Photo: Jenny Bashford, AHDB

The resilience of potato and horticulture businesses to changes in abstraction licencing

Survey Report

Report for AHDB

AHDB Reference number: CP 159

Ricardo Energy & Environment Reference number: ED61611

Project details

Project title:	The resilience of potato and horticulture businesses to changes in abstraction licencing
Project number:	CP 159
Project leader:	Dr Jeremy Wiltshire, Ricardo Energy & Environment
Report:	Survey report, 30th November 2016
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Date project commenced:	8th December 2015
Date project completed:	30th November 2016

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AUTHENTICATION

We declare that this work was done under our supervision according to the procedures described herein and that the report represents a true and accurate record of the results obtained.

Dr Jeremy Wiltshire

Knowledge Leader, and CP 159 Project Manager

Ricardo Energy & Environment

Signature  Date: 30th November 2016

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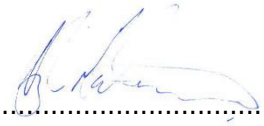
Signature  Date: 30th November 2016

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Introduction

AHDB Horticulture has a research strategy to drive technical innovation in horticulture, 2013-2018, called “Fit for the future”. Within this, there is a crop inputs theme, which includes the aim of optimising the management of water use to improve returns and reduce environmental impact. One of a shortlist of key priorities addressing relevant challenges that will have a direct impact on the industry is “Soil, nutrient and water management”, owing to the sector’s need to maximise crop yield and quality with minimum environmental impact.

Horticulture levy investment utilises a strategic approach that concentrates on six broad programmes of activity, one of which is “inputs” (energy, nutrition and water). These broad programmes of activity flow down to each of the AHDB Horticulture Sectors, and to the panels of grower groups. For example, the British Carrot Growers Association (BCGA) gives a target for water management under its Objective 2 (increase returns on investment through efficient use of resources). Other associations have similar targets relating to water management.

AHDB Potatoes has a Research and Innovation Strategy (2015 to 2020) that details potato industry research priorities. One of the topics within these priorities is ‘Soils, Water management and Crop nutrition’. It is a priority to increase system resilience and ensure that robust advice is developed to best exploit available soil water and irrigation. The AHDB Potatoes document ‘Engagement with Impact’ builds on the Research and Innovation Strategy and gives more detail of how knowledge will be delivered: water use (‘resource availability and exploiting soil water and irrigation, precision application systems’) is shown as a strategic priority.

This project helps to meet the AHDB priorities by gathering information from levy payers and key stakeholders to provide evidence on:

- The current status of water use in these sectors;
- The measures being adapted by businesses to build resilience to water availability challenges;
- The impacts the proposed legislative changes could have on the sectors.

In recent years some other studies and surveys, on water management in the agricultural and horticultural sectors, have influenced research and strategy documents relevant to the sector.

The NFU carries out a water survey every 5 years to analyse the agricultural sectors water use, investment and water efficiency measures, and considers the attitudes of land managers towards climate change adaption and regulation. In the 2011 survey, 514 farmers and growers in England and Wales were surveyed either by telephone or online. This on-going survey represents all agricultural sectors. On average 60% of respondents represent the

livestock sector. In 2011: 67% of the survey participants used less than 7,500m^3 per year; 8% used more than 60,000 m^3; 49% of groundwater users abstracted more than 20m^3 /day; 18% of respondents irrigated; 15% of respondents were associated with the horticulture sector and 72% of that group irrigated. Arable and horticultural growers were found to be the least likely to use mains water, instead utilising reservoirs more frequently.

Of those surveyed, 25% held abstraction licences and these were mainly on arable and horticulture farms. Approximately half had time limits on the licence. Of those with abstraction licences, 21% were members of an abstraction group and 58% were aware of the Environment Agency (EA) catchment abstraction management strategy (CAMS) approach.

Respondents were found to employ around three water management measures each on average, but 22% stated that they used none. The responses received in the survey indicated that investments in water infrastructure over £10K were not common, but 39% of those surveyed spent up to £10K. 28% had improved water efficiency on their holding with 7% having received funding to assist with this process.

When questioned about climate change and its impact on water the majority answered with a neutral response, possibly suggesting a need for a greater understanding of what the implications may be[1].

