

PESTICIDE USAGE SURVEY REPORT 312

POTATO STORES IN THE UNITED KINGDOM 2022



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- are produced according to sound methods.
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Once statistics have been designated as National Statistics it is a statutory requirement that the Code of Practice shall continue to be observed.

If you have any enquiries or feedback on the statistics included in this report, they can be directed to the contact given below:

Pesticide Usage Survey Team – e-mail: PUS@fera.co.uk

Telephone: 0300 100 0321

DATA USES

The data are used for a number of purposes including:

- Quantifying pesticide usage and changes in the use of active substances over time.
- Policy, including assessing the economic and/or environmental implications of the introduction of new active substances and the withdrawal/non-authorisation of pesticide products (the data reported to organisations such as the OECD and EU enabling the UK to honour international agreements); evaluating changes in growing methods and Integrated Pest Management where this has an impact on pesticide usage.
- Informing the pesticide risk assessment (authorisation) process.
- Informing the targeting of monitoring programmes for residues in food and the environment.
- Contributing to assessing the impact of pesticide use, principally as part of the Pesticides Forum's Annual Report.
- Responding to enquiries (for example, Parliamentary Questions, correspondence, queries under the Freedom of Information Act or Environmental Information Regulations, etc.).
- Providing information to assist research projects which can support all the above activities.
- Training/teaching programmes which are designed to improve practice in the use of pesticides by the farming/training industries.
- Informing the Wildlife Incident Investigation Scheme (WIIS) programme to help identify potential misuse of pesticides.

REVISIONS POLICY

This report presents a comprehensive summary of data for potatoes harvested in 2022 and stored during 2022/2023. We will provide information on any revisions we make to the report or the datasets if any inaccuracies or errors occur. Details of any revisions, including the date upon which they were changed, will appear on the following website:

<https://pusstats.fera.co.uk/published-reports>

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OVERVIEW OF MAIN FINDINGS

This report presents information on all aspects of pesticide usage during storage of potatoes harvested in 2022 and stored during 2022/2023. Data were collected predominantly by postal survey and telephone from 62 farm stores and from 114 merchant stores in the United Kingdom.

Compared to the previous survey, the number of farm stores has increased from 45 to 62, whereas the merchant stores have decreased from 128 to 114. Overall, the total number of stores has increased slightly from 173 to 176.

Data collected from both farm and merchant stores are combined, but data for seed and ware potatoes are presented separately in this report. This reflects changes in potato storage practice over the last decade, which has resulted in very little difference between the way in which farm and merchant stores are managed. In addition, data collection has changed over time (including pre-Covid) from a primarily visit survey to a combination of postal and telephone calls.

The estimated weight of ware potatoes stored from the 2022 harvest was approximately 3.1 million tonnes, of which this survey estimated that 50% received no post-harvest treatment (77% of the untreated crop was in refrigerated stores). The basic tonnage treated was 1.5 million tonnes, though some potatoes received multiple treatments. The total tonnage treated, which includes multiple treatments to the same tonnage, was 2.7 million tonnes.

The biggest change to stored ware potatoes in 2022 has been the use of alternative active substances following the loss of authorisation for chlorpropham in 2020. In 2020 the main alternative to chlorpropham was the biopesticide spearmint oil. In 2022, the main active substance used on ware potatoes was 1,4-dimethylnaphthalene, closely followed by spearmint oil. Other active substances encountered on ware potatoes in 2022 were ethylene, orange oil and imazalil.

1,4-dimethylnaphthalene, authorised in 2022 and used as a potato sprout suppressant, accounted for 41% of the total tonnage of ware potatoes treated, 40% were treated with spearmint oil, 15% with ethylene, 4% with orange oil and 1% with imazalil. A total of 101.3 tonnes of active substances were used to treat ware potatoes. Spearmint oil accounted for 69% of the total weight of active substances used, 1,4-dimethylnaphthalene 22%, orange oil 9% and less than 1% with imazalil. Ethylene gas does not normally have a weight of active substance associated with it and it is impossible to estimate the weight applied, as this depends on the store capacity, crop volume, the quality of store construction and the duration of storage.

Between 2018 and 2020, the use of maleic hydrazide in the field increased by 65% in terms of area treated and 69% by weight applied. Between 2020 and 2022, there was a slight increase, 2% by area treated and a decrease of 3% by weight, despite a 13% decrease in ware potatoes grown over the same period. The use of maleic hydrazide in the field prevents the sprouting of potatoes in store. This increase in usage is likely to be due to growers anticipating the need to prevent sprouting in store, knowing that chlorpropham would not be available.

A comparison is made between this survey and previous surveys conducted between 2012 and 2020.

The tonnage of ware potatoes stored each year is variable and is dependent on the areas grown, weather conditions and annual yields (see Figure 1).

The percentage of the untreated tonnage of ware potatoes decreased from 62% in 2020 to 50% in 2022.

The weight of active substances applied to ware potatoes in 2022 was 2% less than in 2020, but over three times greater than in 2012. This increase is almost entirely due to the higher rate of spearmint oil, which also makes it difficult to compare usage with previous years (see Figure 2).

From this survey, it is estimated that 33% of the 470,198 tonnes of the stored seed potatoes were treated, either on entry to the store or during the storage period, with a single application of a pesticide. The formulations recorded were imazalil, fludioxonil and ethylene, accounting for 92%, 4% and 4% of the total tonnage treated respectively. A total of 2.2 tonnes of active substances were used, principally imazalil at 94% of the total weight and fludioxonil at 6%. No weight of ethylene has been reported as information was only available from a limited number of stores.

The total tonnage of stored seed potatoes in the United Kingdom decreased by 7% between 2020 and 2022, with the basic tonnage treated decreasing by 5% over the same period (see Figure 3). This minor change resulted in an 8% decrease in the weight of active substances applied between the two years (see Figure 4).

Over the longer term (since 2012), the tonnage of seed potatoes both stored and treated has varied with no clear trend. In 2022, the tonnage stored was 3% higher than in 2012, whilst the basic tonnage treated was 34% higher.

The weight of active substances applied to seed potatoes in 2022 was similar to those seen since 2018 but considerably lower than the weights applied in 2014 and 2016 (Figure 4).

INTRODUCTION

The Expert Committee on Pesticides (ECP) advises government on all aspects of pesticide use. In order to discharge this function, the Committee must regularly monitor the usage of all pesticides. It needs accurate data on the usage of individual pesticides.

As part of the on-going process for obtaining data, the Pesticide Usage Survey Teams of:

- Fera Science Ltd., a joint venture between Capita PLC and the Department for Environment, Food & Rural Affairs (Defra).
- SASA, a division of the Scottish Government's Agriculture and Rural Delivery Directorate.
- Agri-Food & Biosciences Institute (AFBI), Department of Agriculture, Environment and Rural Affairs (DAERA)

conducted surveys of pesticide usage in potato storage from the 2022 harvest by contacting holdings throughout the United Kingdom during the winter of 2022/2023, with follow up contacts in May & June of 2023.

