residue monitoring and in environmental studies, where there may be critical periods during the year affecting the impact on non-target species.

5. Sample Selection

It is not the aim of this section to define the sampling method to be used in each country, as this is best achieved using each country's own statistical offices. However, it is important to ensure that the data collected is statistically sound for each crop. The methodology already in use within some of the Task Force members is given for guidance.

The basis of a sound sample is knowledge of the true population. Without an adequate census of the entire farming community, there would be little point in trying to undertake a survey of pesticide use, as there would be insufficient data on which to raise the sample to give national estimates.

All countries within the EU have at least the information from the most recent farm structure survey and this may form a suitable basis from which to work.

Given the resources available, sample selection should aim for the largest sample practically possible.

Regional differences in climate, pest and disease pressure, farming intensity and general farm practice often bring about significant regional differences in pesticide use even on the same crop. Thus, sampling should initially be stratified by region.

The sampling unit may be:

- a farm (and all its crops, as in the UK, or the largest field of each crop, as in Sweden)
- a single crop on a farm (but the entire area of crop grown on that farm, as in the Netherlands)
- a field of a particular crop (as in the US)
- a field (with its crop chosen at random, as in France).

Where the sampling unit is the whole farm, if farm size is thought to influence the degree of pesticide use, samples should be stratified by farm size group within region. This approach has several advantages. Firstly, farming practice, and particularly the use of pesticides, may vary considerably with enterprise size. In the UK, farmers with enterprises of less than 50 ha are known to be less likely to use pesticides at reduced rates than farmers with enterprises over 250 ha. In the Netherlands, however, there appears to be no difference in use across farm sizes and stratification by size is not considered necessary. Farms may therefore be selected at random within any regional stratification. A brief description of the Swedish methodology is given in Appendix IV.

Where the sampling unit is a single crop on a farm, farms should be selected at random within any regional stratification for each crop to be surveyed.

Where the sampling unit is a field of a particular crop, a random sample of fields should be selected such that the probability of selecting a particular field is directly proportional to the total area planted of the crop to be surveyed, within any regional stratification.

Where the sampling unit is a field, the fields should be selected at random, within any regional stratification.

6. Establishing a regional breakdown

Stratification by region is inevitably necessary, for example where soil types vary regionally which may particularly influence pesticide use, and may be essential where there is regional variation in pesticide legislation (e.g. the US).

Stratification by region should aim to divide the country into areas of similar agro-environmental characteristics, and such a breakdown may already be used in many countries. Within the EU, there also exists the regional breakdown used by the Farm Accountancy Data Network (FADN), which, for example, recognises 21 distinct regions in Italy, 22 in France and 17 in Spain, etc.

Where this breakdown is not detailed enough, other systems may be used. For example, FADN recognises Scotland as one region, whereas Scotland has been divided into 11 clear land use regions by Wood (1930), which are used for the purposes of surveying pesticide use within Scotland.

In England and Wales, six regions are used, corresponding to the original Ministry of Agriculture administrative regions, which have a certain degree of homogeneity with regard to land use and climate and consequent pest and disease pressures. This gives slightly more detail than the four regions used by FADN, whilst in the Netherlands 14 agricultural areas are used while Sweden divides the country into 102 yield districts.

While it may be necessary to select the sample and collect data regionally, it is not necessary to present data by all regions. However, it allows usage to be broken down more easily into areas that may map to, for example, catchments.

7. Establishing farm size groups

Pesticide usage may vary with farm size on the same crop. For example, larger farms may be managed by more highly trained personnel who are prepared to apply pesticides at reduced rates when pest pressure is low, or are more aware of newer products or methods of pest control.

Where size grouping is thought to be necessary, it should aim to divide farms into size groups with roughly equal total areas of holdings in each group. In the UK, farms are generally grouped into five classes. This enables the government to select the proper number of farms in each group for visits, and avoid visiting large numbers of small farms, which make little contribution to total pesticide use, or visiting too few large farms, which contribute significantly.

For example, groupings of arable farms in England and Wales were adjusted to give the most even distribution of areas across size groups, as shown in Table 4.