The NFU carried out further research in 2015, conducting an irrigation survey in the Lark and Wissey catchment, in East Anglia. The Lark catchment consists of 149 abstraction licences (25% survey response rate) and the Wissey 31 licences (42% survey response rate). According to this research, farmers in the sub-catchments used two-thirds of the water allocated to them in their abstraction licences during 'average/normal' weather years; rising to three-quarters of their maximum licensed volume in 'dry years' (2006 and 2010-12). Cumulative average use was partly suppressed by farmers with 'sleeper' licences declaring 'nil' returns. Two-thirds of farmers surveyed in the Lark and half the farmers surveyed in the Wissey said they use 100% of available water in dry years. The source of water abstracted was evenly split between surface and ground water.

The Wissey catchment had significantly more investment in storage than the Lark catchment. Less than 10% of reservoir construction projects were financially supported by the EU Rural Development Programme. Most reservoirs installed were older than 10 years indicating that farmers recognised there is a problem with the availability of water and it is not a new issue. The majority of farmers were of the opinion that there will be enough water available over a 10-year horizon. The study found a combination of greater drought risk and government

[1] Bashford and Clifford (2011) NFU Water Survey 2011 Overall Results http://www.demonstratingcatchmentmanagement.net/wp-content/uploads/2012/01/NFU-Water-Survey-2011_-FINAL-EXTERNAL-V4-2.pdf

proposals for water abstraction licensing reform is believed to be the major contributor to declining confidence.

Both catchments are described as over licenced by the EA, but farmers don't have a good understanding of the water available in their catchment. Impact of water shortages on profitability was variable but nearly 50% reported no change, possibly influenced by increased output prices.

Across both catchments, farmers reported that they have either already adopted measures to adapt to water availability pressures, or they have planned to do so. Measures included: changing their cropping (i.e. grow different crops or change the relative production areas of the mix of crops on the farm), investing in irrigation technology, and using new techniques to improve efficiency. However water trading was not common practice with only a small percentage of farmers engaging in this activity[2].

Defra also carries out an irrigation survey every five years. The 2010 survey provided information on water volumes, costs of water, irrigated areas and management practices. Results found that agriculture used 184 million m^3 of water. Of this 41% was used for livestock drinking and 38% for irrigation. Water usage is directly correlated to the area of land irrigated and the weather conditions. According to the survey, 2010 saw a 28% decrease in irrigated area compared to 2005 due to wetter conditions. Of the irrigation carried out in 2010, 93% was done by the hose reel method. The survey reported that water accounts for 1% of the total fixed costs and that the financial driver is the main reason for farmers to implement water efficiency measures[3].

As part of the European Regional Development Fund (ERDF) Water Advisory Team for Efficient Resource Recovery (WATERR) project, East Malling Research conducted a survey of 125 growers in the South East of England to review irrigation businesses[4]. Spray irrigation was mainly used on field crops while trickle irrigation was mainly used on fruit crops. The study found that in Kent 40% of irrigation was sourced from river abstraction and a further 26% of growers relied on public water supply. However, over the last five years only approximately 10% of growers had restrictions enforced on the abstraction licence, which has reduced the impact of limited water availability on their businesses. The perception amongst Kent growers is that the impact of water availability will increase in future years, and as a result, growers are making plans to increase water available to their businesses. The survey

[2] Clifford and Hammett (2015) Water availability in a changing climate: A survey of irrigated crop growers in the river Lark & Wissey catchments, https://www.nfuonline.com/wissey-and-lark-water-use-report-may-15/
[3] Defra (2011) Water Usage in Agriculture and Horticulture Results from the Farm Business Survey 2009/10 and the Irrigation Survey 2010, http://www.swarmhub.co.uk/index.php?dlrid=4088
[4] Dracott (2015) Irrigation Business Review Findings: Water Availability, Irrigator Support Needs and Planned Support Programme, ERDF 'WATERR' project, PowerPoint presentation

identified that growers needed more support to understand abstraction reform and translate research into documents which offer practical and commercial solutions. Growers highlighted a need for additional training resources on irrigation for their staff, and independent information and advice on irrigation technology for their specific business.

As a result, the WATERR project has planned to deliver further workshops, guides, factsheets and case studies to support the industry. This work will be an essential contribution to this project to avoid duplication of effort and allow collaboration and benefits to be disseminated outside of the South East region.