This was the seventh survey of usage on potato storage in the United Kingdom and the sixteenth survey of pesticide usage in potato stores carried out by the Great Britain Pesticide Usage Survey Teams. The previous report for the United Kingdom covered all pesticide usage on potatoes harvested and stored in 2020 (Garthwaite et. al., 2022). Other surveys of potato storage in the United Kingdom were conducted in 2010, 2012, 2014, 2016 and 2018.

Copies of published United Kingdom potato storage reports can be found here:

<https://pusstats.fera.co.uk/published-reports>

Since 2010 all surveys of pesticide usage in agriculture and horticulture have been fully co-ordinated by the survey teams of England & Wales, Scotland, and Northern Ireland. The methodology used for sample selection and the collection of data from sample holdings is identical in each region. Reports are produced of pesticide usage throughout the United Kingdom. All teams have undertaken United Kingdom Statistics Authority (UKSA) audits.

Information on all aspects of pesticide usage in the United Kingdom as a whole, or for Wales or the Defra regions of England, may be obtained from the Pesticide Usage Survey Team at Fera Science Ltd., Sand Hutton, York, UK YO41 1LZ.

For further information please contact:

The survey team – e-mail: PUS@fera.co.uk

Telephone: 0300 100 0321

Or visit the website: <https://pusstats.fera.co.uk/home>

Alternatively, please contact: Fera at: science@fera.co.uk

Further data relating specifically to Scotland may be obtained from the Pesticide Usage Survey Team at SASA. Also available at:

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

Copies of reports on pesticide usage in Northern Ireland may be obtained from His Majesty's Stationery Offices. Also available at:

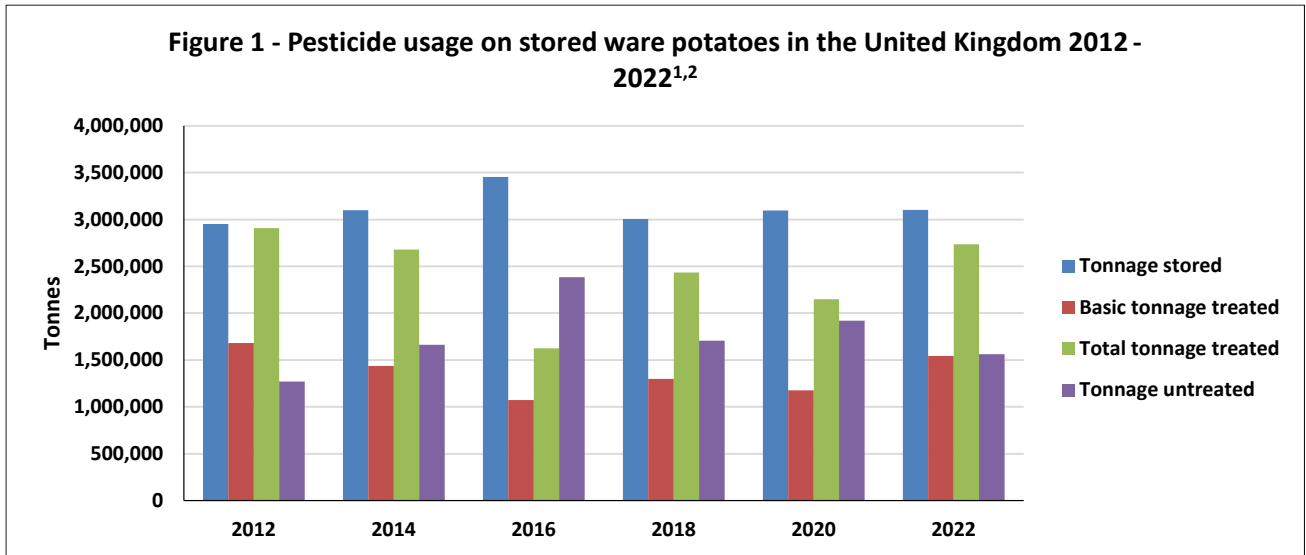
<https://www.afbini.gov.uk/articles/pesticide-usage-monitoring-reports>

DEFINITIONS AND APPROACHES USED IN THIS REPORT

- a) The term 'Applications' is used throughout this report to refer to the number of pesticide treatments applied to a store (whole or part).
- b) 'Basic tonnes treated' is the gross weight of potatoes treated with pesticides excluding repeat applications, i.e. the total tonnes stored minus the untreated tonnage ('Tonnes untreated').
- c) 'Total tonnage treated' is the gross weight of potatoes treated with pesticides including repeat applications, i.e., basic tonnes treated x number of applications.
- d) 'Bulk stores' include loose potatoes in a variety of stores, as opposed to those stored in boxes. Potatoes stored in bags are excluded from this survey.
- e) 'Unventilated ambient stores' include structures that are naturally ventilated and rely on convective ventilation.
- f) 'Ventilated ambient stores' include structures using forced air ventilation. They do not use refrigeration.
- g) 'Refrigerated stores' include structures using refrigeration; they may also have forced air ventilation.
- h) 'Merchant stores' include companies not involved in growing but purchasing potatoes from a third party. They also include farm owned stores storing potatoes from their own and other growers' holdings. They will have stored ware potatoes for a period of more than two months.
- i) A 'Farm Store' holds only potatoes from the single holding where the store is located for a period of more than two months (ware potatoes only).
- j) In this report the term 'formulation(s)' is used to describe the pesticide active substance or mixture of active substances in a product(s).
- k) 'Seed potatoes' are those stored and used for planting the next season's crop. Prior to planting, seed potatoes are placed in a 'chitting house' where the tuber can produce shoots and rootlets prior to planting.
- l) For this report it has been assumed that between 80% - 87% of all harvested seed potatoes are stored. These figures are based on statistics from the SASA Potato Department and previous estimates of storage. It is likely that most, but not all, seed potatoes will have been stored for two months or more. The crop is stored before export or sales to other merchants and growers.
- m) 'Ware potatoes' are those used for human consumption, including those processed by a manufacturer.
- n) 'Arable crops' include cereals, combinable peas & beans, oilseed rape, linseed, potatoes, and sugar beet.
- o) There is no standard recommended rate per tonne of potatoes for the use of ethylene. The application equipment is pre-set to maintain the required level of ethylene concentration in each store. Consequently, the quantity of ethylene used will vary according to the store capacity, crop volume, the quality of store construction and the duration of storage. In most cases the actual amount of ethylene used was not available and it was not considered appropriate to include the information available from only a limited number of stores.
- p) 'Storage' is defined as ware potatoes being in store for two months or longer. For seed potatoes, storage times may be shorter than this.