Table 4. Size grouping, numbers of farms and total areas for arable farms in England and Wales

	< 50 Ha	50-100 Ha	100-150 Ha	150-250 Ha	> 250 Ha	Total
Area of farms	687,118	710,797	550,187	719,954	940,621	3,608,679
% by area	19	20	15	20	26	100
Number of farms	39,629	9,972	4,502	3,786	2,367	60,256

Using this breakdown, farms are easily divided by simple size groups, aiming to apportion approximately 20% of the total arable area into each group. The 100-150 ha group falls below this ideal, while the largest size group (> 250 ha) accounts for a larger than ideal area. Adjustments could be made to the size of the larger groups to offset this, e.g. by trying size groups of 100-180 ha, 180-280 ha and > 280 ha.

Alternatively, size grouping may be based on the European economic-size unit (eeu). The eeu is an elaborate size unit derived from the cultivated area and price derived for the crop in question.

8. Establishing the sample

Sampling should aim to select farms from representative numbers within each regional (and size group) cell. Within very small cells, a minimum of two farms should be sampled to ensure statistical validity. As a guide, the numbers of farms and/or fields surveyed for each crop within countries already undertaking surveys are listed in Table 5.

Table 5 Sample sizes and populations within some countries currently conducting surveys

Crop	No of farms visited	No of farms growing crop	No of fields surveyed
UK			
Winter wheat	864	43,960	7,701
Winter barley	710	35,388	2,766
Set-aside	875	39,208	2,417
Spring barley	517	28,909	2,043
Oilseed rape	516	16,770	1,761
Sugar beet	190	9,543	768
Ware potatoes	201	16,918	590
Peas	127	4,546	286
Beans	182	6,218	494
Mushrooms	90	221	288 (crops)
Edible protected crops	250	2,937	1,184 (crops)
Seed potatoes	45	1,355	77
Sweden	*3,775	74,500	3,775
US			
Corn	1,757		1,757
Cotton	1,189		1,189
Potatoes	676		676
Soybeans	2,657		2,657
Winter wheat	1,516		1,516
Spring wheat	308		308
Durum wheat	122		122
Selected fruit crops	7,204		7,204
Selected vegetable crops	6,281		6,281

* N.B. The number of farms visited is not the same as the number of farms in the sample drawn. Since the frame is updated only once a year it contains a small amount of non-active farms.

9. Producing national estimates

Essentially, a statistically valid random sample will give an average use per hectare for each pesticide on each crop (within each region). Multiplying this by the total area grown (within each region) gives the total use.

Where farms have additionally been stratified by size, assuming a sound sampling procedure has been followed, sample data may be raised to produce national estimates which corrects for over- or under-sampling of a crop within any region. A raising factor can be generated for each cell, which is equal to the total area of farms within that cell divided by the total area of farms sampled within that cell:

For each cell $Rf1_{sr} = \frac{\text{total area of farms within size group s in region r}}{\text{total area of farms visited within size group s in region r}}$

Any slight over-, or under-sampling of a particular crop within a region may be corrected for, using a correction factor derived from the total area of that crop grown within the region divided by the raised estimate of crop grown in that region:

For crop c $Rf2_{cr} = \frac{\text{total area of crop c grown in region r}}{\Sigma_1^n(\text{area of crop c grown on farm n in size group s in region r} * Rf1_{sr})}$

Rf2 should approximate to 1.

10. Defining the survey period

Whilst a standard 12 month period from January through to December is the most logical period over which to survey, any crops other than perennial crops may well be grown in rotation. A particular field to be surveyed could have had two different crops growing on it within a single calendar year.

The survey period should therefore cover 12 months and consider all pesticide applications made to the land on which the crop is grown over a 12 month period, defined by the cultural practices of the crop grown. For example, arable crops grown in Northern Europe are best surveyed over a period following the harvest of the previous season's crop to include any pre-drilling clean-up treatments to the land, then through drilling of the surveyed crop to harvesting in the survey year. Note that the survey year is always considered to be the year in which the harvest was taken. This is illustrated in Tables 6 and 7.