Project objectives

The key objectives were:

1. To undertake a survey of horticulture and potato growers, to give understanding of water availability and management across Britain, for the following sectors:
    - Potatoes,
    - Field horticulture,
    - Protected horticulture,
    - Containerised plants grown outdoors.
2. Identification of knowledge and infrastructure gaps.
3. Compare survey results with other similar recent research.
4. Develop a stakeholder document to give clear guidance on the current abstraction licence system and on the actions growers could take in light of the upcoming legislative changes.

The purpose of this report

This report provides the results of the survey of horticulture and potato growers. Other project outputs include a stakeholder document, and this is produced separately.

Materials and methods

AHDB databases

Ricardo Energy & Environment were provided with a database that contained contact information for approximately 3,800 levy payers. A split of those levy payers within this database is provided in Table 1.

Table 1. Indicative breakdown of AHDB levy payers in the main database provided to Ricardo Energy & Environment.

Description	Number of levy payers in database	% of database
Total number in database	3,830	100%
Email address	2,313	60%
Phone number, no email address	451	12%
No email address, no phone number	145	4%
No water availability data	923	24%
Total number of growers in the potato sector	2,584	67%
Total number of growers in the field horticulture sector	796	21%
Total number of growers in the protected horticulture sector	402	11%
Total number of growers in the outdoor containerised plants sector	309	8%

Additional AHDB database

An additional database was provided to Ricardo Energy & Environment in the latter part of May 2016. This database held 698 contacts. Of these contacts, 234 had an email address and were sent the email introducing the survey with a link to complete online. Of those who did not have an email address recorded, 143 had a phone number. One hundred and nineteen of these had water availability data associated with their holding, and were contacted by telephone.

Water availability categories

Water availability categories were assigned using data on consumptive abstraction available for catchments. Growers that were surveyed were allocated to catchments using their location data, and then the growers were allocated the availability category for their catchment. The categories relate to the percentage of the time that consumptive abstraction is expected to be available, and the categories are as follows.

Consumptive abstraction available:

- less than 30% of the time
- at least 30% of the time
- at least 50% of the time
- at least 70% of the time
- at least 95% of the time

Target numbers for different sectors

Statistical methods were used to determine the target number for each of water category and four main sector (potato; field horticulture; protected horticulture; outdoor containerised plant) combinations. Our approach to determining sample size was designed to achieve a balance between statistical accuracy and the budget available.

The target numbers for potatoes were calculated using a confidence interval of 90% and a margin of error of 15%. This was to ensure that the potato sector received less of the time and budget from the survey. As the potato sector covers a single crop, this is deemed acceptable. The other three sectors were calculated using a confidence interval of 95% and a margin of error of 10%. The target numbers derived using this method are shown in Table 2.

Table 2. Target numbers for different sectors with the different water availability categories.

	less than 30%	at least 30%	at least 50%	at least 70%	at least 95%	Totals
Potatoes	28	27	28	27	28	138
Field Hort	67	38	53	49	53	260
Protected Hort	53	29	35	26	45	188
OCP	47	27	34	17	36	161

						747

The sample target sizes were calculated using the following equation:

$$Sample\ size = \frac{\frac{0.25z^2}{e^2}}{1 + \frac{0.25z^2}{e^2 N}}$$

Where N = Population size, e = margin of error, and z is the Z-score (1.96 if the confidence level is 95%; 1.65 if the confidence level is 90%)[5].

This is a standard statistical equation used to determine the sample size required to calculate a proportion with an acceptable level of precision. The equation provides a valid estimate for the required sample size for each sub-group.

Methodology for contacting members

The contacts in the levy database were reached through email, telephone and a paper mailing. This activity was carried out between March and June 2016. Further detail is given on each of the approaches to contacting members below.

Email

More than half of the contacts in the database held an email address (60%). Between March and June 2016, all contacts with an email address were emailed to notify them of the survey and encourage them to complete it. A two-week deadline was given, and once this had passed, a follow up email was sent to prompt any further responses. Once all contacts had been emailed, a final reminder was sent to all, and finally, a thank you email with a last chance request was sent in June. Any new email addresses collected during the telephone calls (see below) were included in these reminder and final emails.

Telephone

Two types of telephone calls were used to glean data from levy payers. Phone calls were made to those who had received the email and had not responded. A script was used whereby telephonists confirmed whether the email had been received, recorded an updated email address where the email had not been sent to the most appropriate contact, and offered to

[5] Townend, J. (2002). *Practical statistics for environmental and biological scientists*. Chichester: Wiley.

conduct the survey over the telephone. Where a new email address was provided, an email with a link to the survey was sent to the new email address.