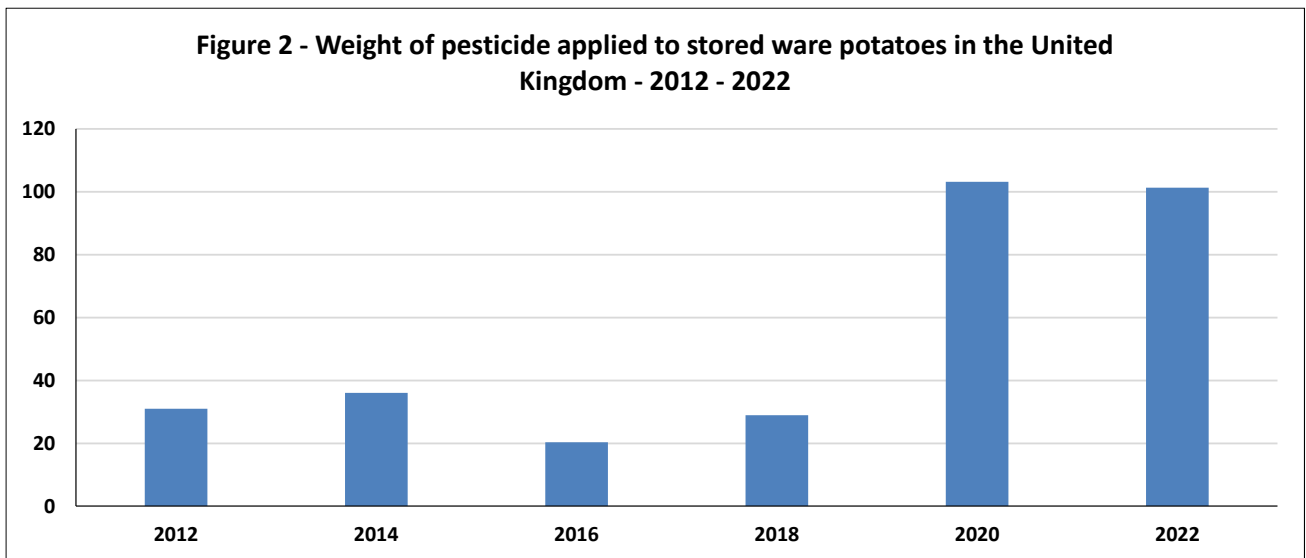
TRENDS

WARE POTATOES



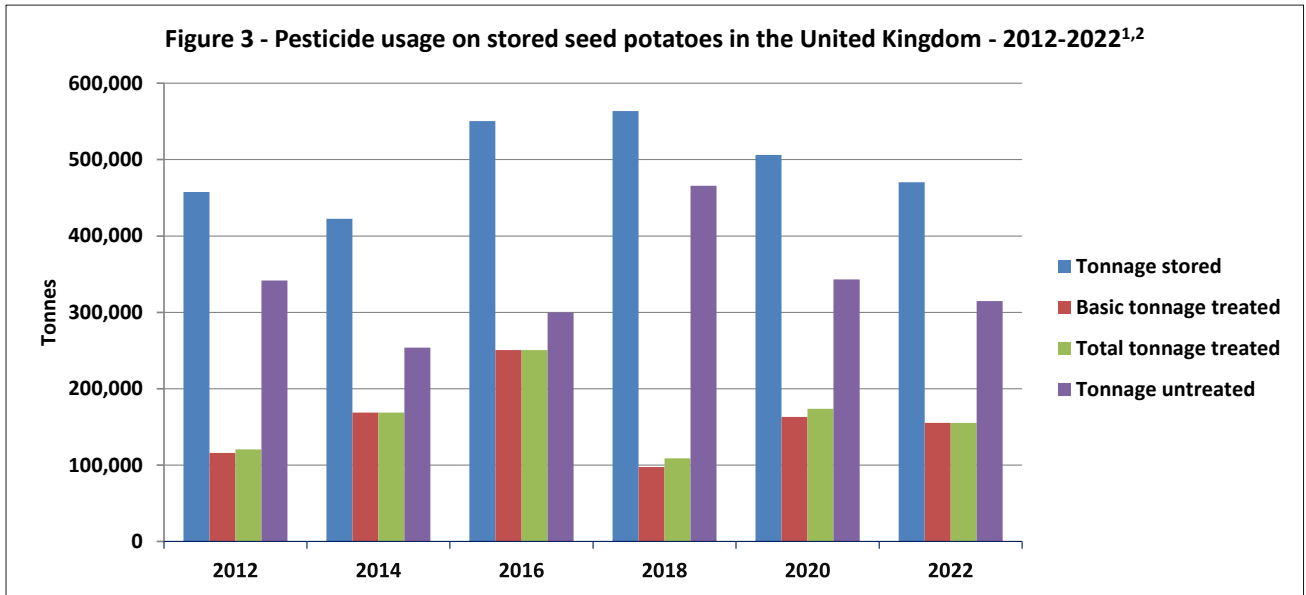
¹The basic tonnage treated is the tonnage stored minus the untreated tonnage

²The total tonnage treated includes repeat applications



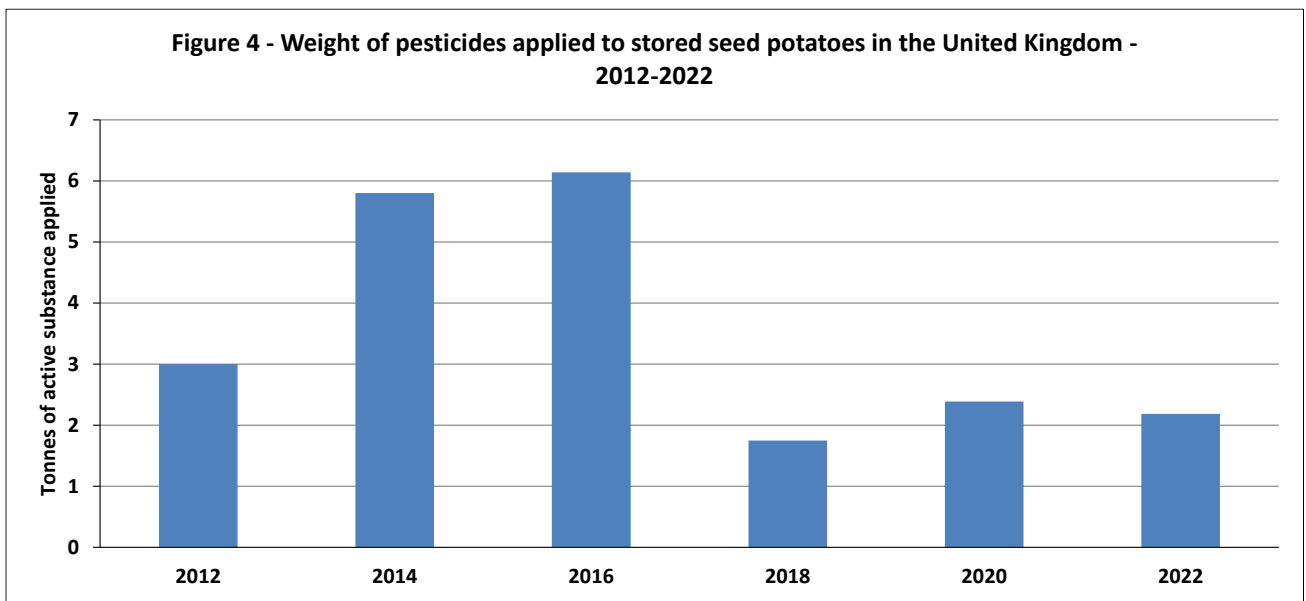
TRENDS (Cont.)