A decision needs to be taken whether to include all pre-drilling treatments to the land to control weeds prior to sowing, or whether to include these as post-harvest treatments at the other end of the growing year. Care must be taken not to omit both or include both, however, as the former would under-estimate use while the latter would lead to double counting and an over-estimate of usage.

Table 6. Schematic representation of survey period for autumn-drilled crops

July	August	September	Oct-Dec	January-June	July	August
	← Survey period →					
Harvest of previous crop	Pre-drilling clean-up	Drilling of survey crop	Autumn pesticide use	Spring pesticide use	Harvest of survey crop	Pre-drilling clean-up
				← Survey year →		

For spring-sown crops, where land may have laid fallow since the previous harvest, any weed or pest control treatments to the land over that period should be associated with the crop subsequently grown. While not necessarily appropriate applications to that crop, omission will lead to an under-estimate of national pesticide usage.

Table 7. Schematic representation of survey period for spring-drilled crops

July	August-December	January-June	July	August
	← Survey period →			
Harvest of previous crop	Autumn weed control? Land lies fallow	Pre-drilling clean-up Drilling of survey crop Pesticide use	Pre-harvest pesticide use Harvest of survey crop	Pre-drilling clean-up
		← Survey year →		

For short-term crops such as lettuce, or any crops where more than one cycle is grown within a 12 month period, the optimum period over which data are recorded may well be influenced by the appropriateness or seasonality of other crops within the same survey. Lettuce grown under glass is therefore surveyed in the UK over the period October to September, as this is the period appropriate to the growth of many other protected crops. Because crops during the winter may grow more slowly than during the summer, it is important to record details of inputs during the whole 12-month period, rather than for one crop multiplied up by the number of crops per year. Crops may require more protection from disease or pests during periods of slow growth and therefore have higher inputs at some times of the year that at others. Conversely, pest pressure may be higher during warm weather resulting in higher inputs to some crops during the summer than in the winter.

Mushrooms may be considered over a 12-month period from January to December, as there is no true seasonality to the crop. Pesticide applications may vary within the year because of the influences of external temperatures, which may, for example, increase problems from sciarids or phorids in the summer months. Again, it is therefore important to record details of inputs during the whole 12-month period.

Perennial crops with a natural season of growth, such as fruit crops, are best considered over a period commencing after the end of harvest in one year through to the end of harvest in the following year. It is important to remember to consider the whole 12-month period, however, and any applications during the dormant period, such as winter washes, pruning paints or weed control, should not be excluded.

11. Additional information

The above guidelines outline the minimum data requirements thought necessary to provide valuable information from a survey, essentially what is being used, where, when and in what quantities. Whilst not highlighted as essential, many aspects of the agronomy of crops may provide useful further information on pesticide use or assist in the analysis of differences in use between crops. Countries should consider which aspects of the demands outlined in the introductory section are of most relevance to their situation and consider collecting any further information from the list below which may enhance that data, should resources permit.

Crop type

In this context, crop type may further define the crop beyond that broken down within a census or Farm Structure survey definition, or as “winter” or “spring”, as previously defined under “Crop”. For example, this may be of the form “culinary”, “dessert”, or “cider” for apples and pears.

Crop type is an important parameter to collect as pesticide inputs may differ significantly between different crop types. In the UK for example, inputs to many areas of cider apples are often low, or zero, compared to apples grown for dessert consumption. Furthermore, dessert apples often have higher inputs than culinary apples in the UK, while the variety Cox frequently have higher inputs than other dessert varieties.

Other important distinctions may exist between crops grown for processing and those grown for sale on the fresh market, e.g. blackcurrants, strawberries, and potatoes, which can be grown for seed, ware (human consumption) or industrial use. This distinction should be made if such crops are not separated at the census level or in the farm structure survey, as pesticide use can be markedly different between the different types.