The second type of telephone call was to those who had no email address so would have received no prior communication of the survey. These contacts were introduced to the purpose of the survey and asked whether they would like to complete the survey over the telephone or have an email sent to them with a link to the online version. Email addresses were recorded and an email was sent to these contacts.

The telephone calls were prioritised by allocating contact lists to telephonists based on weekly reporting. This enabled sectors where responses were lower than others to be targeted. Because of this prioritisation, the majority of phone calls made were to those in field horticulture, protected horticulture, and outdoor containerised plants sectors.

A dedicated helpline was set up to provide a central number for growers to return calls from the survey team or request assistance with completing the survey. The helpline was open between 8.30am and 5.00pm with a voicemail facility available outside of office hours. 98% of all calls received by the helpline team were answered within 30 seconds.

A breakdown of the activity by the telephone survey team is shown in Table 3. This breakdown does not include details of multiple calls to an individual grower if the telephone survey team was unable to establish contact on the first attempt (i.e. where it was not possible to leave a voicemail).

Table 3. Telephone calls conducted, including number of surveys carried out over the telephone

Telephone activity	Number
Number of individual growers contacted by telephone	724
Number of inbound calls to the helpline	64
Number of surveys completed over the telephone	6
Number of growers who stated that they were unwilling to complete the survey	52

Mailing

In addition to the email and telephone contact, Ricardo Energy & Environment sent out a paper mailing to 500 growers. Hard copies were also sent when requested during telephone calls. The 500 growers selected for the mailing were chosen based on priority sectors

(combinations of sector and water availability categories) with low numbers of responses received.

Results

Number of contacts made

- Number returned from paper mailing: 55 (53 complete)
- Number of surveys carried out over the phone: 6
- Number of emails delivered: 8,534 (94.42%)
- Number of emails opened: 3,685 (43.18%)
- Number of unique clicks on the link: 792
- Number of unsubscribes: 16

Number of surveys carried out

The number of entries to survey monkey totalled 821. However, some of these were test entries, some individuals had entered dummy data in the first part of the survey in order to browse the rest of the questions, and some were duplicated by a more complete, later survey completion.

The total number of entries was screened on these points, leaving a total number of 688 responses to the survey. Of these, 550 had clicked the done button at the end of the survey. Added to these 550 responses are 138 responses where the respondent had not clicked the done button. Thirty-four of these completed the front page only, leaving 104 useful responses without the done button clicked; the sum of the 550 and 104 useful responses is 654. Of these 654 responses, those who did not provide answers to the questions regarding crops grown were removed from the final total used for data analysis. This was done to ensure that all responses could be linked to crop sector. The number of surveys completed, and analysed are summarised in Table 4.

Table 4. Number of respondents.

Description	Number of responses
Total respondents logged on survey monkey	821
Responses after removal of test entries, dummy data, and duplicate entries	688
Number of 688 respondents who had clicked the done button (‘done’)	550
Number of 688 respondents who did not click the done button (‘not done’)	138

Number of 138 ‘not done’ respondents who filled in more than the front page	104
Number for initial analysis (550 ‘done’ plus 104 ‘not done’)	654
Number removed from this initial list due to not reporting on crop grown	60
Total number of respondents used in data analysis	594

Only the first question (contact details etc.) was mandatory; all other questions were not mandatory and could be skipped. The survey was designed this way to encourage participation.

In Table 5 the number of responses is categorised by the four main growing sectors, which were subsequently used in this project to present the survey results.

Table 5. The number of responses and total number of growers in each main sector, based on the information provided by respondents.

	Number of responses	Total in sector	Percentage
Potatoes	471	2,584	18%
Field Horticulture	429	796	54%
Protected Horticulture	104	402	26%
Outdoor Containerised Plants	48	309	16%
Total number of responses*	1052		

*This number is greater than the total number of 594 useful survey responses because many growers produce crops in more than one sector.

Spatial distribution of results

Table 6 shows the number of responses in England, Scotland and Wales for the 594 respondents included in the data analysis.

Table 6. Survey responses for England, Scotland and Wales.