SEED POTATOES



¹The basic tonnage treated is the tonnage stored minus the untreated tonnage

²The total tonnage treated includes repeat applications

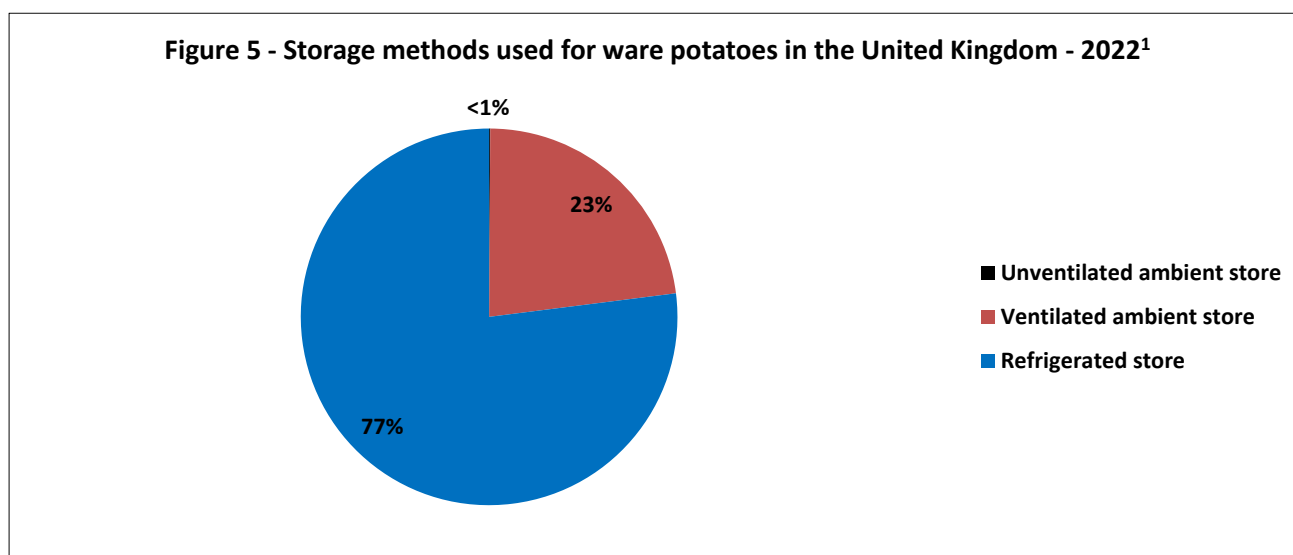


WARE POTATOES

- An estimated 3,103,547 tonnes of ware potatoes were stored in the United Kingdom (please see the methodology used to estimate the tonnes stored on page 16)
- 110,738 ha of ware potatoes were grown in the United Kingdom in 2022
- An estimated 1,542,663 tonnes were treated with an average of 1.77 treatments resulting in a total treated tonnage of 2,736,179 tonnes
- A further 1,560,885 tonnes (50%) remain untreated (82% of these in refrigerated stores)

Ware potatoes – Storage methods

Approximately 84% of ware potatoes were stored in boxed stores, the remaining 16% in bulk stores.



¹ Please note - All Pie-Charts within this report should be read clockwise from the top, as both the pie segments and the contents of the key appear in the same order.

Ware potatoes – Pesticide Usage

Active substance	Total tonnes treated	Active substance (tonnes applied)
1,4-dimethylnaphthalene	1,112,517	21.99
Ethylene	409,926	0.00
Imazalil	17,932	0.27
Orange oil	108,360	8.71
Spearmint oil	1,087,444	70.31
Total	2,736,179	101.27

1,4-dimethylnaphthalene, spearmint oil and orange oil were normally applied as a fog in applications made by contractors during the storage period. Ethylene was applied as a gas throughout the storage period with its concentration monitored and maintained in store to prevent sprouting of tubers. All three active substances were applied as sprout suppressants, replacing the use of chlorpropham since the 2018 survey.

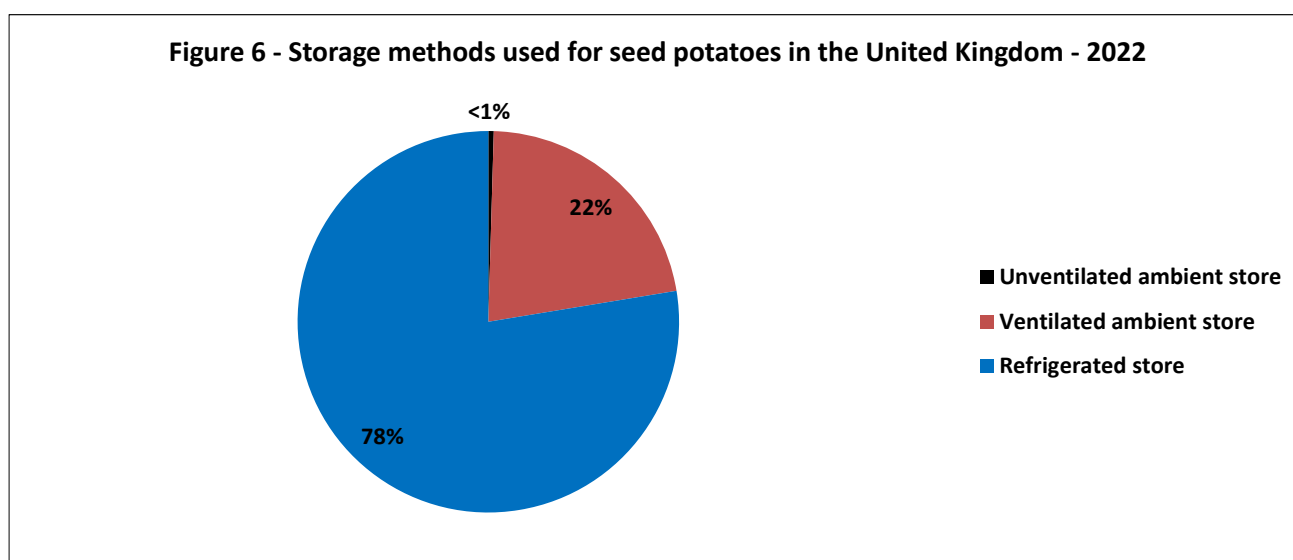
There was limited use of imazalil in ware potato stores. It was used for disease control, being applied as a spray to the tubers on entry into the store.