Variety

In addition to crop type, there is merit in recording the variety or cultivar of the crop grown where this may be expected to influence pesticide inputs. Crops such as wheat, with known variability in disease resistance, may have considerably different fungicide regimes applied to different cultivars within the same farm. By collecting information on the variety of crop grown, this variation can be examined, as growers may not be exploiting varietal resistance to the full. Such knowledge may give clear indications where advisory work and extension services may suggest changes in practice, which can bring about a reduction or optimisation of pesticide inputs.

Crop stage

The need to record the developmental stage of the crop may not be necessary if this is implicit from the timing of the application or the crop definition. However, it may be necessary to record crop stage under certain circumstances. For example, in the UK, pesticides approved for use on any crop for human or animal consumption may be applied to nursery fruit trees, vines prior to final planting out, bushes, canes and non-fruiting strawberries, provided any fruit harvested within one year is destroyed. It is therefore important to record that the crop stage was pre-production during the nursery or maiden phase, as many applications would be non-approved to the fruiting crop. If these crops are already defined as nursery stock, then crop stage is unimportant.

Similarly, crop stage may be taken as “before planting” or “after harvest” to include pesticide applications made to land associated with the production of a crop but not necessarily applied to that crop. Again these may appear as non-approved uses if the crop stage is not recorded.

Desiccant or herbicide applications to ripened crops, such as glyphosate applications to wheat prior to harvest, should be recorded as “before harvest” to distinguish them from applications which would clearly appear to have killed the crop had they been applied earlier.

Applications of insecticides to vegetables, for example chlorpyrifos, will alter considerably as crop stage develops. Drenching of compost during propagation of brassicas to control soil pests will be at much higher rates per unit area than later foliar applications against aphids or caterpillars.

Formulation and method of application

A record of the formulation will often be implicit in the product name (e.g. granular, seed treatment, etc.) but the method of application of the pesticide(s) should be kept, and the detail is dependent on the resources available within each county. In its simplest form, this needs to be no more detailed than "ground spray", "aerial application", etc. Within granular applications, however, it is important to know whether the granules were broadcast or incorporated, as this may well have significant environmental implications.

If resources allow, more precise information on the type of spraying equipment used may have considerable implications for operator or bystander safety, drift, environmental contamination, etc. Thus a record of whether the applications were made by knapsack, air-assisted sprayer, ultra-low volume equipment, etc. would be useful.

The range of methods of application available differ widely within different commodities surveyed, with options such as fogging, misting and smokes common within protected crops.

A comprehensive listing of the principal methods of application recognised and defined within the range of commodities surveyed within the UK is given in Appendix V.

Spray round

In order to estimate the number of times a crop has been treated, it is necessary to maintain some record of the spray round within which the product has been applied. A spray round may be defined as a single treatment to the crop to apply pesticide(s), and in the case of, for example, cereals, may involve the application of a complex tank-mix of chemicals including fungicides, herbicides, growth regulators and insecticides within a single treatment.

Collecting such data will allow later consideration of the average number of times a crop has been treated with a fungicide, insecticide, etc., and give a clear indication of what products are frequently being tank-mixed together. Thus the first pesticide application should be marked as spray round 1. For many annual crops, this may well be any seed treatment applied to the crop, and to allow an estimate of the proportion of crop not treated with a seed treatment there is merit in recording this first treatment as "Not treated" with a seed treatment where none was used.

All the products mixed together within one application should be linked using the same spray round number, which increases by one for each subsequent application made to the crop.

Granular applications should be given a unique spray round number, even if they were applied at the same time as a sprayer passed over the crop, which is sometimes the case. As they were not physically mixed in with the other chemicals applied, and also require a separate method of application, it is not feasible to include them in with an accompanying spray.

An example of the use of spray round to link chemicals applied together is given in Table 8.

Table 8 Layout of data to illustrate the use of spray round to link chemicals applied together

Date	Product	Method of application	Spray round
12/9/96	Seed treatment A	Seed treatment	1
15/10/96	Herbicide B	Ground spray	2
15/10/96	Herbicide C	Ground spray	2
12/3/97	Herbicide D	Ground spray	3
12/3/97	Fungicide E	Ground spray	3
12/3/97	Fungicide F	Ground spray	3
12/3/97	Growth regulator G	Ground spray	3
12/3/97	Molluscicide H	Granular broadcast	4

Target species or reason for use

Where possible, the grower’s perceived reason for use should be recorded. This may be a target species, either a pest or weed(s), disease or range of diseases or, in the case of growth regulators, for reasons such as straw shortening, fruit set, fruit thinning or ripening. The reason given may not always appear appropriate but should be recorded as this may give a further indication of where pesticides may be being used inappropriately. From knowledge of this, there may be scope for better advice or labelling, thereby reducing inputs.

Crop rotation

Crop rotation was not identified as an essential element by the Task Force but was highlighted as important during the OECD workshop on Pesticide Risk Indicators in Copenhagen. It is more related to pest management outside pesticide use but might have implications for monitoring the development of integrated crop management. Crop rotation will indirectly affect pesticide use as previous cropping history can significantly influence the spectrum of weeds, pests and diseases likely to be encountered in the crop. Changes in soil fertility may also influence the requirement for applications of growth regulator. Recording the previous cropping history of the land on which the surveyed crop is being grown therefore best monitors crop rotation. Studies on disease levels in major arable crops in England and Wales (wheat, winter barley and oilseed rape) have shown an effect of previous crop, an effect from the length of break from the current crop and an effect of continuous cropping of up to three or more years. It would therefore indicate a requirement to record previous crop for at least three years prior to the current crop.

Drilling method

The availability of treated seed to birds and mammals will be influenced in part by the method of drilling, which will also influence sowing rate. Differences in drilling method, such as direct, broadcast, broadcast and ploughed in, precision, conventional, etc. may be recorded.

Sowing date and harvest date

Sowing date is a useful parameter to record because it can influence crop development, and therefore requirement for and timing of pesticide applications. Harvest date may have implications for applications made within the harvest interval for some crop/pesticide combinations. It is particularly important in countries like the US, where the development of the "risk cup" approach to registration may be influenced by the probability of finding residues in edible crops because of incorrectly observed harvest intervals.

Both these may also be helpful in explaining odd or non-approved uses if application dates turn out to be outside the cropping period, i.e. before planting or after harvest applications.

Crop covers

Use of crop covers may have implications for monitoring the uptake of integrated pest management techniques. For vegetable crops, crop covers are sometimes used to protect crops from the weather and pests. These could take the form of polythene or fleece and may influence, reduce or negate the requirement for certain pesticide applications, for example organophosphate insecticides to control carrot fly in carrots and parsnips. The type and period of cover should be noted.

Mulches

Particularly important in soft fruit production, but may also be used for other crops, mulches of organic material, such as straw or peat, or artificial mulches in black, white or other coloured polythene are often used. While reducing the need for herbicide applications, such covers may exacerbate pest problems, such as vine weevil in strawberries. A note of the present or absence of mulch and its type should be made.

Age of crop

This may be unnecessary where crop definition already distinguishes between crops of different ages, for example maiden versus fruiting trees. Where this is not the case, for perennial crops, such as fruit trees, olives, etc. and temperate crops such as rhubarb, cane fruit, bush fruit and strawberries, the age of the crop may influence pesticide inputs and some age structure suitable to the individual crop and its pesticide programmes should be devised and recorded. For example, strawberry crops should be recorded as maiden, one, two or three years old. Fruit trees may be classed as maiden, less than 5 years old and 5 or more years old, or some system that would distinguish between gross differences in use as crops age, if this were the case. Grassland in England and Wales is classified for census purposes as (1) sown within 5 years of the survey; (2) all other grassland except rough grazing and (3) rough grazing. For pesticide usage purposes, the "within 5 years" category is further broken down into areas sown within 12 months of the survey and those over 12 months old. This allows consideration of seed treatments and molluscicide and herbicide applications during the establishment year, which may be much higher than on established grass.

Whilst outside the scope of these guidelines, countries may wish to consider the value of such surveys as means of obtaining additional information on pesticides such as handling practice, usage of personal protective clothing, spraying machinery maintenance and calibration procedures, spraying machinery filling and washing practices, etc.