SEED POTATOES

- An estimated 470,198 tonnes of seed potatoes were stored in the United Kingdom (please see the methodology used to estimate the tonnes stored on page 16)
- 15,846 ha of seed potatoes were grown in the United Kingdom in 2022 (with 75% of the area grown in Scotland)
- An estimated 155,305 tonnes were treated with a single pesticide application
- A further 314,893 tonnes (67%) remain untreated (87% of these in refrigerated stores)

Seed potatoes – Storage methods

All seed potatoes encountered in the survey were stored in boxes.



Seed potatoes – Pesticide Usage

Three pesticide formulations (imazalil, ethylene and fludioxonil) were the only pesticides encountered in seed potato stores accounting for 92%, 4% and 4% of the total treated tonnage respectively.

Active substance	Total tonnes treated	Active substance (tonnes applied)
Ethylene	6,450	.
Fludioxonil	5,520	0.14
Imazalil	143,335	2.05
Total	155,305	2.19

Imazalil and fludioxonil formulations were applied as sprays for disease control – normally on the elevator as the seed potatoes entered store. It is important to note that imazalil is not authorised for use on ware potatoes and that crops treated with imazalil should not be used for either animal or human consumption. Whilst fludioxonil has authorisation as both a storage treatment and as a seed treatment, the treatments within this report relate only to its use as a storage treatment.

Ethylene gas was encountered in seed potato stores for the first time in 2014 and has been observed in all surveys since then. It is used to manipulate and increase sprout development in refrigerated stores.

APPENDIX 1 – DISTRIBUTION OF SAMPLED STORES

Table 1. Number and distribution of ware and seed potato stores sampled in the United Kingdom - 2022		
Region	Farm Stores	Merchant Stores
East Midlands	8	10
Eastern	14	16
London & South East	3	0
North East	1	1
North West	2	5
Northern Ireland	5	0
Scotland	16	57
South West	2	4
Wales	0	2
West Midlands	2	2
Yorkshire & the Humber	9	17
Total	62	114

APPENDIX 2 - WARE POTATOES

Throughout all tables, "." indicates that there was no recorded weight of either crops stored or pesticides used.

	Unventilated	Ventilated	Refrigerated	Total
Bulk storage	241	344,414	164,266	508,922
Boxed storage	2,762	366,493	2,225,371	2,594,626
Total - all storage methods	3,003	710,907	2,389,637	3,103,547

	Unventilated ambient		Ventilated ambient		Refrigerated		Total		All storage methods
	Bulk	Box	Bulk	Box	Bulk	Box	Bulk	Box	
Chemical									
1,4-dimethylnaphthalene	.	.	479,073	160,853	80,497	392,095	559,570	552,948	1,112,517
Ethylene ¹	.	.	7,076	23,275	.	379,574	7,076	402,850	409,926
Imazalil	.	.	.	17,932	.	.	.	17,932	17,932
Orange oil	.	.	50,865	.	56,691	804	107,556	804	108,360
Spearmint oil	.	.	200,359	52,992	93,520	740,574	293,879	793,565	1,087,444
Total	.	.	737,373	255,052	230,707	1,513,047	968,080	1,768,099	2,736,179
Not treated	241	2,762	64,258	207,497	59,216	1,226,911	123,714	1,437,170	1,560,885

	Tonnes treated	Tonnes (active substance)	% tonnes	% active substance
Chemical				
1,4-dimethylnaphthalene	1,112,517	21.99	41	22
Ethylene ¹	409,926	.	15	.
Imazalil	17,932	0.27	1	<1
Orange oil	108,360	8.71	4	9
Spearmint oil	1,087,444	70.31	40	69
Total	2,736,179	101.27		

¹There is no standard recommended rate per tonne of potatoes for the use of ethylene. The application equipment is pre-set to maintain the required level of ethylene concentration in each store. Consequently, the quantity of ethylene used will vary according to the store capacity, crop volume, the quality of store construction and the duration of storage. In most cases the actual amount of ethylene used was not available and it was not considered appropriate to include the information available from only a limited number of stores.

APPENDIX 3 – SEED POTATOES

Table 5. Storage pesticide use on seed potatoes in the United Kingdom, 2022 (tonnes treated)

	Unventilated Ambient		Ventilated Ambient		Refrigerated		Total		All storage methods
	Bulk	Box	Bulk	Box	Bulk	Box	Bulk	Box	
Chemical									
Ethylene ¹	6,450	.	6,450	6,450
Fludioxonil	5,520	.	5,520	5,520
Imazalil	.	.	.	65,226	.	78,109	.	143,335	143,335
Total tonnage treated	.	.	.	65,226	.	90,079	.	155,305	155,305
Not treated	.	2,147	.	37,969	.	274,777	.	314,893	314,893
Total tonnage stored	.	2,147	.	103,195	.	364,857	.	470,198	470,198

Table 6. Usage of individual active substances on stored seed potatoes in the United Kingdom, 2022

	Total tonnes treated	Tonnes (active substance)	% tonnes treated	% active substance
Chemical				
Ethylene ¹	6,450	.	4	.
Fludioxonil	5,520	0.14	4	6
Imazalil	143,335	2.05	92	94
Total	155,305	2.19		

¹There is no standard recommended rate per tonne of potatoes for the use of ethylene. The application equipment is pre-set to maintain the required level of ethylene concentration in each store. Consequently, the quantity of ethylene used will vary according to the store capacity, crop volume, the quality of store construction and the duration of storage. In most cases the actual amount of ethylene used was not available and it was not considered appropriate to include the information available from only a limited number of stores.