12. Pesticide classification

For the purposes of these guidelines, and to allow meaningful comparisons of usage data between countries, pesticides should be classified into the major groups of fungicides, herbicides, insecticides, molluscicides, growth regulators and "other pesticides", within which usage of certain chemicals is specifically defined. Each group is outlined below.

General classification

Fungicides

Include all chemicals used as fungicides, including the fungicidal elements of seed treatments, but excluding any non-fungicidal seed treatments. Exclude sulphur, which, because of the very large amounts applied to some commodities in some countries, may distort inter-country comparisons. Sulphur should be reported individually within "Other pesticides".

Herbicides

Include all chemicals used as herbicides, including herbicides used for the purposes of desiccation (e.g. diquat & glufosinate-ammonium). Exclude sulphuric acid, however, which may form a major part of all herbicide usage in some countries (approx. 13,000 tonnes or 57% of all herbicides by weight applied in the UK in 1996). Sulphuric acid should be reported individually within "Other pesticides".

Insecticides

Include all chemicals used as insecticides, including the insecticidal elements of seed treatments, but excluding any non-insecticidal seed treatments. Include all nematicides, together with all acaricides such as fenbutatin oxide, cyhexatin, dicofol and tetradifon, not recognised as having any insecticidal activity. Exclude molluscicides, which will be reported separately in their own section.

Molluscicides

Include all chemicals used as molluscicides, including the molluscicidal elements of seed treatments, but excluding any non- molluscicidal seed treatments.

Growth regulators

Include all chemicals used as growth regulators, including carbaryl where this was specifically used for fruit thinning, rather than insect control.

Other pesticides

Include all chemicals not included in the above five categories, but present data on the following chemicals individually where approval exists within the country:

- sulphur
- sulphuric acid
- methyl bromide
- tar oils and tar acids

Other pesticides will include soil sterilants such as dazomet, metam-sodium, chloropicrin and 1,3-dichloropropene and chemicals such as dichlorophen and formaldehyde, together with the rodenticides and talpicides.

Appendix I – The Eurostat Task Force

The Task Force was drawn from member states and the OECD to represent all the countries that currently had experience of undertaking surveys of pesticide use. The Task Force has met on several occasions to discuss the development and editing of these guidelines before their final presentation to Eurostat.

Members are willing to discuss these guidelines and offer advice and support to anyone wishing to begin the collection of pesticide usage data within their own country. The membership is:

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Appendix II – Listing of major crops covered by each survey in the UK, the Netherlands, Sweden and the US

Arable crops	**Grassland**	**Soft fruit**	**Outdoor**	**Orchards**	**Hardy nursery**	**Protected**	**Hops**	**Outdoor bulbs**	**Mushrooms**
	& fodder		**vegetables**		**Stock**	**crops**		**& flowers**	
UK									
Winter wheat	Rough grazing	Strawberries	Cabbages (8 types)	Cox apples	Roses	Tomatoes	Hops	Bulbs	Mushrooms
Spring wheat	Permanent grass	Raspberries	Broccoli	Other dessert apples	Shrubs	Cucumbers		Chrysanths	
Winter barley	Grass < 5 yrs old	Blackcurrants	Brussels sprouts	Bramley apples	Fruit stock	Lettuce		Other flowers	
Spring barley	Maize	Red/white currants	Calabrese	Other culinary apples	Ornamental trees	Peppers			
Oats	Fodder beet	Gooseberries	Cauliflowers (2 types)	Pears	Herbacious plants	Celery			
Rye	Mangolds	Blackberries	Carrots	Cider apples	Other	Other veg			
Triticale	Kale	Hybrid berries	Celery	Perry pears		Seedling veg			
Oilseed rape	Stubble turnips	Vines	Parsnips	Plums		Strawberries			
Linseed	Turnips & swedes		Courgettes & marrows	Cherries		Other fruit			
Ware potatoes	Other crops		Pumpkins	Other top fruit		Chrysanthemums			
Seed potatoes			Lettuce & endive			Pinks			
Peas (dry harvest)			Leeks			Carnations			
Field beans			Onions			Alstroemeria			
Sugar beet			Radish			Other flowers & foliage			
Set-aside			Turnips/swede			Pot chrysanths			
			Beetroot			Other pot plants			
			Other root veg (3 types)			Bedding/seedling plants			
			Peas (fresh)			Hardy nursery stock			
			Beans (3 types)						
			Sweetcorn						
			Other veg (8 types)						
Netherlands									
Winter wheat		Strawberries	Asparagus	Apples	Wood & hedge plants	Tomatoes		Bulb production	Mushrooms
Spring barley			Leeks	Pears	Lane & park trees	Cucumbers		Hyacinths	
Peas (dry harvest)			Salsify		Fruit stock	Peppers		Tulips	
Peas (green harvest)			Lettuce		Roses	Roses		Narcissi	
Red kidney beans			Cabbages		Ornamental conifers	Carnations		Iris	
Grass seed			Brussels sprouts			Chrysanthemums		Gladioli	
Seed potatoes			Runner beans			Fresias		Lilies	
Ware potatoes			Bunched carrots			Lilies (cut flowers)			
Industrial potatoes			Winter carrots			Flowering pot plants			
Sugar beet			Chicory			Foliage pot plants			
Maize									
Seed onions									

Arable crops	Grassland & fodder	Soft fruit	Outdoor vegetables	Orchards	Hardy nursery Stock	Protected crops	Hops	Outdoor bulbs & flowers	Mushrooms
Sweden[1]									
Winter wheat	Rough grazing		Covered only as outdoor vegetables						
Spring wheat	Permanent grass								
Winter barley	Green fodder								
Spring barley									
Oats									
Triticale									
Rye									
Mixed grain									
Oilseed rape									
Linseed									
Ware potatoes									
Industrial potatoes									
Peas (dry harvest)									
Field beans									
Sugar beet									
US									
Corn		Blackberries	Asparagus	Apples					
Upland cotton		Blueberries	Broccoli	Apricots					
Potatoes		Grapes	Cabbage	Avocados					
Rice		Kiwifruit	Canteloupes	Cherries, sweet					
Soyabeans		Raspberries	Carrots	Cherries, tart					
Winter wheat			Cauliflower	Dates					
Durum wheat			Celery	Figs					
Other spring wheat			Cucumbers	Grapefruit					
			Aubergines	Lemons					
			Peas (fresh)	Nectarines					
			Honeydews	Olives					
			Lima beans	Oranges					
			Onions	Peaches					
			Peppers	Pears					
			Snap beans	Plums/prunes					
			Spinach	Tangelos					
			Strawberries	Tangerines					
			Sweetcorn						
			Tomatoes						
			Watermelon						
			Lettuce						

[1]Energy forest grown on arable land is included in the survey.

Appendix III – Definitions used in the presentation of usage data

There are many ways of presenting usage data, which can often result in confusion and even mislead the reader. Essentially, usage has several main components, the easiest to understand being the weight of active substance applied. There can be no confusion over this as it cannot be adjusted or presented in any way but as a straightforward tonnage of active substance per annum to a particular crop or given area.

The area treated with this weight of pesticide, however, may be presented in many ways:

Basic area treated

Firstly, there is the true area of crop treated, often termed the basic area. This is the area of crop receiving a particular pesticide (or all pesticides) and is most easily understood (and calculated) by considering the area of crop grown minus the area not receiving that particular pesticide (or any pesticide). In this way, multiple applications are ignored and a crop is considered either treated or not.

Application area treated

Secondly, area treated may be considered in terms of the number of applications made to a crop. No fixed terminology exists for this and it may be appropriate to define new terms at this point. A crop receiving a tank-mix of pesticides on seven different occasions, irrespective of the number of pesticides in each tank-mix, may be considered to have an application area treated of seven times its basic area treated. Thus if fungicides were applied on four of those occasions it would have a fungicide application area treated of four times its area and so on.