APPENDIX 4 - COMPARISON

Table 7. Comparison of production, storage, and treatment of potatoes in the United Kingdom - 2012-2022							
		2012	2014	2016	2018	2020	2022
Area grown (ha)	Ware	131,825	123,317	120,707	127,859	126,704	110,738
	Seed	16,946	17,214	16,733	16,478	16,363	15,846
Tonnes stored	Ware	2,952,083	3,098,269	3,454,294	3,003,620	3,096,086	3,103,547
	Seed	457,519	422,591	550,582	563,652	506,108	470,198
Basic tonnes treated¹	Ware	1,681,507	1,435,552	1,071,307	1,298,686	1,177,314	1,542,663
	Seed	115,969	168,884	250,770	97,751	163,127	155,305
Total tonnage treated²	Ware	2,907,145	2,677,280	1,623,981 ⁴	2,435,656	2,149,001	2,736,179
	Seed	120,593	168,884	250,770 ⁴	109,013	173,628	155,305
Tonnes untreated³	Ware	1,270,576	1,662,717	2,382,987	1,704,934	1,918,779	1,560,885
	Seed	341,550	253,707	299,812	465,901	342,981	314,893
Weight applied (tonnes)⁵	Ware	31	36	20 ⁴	29	103	101
	Seed	3	6	6	2	2	2

¹ Basic tonnes treated = tonnes stored – tonnes untreated

² Total tonnage treated = basic tonnes treated x number of treatments

³ Tonnes untreated = potatoes stored which receive no pesticide treatments during storage

⁴ This figure has been updated since the 2016 report was published

⁵ Weight applied refers to different active substances. The increase in weight applied for 2020 and 2022 reflects the introduction of new active substances and products after chlorpropham was withdrawn. Please see page 1 (Overview of main findings) for more details.

APPENDIX 5 – INTENDED USE OF WARE POTATOES

	Chipping	Crisping	Canning	Fresh market	Other uses	Total
1,4-dimethylnaphthalene	320,822	620,602	.	109,248	61,845	1,112,517
Ethylene	64,330	.	.	289,889	55,708	409,926
Imazalil	17,932	17,932
Orange oil	72,773	20,103	.	.	15,483	108,360
Spearmint oil	186,090	288,459	.	594,674	18,221	1,087,444
Treated tonnage	644,015	929,164	.	993,810	169,190	2,736,179
Tonnage stored	481,457	352,833	.	2,092,242	177,016	3,103,548

As can be seen from Table 8, over two thirds, 67%, of all ware potatoes stored, were intended for the fresh market, 16% for chipping and 11% for crisping.

Other intended uses accounted for 6% of the total tonnage of ware potatoes stored. The majority of these, 69%, were used for processing, including mash, pasties, and waffles, with 20% for stockfeeding and the remaining 11% were of unknown use.

1,4-dimethylnaphthalene, spearmint oil and ethylene were the most extensively used active substances on chipping, crisping and fresh market potatoes. Spearmint oil was the principal active substance used on fresh market potatoes. Most chipping and crisping potatoes were treated with 1,4-dimethylnaphthalene rather than spearmint oil or ethylene. Use of ethylene was encountered mainly on fresh market potatoes and use of orange oil was encountered mainly on chipping or crisping potatoes.

APPENDIX 6 – MITIGATION METHODS USED TO REDUCE CHLORPROPHAM RESIDUES (England & Wales)

Table 9 – Mitigation measures taken by stores with the most recent use of chlorpropham in England & Wales (n = 48 stores) (1 store made two responses)
No additional measures taken to reduce residues.
Washed down and re-foamed. Boxes stood in sun.
Pressure washed. Boxes not stood outside.
Deep cleaned two years ago.
Deep cleaned and hoovered.
Regular cleaning and 1 residue test - no residue's found.
Washed down. Insulation foam resprayed. Boxes left outside in summer.
Stores pressure washed 2 years ago.
Used for 30 years. Cleaned down following AHDB guidelines. Vacuumed and brushed. Doors left open/boxes stood outside.
No measures taken.
Thorough cleaning and ventilation. Allowing boxes to stand in sunlight to help with breakdown of residues.
Chlorpropham used many years ago. Use good store hygiene & thorough cleaning.
Residue tests and store cleaning.
Pressure washed boxes stood in sunlight.
Sites used for storing have followed CIPC stewardship guidelines - most sites BRC accredited.
Fully cleaned, hoovered. New tunnel linings. New linings. New floor slats. Re-insulated. Walls lined with Terram - no residues yet.
Cleaned and re-insulated. Boxes stood outside. No residues found.
Brushed and hoovered. Boxes stood outside.
Followed cleaning guidelines.
Brushed/vacuumed/cleaned as per guidance in summer 2020.
Replaced boxes. Cleaned thoroughly (including chamber).
Jet 5.
Thoroughly cleaned before storing.
Pressure washed. Swept out. 50% boxes outside.
Jet 5 wash & clean.
Washed walls. Brushed roof/walls. Steam cleaned.
Professionally cleaned. Boxes washed and stood outside. Residue tested.
Washed & disinfected each year. Boxes stood outside once empty.
Swept out and pressure washed to get rid of residues.
Deep clean. Residue test. Boxes in sunlight.
Residue tests. Followed AHDB guidance.
Industrial vacuum. Jet wash. Boxes stood outside. No residue tests.
Boxes put in sun. Power washed store every year.
No mitigation in 2022, has been done previously.
Dedicated store. Deep cleaned.
Professionally cleaned. Some boxes stood outside. Residue tests in factories.
Power washed. Hoovered.
Deep clean as per a chicken building.
Swept and hoovered. Clean ducts. Jet 5 fog.
Residue tests. Boxes outside. Pressure washed, hoovered. Grinder on fans.
Big clean out. Residue tests focussed on tunnels.
Cleaned out shed. Residue testing by processor.
Thoroughly cleaned.
Deep clean. Some wood around fans has been replaced.
Store walls brushed and hoovered. Boxes stored outside.
Hot pressure washed. No residues.
Pressure washed ducts. Boxes stood outside. Residue tests taken.
Swept out. Boxes stood outside.
Dry clean (no pressure washing). Boxes stood in sunlight.

APPENDIX 6 – MITIGATION METHODS USED TO REDUCE CHLORPROPHAM RESIDUES (England & Wales) (cont.)

Table 10 – Summary of mitigation measures taken to reduce chlorpropham residues at sampled stores in England & Wales (n = 48 farms)

Action taken	Number of farms
Cleaning/washed down (includes cleaning, washed down and deep clean).	37
Boxes stood outside.	18
Vacuumed/swept.	13
Residue tests.	10
Replacement foam and structures (also includes replacement boxes).	6
Follow guidelines.	5
Disinfection.	4
No action taken.	3
Increased ventilation.	2

Table 11 – Responses from stores in England & Wales that had not used chlorpropham recently (n = 8 stores)

Used 15-20 years ago. Hopefully residues are no longer there.
Last used 7 years ago. No specific cleaning for residues.
Washes store out. Re-insulated store (foam). Residue tests. Chlorpropham used 7 years ago.
Chlorpropham used 7 or 8 years ago. Used Jet 5 to clean out store.
Chlorpropham used 4 years ago. No specific clean. No residues.
Chlorpropham used over 10 years ago.
Chlorpropham used 4 years ago. Stores disinfected.
There may be residues in boxes from other stores but chlorpropham has never been used at this store.

In England & Wales additional information was collected on the steps taken to reduce the occurrence of chlorpropham residues in stores that had used this active substance in the past.

Table 9 details the individual responses made by each of the 48 farm and merchant stores. All stores had used chlorpropham in the recent past and only three stores (6%) indicated that no action was taken to reduce chlorpropham in store in 2022. However, one of these three indicated that some mitigation measures had taken place before 2022.

Table 10 summarises the responses and it is important to acknowledge that some stores employed a variety of methods to try and reduce chlorpropham residues. A total of 37 of the 48 stores, 77%, used some form of cleaning or washing down of their stores. 18% of stores stood boxes outside so that sunlight could degrade any chlorpropham residues present and 13% swept out or vacuumed the stores. Ten percent of the stores had residue tests conducted to detect the presence of any chlorpropham that may be present in the stored crop.

Table 11 presents information on the behaviours of store owners that had not used chlorpropham for a number of years or that had not used chlorpropham at all.

APPENDIX 7 - METHODOLOGY

METHODS

The samples of holdings to be surveyed were selected using data from the Agricultural Census Returns, June 2021 for England & Wales (Anon., 2022 a, b), for Scotland (Anon., 2022c) and Northern Ireland (Anon, 2022d).

The samples for the arable survey (Ridley et. al., 2023) were drawn from the census returns to represent the area of all arable crops grown throughout England, Wales, and Northern Ireland. For England the sample was selected within each of the eight Government Office Regions (GORs). The Welsh Assembly Government provided a further sample, which represented the area grown in Wales.

For Scotland, the June Agricultural Survey has been used in previous pesticide usage surveys to draw a sample of farmers growing the relevant crops to participate in the survey. To allow for the Agricultural Statistics Transformation Programme, the 2022 June Survey was paused. This pause was agreed with the Office for Statistical Regulation and data users. For this survey, the May 2022 Single Application Form (SAF) data was used to draw the sample using the same methodology as previous surveys. SAF data accounts for the majority of land area for arable crops. The sample drawn is based on the area of crops grown, rather than number of holdings. As such, no attempt is made to account for holdings that are not captured by SAF returns. (Note: The difference in total Scottish arable area recorded between SAF 2022 and Agricultural Census 2021 was less than one per cent. The largest difference was biased towards the smaller size groups, less than five per cent of a difference) (Davis et. al., 2023).

The samples for the arable survey were stratified according to the total area of all arable crops grown in each region and by farm size group based on the total area of arable crops on each farm. The area of arable crops sampled in each size group and each region was proportional to the total area of arable crops grown on holdings of each size group in each region. All three survey teams followed the same methodology for data collection and used the same forms and instructions for their completion. The size groups, based on the total arable area are as follows: <50ha (A); >50-<=100 ha (B); >100-<=150 ha (C); >150-<=250 ha (D); >250-<=500 ha (E) and >500 ha (F).

In England and Wales, most of the data on arable pesticide usage was collected by a sub-contractor, using the sampling frame and stratification methodology indicated above. Whilst the sub-contractor collected detailed field pesticide usage, they did not collect supplementary data on potato storage.

To increase the data relating to potato storage in England and Wales a separate sample was taken using the same stratification indicated above (region and arable farm size group), but only from holdings who indicated on their 2021 June Survey returns that they were growing potatoes. A total of 661 holdings were selected, and an introductory letter was sent to each, explaining the purpose of the survey, and enclosing a postal reply form requesting the total area of arable cropping, the area of potatoes grown, and the tonnage of potatoes stored from the 2022 harvest.

Of the 117 positive responses received from the postal questionnaire in England & Wales, 75 grew potatoes with 43 of these storing potatoes. A further 27 rented land to other growers and 5 grew potatoes but didn't store. All respondents growing and storing potatoes in 2022 were contacted by telephone to confirm the types of stores and storage treatment details. Of the 43 growers storing potatoes, 36 provided on farm storage information. The other seven were moved to the merchant address list as they were growing on farms other than their own.

An additional 5 farm stores were encountered in the main arable survey for England & Wales resulting in a total of 41 farm stores in England & Wales.

A further questionnaire was sent to 77 merchants' stores in England & Wales, of which storage data were received from 57 stores. No responses were made from the remaining 20.

The Pesticide Survey Unit at SASA provided information on 16 farm and 57 merchant potato stores in Scotland and the Pesticide Usage Survey Team at AFBI provided data on a further 5 farm potato stores in Northern Ireland.

Estimated tonnage stored

In recent surveys, the tonnages of both ware and seed potatoes going into store have been based on the AHDB Great Britain figures for crops in store in November. It has always been assumed that any potatoes being moved from November onwards have come from potato stores.

The AHDB data were based on a sample of 300 growers and all figures produced were estimates and not a census of GB storage. Stores that were not involved in any growing were not included in the figures and a percentage needed to be added to the storage estimates provided by AHDB (in 2020, 12% of the sampled tonnage was from non-growers). Tonnages for Northern Ireland accounted for 1% of the total tonnage of ware potatoes stored in the UK in 2018 and 2020.

However, in response to the horticulture and potato levy payers' votes in 2021 on the future of the statutory levy, the decision was made to wind down activity in these sectors and figures on potato storage and movement are no longer available from AHDB.

Therefore, it was necessary to look for additional sources of data. It was decided that the only other reliable data source for ware potatoes were the Defra UK figures:

<https://www.gov.uk/government/statistics/agriculture-in-the-united-kingdom-2022/chapter-7-crops#potatoes>

When comparing the Defra UK production figures for ware potatoes with the AHDB GB figures for 2012 – 2020 (five survey years in total), the Defra UK figures were consistently larger by an average of 8%. This difference was in part due to the inclusion of Northern Ireland data, although this is only likely to comprise 1% – 2% of the total. The remaining difference is most likely to be stores that were not growing and not included in the AHDB totals.

Based on six survey years (2010 – 2020) the average percentage of GB ware production going into store was 70%. This percentage has been used and applied to the Defra ware production figures for the United Kingdom.

In previous years, stocks of seed potatoes in store in November (AHDB figures) had been assumed to be the total tonnage stored. An additional correction factor to consider Northern Ireland seed potato storage was used in both 2018 and 2020 to produce estimates for the United Kingdom.

As the AHDB seed figures were not available for the 2022 harvest, it was hoped that Defra estimates for UK seed potato production could be used as they had been for ware potatoes. However, this was not possible as the Defra estimates for seed production in the United Kingdom was 363,662 tonnes. Estimated tonnages produced by the SASA Potato Department indicated that there were 415,033 tonnes produced in Scotland alone.