Formulation area treated

Thirdly, area treated may be considered in terms of the number of formulations (products) applied. To use the above example, if each tank-mix only contained one product the formulation area treated would be seven times the basic area treated. If each tank-mix contained two products it would be 14 times and so on. For individual formulations therefore, where a crop mainly receives two applications of a particular formulation, the total formulation treated area will approach twice the basic area treated of the crop. This is the way almost all usage data are presented within the UK in the Pesticide Usage Survey Group (PUSG) reports and is generally referred to as treated hectares.

Active substance area treated

Finally, the area treated with each active substance within formulations may also be considered. To use the previous example, if each product was a formulation of two active substances, with seven applications of two products per application the active substance treated area would be 28 times the basic area treated. Though this way of presenting data is rarely used, as tank-mixes become more complex but consist of many formulations at reduced rate, this form of analysis and presentation may become more relevant.

Appendix IV – Description of the Swedish Pesticide Usage Survey

The Swedish Pesticide Use Survey is accomplished as an extension or addition to the national crop statistics run by Statistics Sweden. As a consequence the organisational and statistical structure, as well as the methods of processing, is the same.

The responsibility for the Pesticide Use Survey was given to the National Chemicals Inspectorate (KemI) in July 1992. Statistics Sweden has undertaken the survey on commission since 1992 and before that date was responsible for the survey as well. The survey has been carried out in 1988, 1990 and 1992 as personal interviews with the farmer and in 1994 and 1996 as a mixture of personal and telephone interviews with the farmer. There are advanced plans for an extended survey, in 1998, as a telephone interview.

Statistical structure (1996 survey)

The population frame is the Farm Structure Survey, which contains about 93,000 holdings of which approximately 75,000 are holdings with 5 hectares or more of arable land.

The sample consisted of 3,900 holdings with 5 hectares or more of arable land.

The sampling unit is the agricultural holding and field, either selected plots already earmarked for a cropping survey or the largest fields of each crop on the farm, regardless of whether they have been treated or not.

The sample is stratified in 102 yield districts covering the whole country except the mountain range. Within each yield district PPS sampling is applied independently within each stratum. The probability of a holding being selected is proportional to its size in terms of arable land and crops. Holdings larger than a certain size (somewhat different in each survey) are always included.

Appendix V – Some methods of application encountered during surveys in the UK

Method of application	Arable crops	Grassland & fodder	Soft fruit	Outdoor vegetables	Orchards	Hardy nursery stock	Protected crops	Hops	Outdoor bulbs & flowers	Mushrooms
Ground spray	■	■	■	■	■	■	■	■	■	■
Aerial application	■	■		■				■		
Knapsack	■	■	■	■	■	■	■	■	■	■
Lance							■			
Drench			■	■	■	■	■	■		■
Dip				■		■	■			■
Mist						■				■
Fog							■			■
Fumigant			■			■	■		■	■
Irrigation line							■			■
Granular broadcast	■	■	■	■	■	■	■	■	■	■
Granular incorporated	■	■	■	■		■	■		■	■
Seed treatment	■	■		■					■	
Weed wiper	■	■		■		■				
Dust				■			■	■		
Wound paint					■	■	■			
Biological control agent					■	■	■	■		

OECD Publications in the Series on Pesticides:

No. 1, *Data Requirements for Pesticide Registration in OECD Member Countries: Survey Results* (1993)

No. 2, *Final Report on the OECD Pilot Project to Compare Pesticide Data Reviews* (1995)

No. 3, *Data Requirements for Biological Pesticides* (1996)

No. 4, *Activities to Reduce Pesticide Risks in OECD and Selected FAO Countries. Part I: Summary Report* (1996)

No. 5, *Activities to Reduce Pesticide Risks in OECD and Selected FAO Countries. Part II: Survey Responses* (1996)

No. 6, *OECD Governments' Approaches to the Protection of Proprietary Rights and Confidential Business Information in Pesticide Registration*

No 7. *OECD Survey on the Collection and Use of Agricultural Pesticide Sales Data: Survey Results*

Published Separately:

OECD Guidance for Country Data Review Reports on Plant Protection Products and their Active Substances - Monograph Guidance

OECD Guidance for Industry Data Submissions on Plant Protection Products and their Active Substances **-** Dossier Guidance

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