The two figures are therefore not compatible, and our estimation figures are based on those produced by the SASA Potato Department and contained within the published report for Scotland (Davis et. al., 2023). Scotland accounts for 75% of the total seed potato area grown in the United Kingdom and is likely to contribute a similar percentage to the total tonnage stored. Estimates for England and Wales were produced using an average yield (from the SASA Potato Department) multiplied by the area of seed potatoes grown. Based on the most recent six survey years (2010 – 2020) the average percentage of GB seed production going into store is 87%. This percentage has been used and applied to the estimated seed production figures for England & Wales. An additional figure for the tonnage of seed potatoes stored in Northern Ireland was provided by DAERA.

Raising factors for ware potatoes were calculated by dividing the United Kingdom estimated tonnage stored by the sampled stored tonnage. For ware potatoes the raising factor was 4.02, and for seed potatoes, 3.07. For each calculation and to more accurately estimate quantities stored and pesticides applied, the raising factors used were to six decimal places.

The raising factors used have assumed that the sampled stores and their pesticide usage are representative of potato stores in the United Kingdom, and that the Defra and SASA estimates are without error. We appreciate that the absence of absolute figures for the tonnages of seed and ware potatoes in the United Kingdom, such as those available from the June Survey figures for cropping areas, does present a challenge when estimating national usage.

The Questionnaire

The questionnaire consisted of two forms, which were completed by an experienced surveyor during a telephone interview with the farmer, or for commercial stores, by a store representative following receipt of a comprehensive set of instructions.

Form 1 summarised the area of potatoes and arable crops grown on each holding during the 2022 growing season. It also indicated whether potatoes were stored and asked for contact details in order to follow up on storage information.

Form 2 detailed all aspects of pesticide usage in each store. A separate form was completed for each method of storage and treatment programme. Seed and ware potatoes were recorded separately.

Where necessary, further checks have been made to ensure that farm stores were only storing potatoes harvested from their own holding; this has been established following discussions with individual growers. In some cases purpose built stores may have been built in co-operation with individual merchants in order to store potatoes that they would ultimately purchase. These have remained as farm stores if the potatoes were only from their own holding.

In contrast to surveys conducted by the England & Wales survey team up to and including 2010, which were conducted mainly by visit, the 2022 survey for England & Wales was a combination of postal and telephone surveys. There are inherent problems with postal surveys, the main one of which is that response rates are unpredictable and can be quite low. However, the use of telephone interviews has proved successful in obtaining potato storage information in both 2020 and 2022.

Visits to arable farms in England & Wales, including those with potato storage, are now limited as most arable data are collected by a sub-contractor (Ridley et. al., 2023). However, the aim of this survey was to obtain the number of farm stores similar to those achieved when farm visits were made. For on-farm potato storage in England & Wales a total of 661 letters were sent, assuming a 10% response rate to achieve a total of 60 stores, which would then be in line with the numbers recorded for the last visit survey in 2010 (56 stores in England & Wales).

However, whilst an 18% response rate was achieved overall, only 5% of the total responses were from farms growing and storing potatoes (36 stores in total). However, there were an additional 7 stores added to the merchant address list as they were growing potatoes on holdings other than their own.

The send out to 661 farms in England & Wales in 2022 resulted in 36 farm stores, compared to 55 stores in 2018 when 684 letters were sent out. This difference in response rates between 2018 and 2022 is possibly due to the Covid pandemic. Figures for England & Wales in 2020 and 2022 were very similar, with 37 farm stores in 2020 and 36 in 2022. There were slight increases in the number of farm stores in both Scotland, 6 stores in 2020 increasing to 16 in 2022, and in Northern Ireland, 2 stores in 2020, increasing to 5 in 2022.

Rounding

Due to the rounding of figures, the sum of constituent items in the tables may not agree exactly with the totals shown.

Error checking

Extensive checks are made on the data before, at the time of and following data entry. Data checking routines are used to verify the authenticity of the data collected including the authorisation and approval status of all crop/pesticide combinations, high and low rates of application, the methods of application used to apply pesticides, the timing of pesticide applications and untreated tonnages.

Further checks are made on the integrity of the relational database used to store the raw data collected ensuring that links to product databases are in place prior to the production of the report. The product databases used for the pesticide usage surveys are maintained alongside the commercial product database, *LIAISON*, which is used extensively by agronomists and the major farm management software companies.

Where inconsistencies are found, for example where there are high rates of application or non-approved product usage, these are checked first against the information collected and secondly with the grower and amended if necessary.

Reports are written and checked within the team after which they are sent to reviewers within the ECP Working Party on Pesticide Usage Surveys for their comments and checking.

The final report is pre-announced and published via the Government statistics release calendar and the Fera Science Ltd. website in line with the Code of Practice for Statistics.

Data limitations and use of data

Our experience has shown that the proposed face to face interview and 'main contact plus reserves approach' delivers the highest quality data and minimises non-response bias; no other approach is likely to yield fit for purpose data to meet the quality requirements of the UKSA Code of Practice for Official Statistics. However, for this survey the collection of data over the telephone by an experienced surveyor has proved successful as the data required are relatively straightforward to collect. Drawing a fresh stratified random sample each year is clearly an appropriate survey methodology.

Whilst there are detailed data available on the cropped areas of ware and seed potatoes in the United Kingdom, there are no such figures for stored potatoes. The only data available on stored ware and seed potatoes are based on Defra estimates of ware production for the United Kingdom, estimates of seed production and storage by SASA, and estimates produced by AFBI for Northern Ireland. In the absence of any other data, it has been these figures that have been used to create raising factors and to make national estimates of pesticide usage.

As part of this survey Fera Science Ltd. has implemented the United Kingdom Statistics Authority Code of Practice for Statistics, published in 2009 and revised in 2018. Whilst all three pillars and 14 principles apply, we acknowledge the following:

- **Honesty and integrity:** people in organisations that release statistics should be truthful, impartial, and independent, and meet consistent standards of behaviour that reflect the wider public good.
- **Data governance:** organisations should look after people's information securely and manage data in ways that are consistent with relevant legislation and serve the public good.
- **Efficiency and proportionality:** statistics and data should be published in forms that enable their reuse. Producers should use existing data wherever possible and only ask for more where justified.
- **Accessibility:** statistics and data should be equally available to all, not given to some people before others. They should be published at a sufficient level of detail and remain publicly available.

In accordance with UKSA Code of Practice for Statistics, we work with Defra and HSE statisticians to build on our existing extensive and effective relationships with users of the surveys to further enhance user engagement. There is a broad spectrum of users and stakeholders across policy, research, agricultural supply industry (including consultancies), farming and horticultural businesses, civil society organisations and members of the public. Over the years we have an excellent record of listening to our users and incorporating their feedback into the way we collect and report our statistics.

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