	Total number of levy payers in AHDB database	Number of responses	Percentage of number in database
England	3168	535	17%
Scotland	601	54	9%
Wales	61	5	8%

The following six maps (Figures 1 to 6) give a visual representation of the spatial distribution of respondents. The maps show a concentration of responses in areas where irrigated crops are most grown (mainly the eastern side of Britain, and the West Midlands of England), with a scattering of responses in other areas reflecting the spatial distribution of specialist production sectors (e.g. glasshouse growers in the south of England).

Figure 1. The areas of irrigable land shown by location of the respondents' addresses.

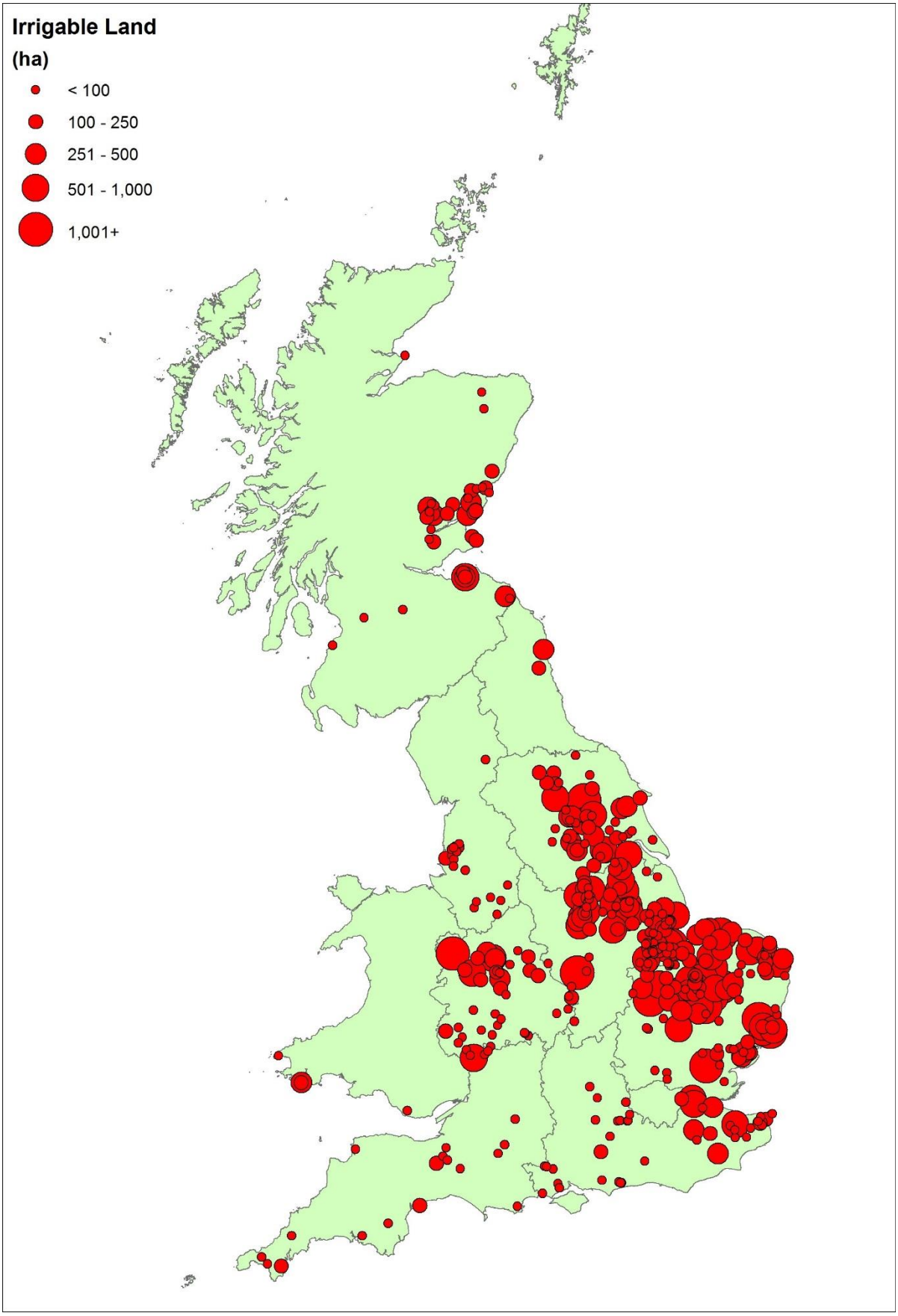


Figure 2. Locations and size ranges of holdings, for potato growers.

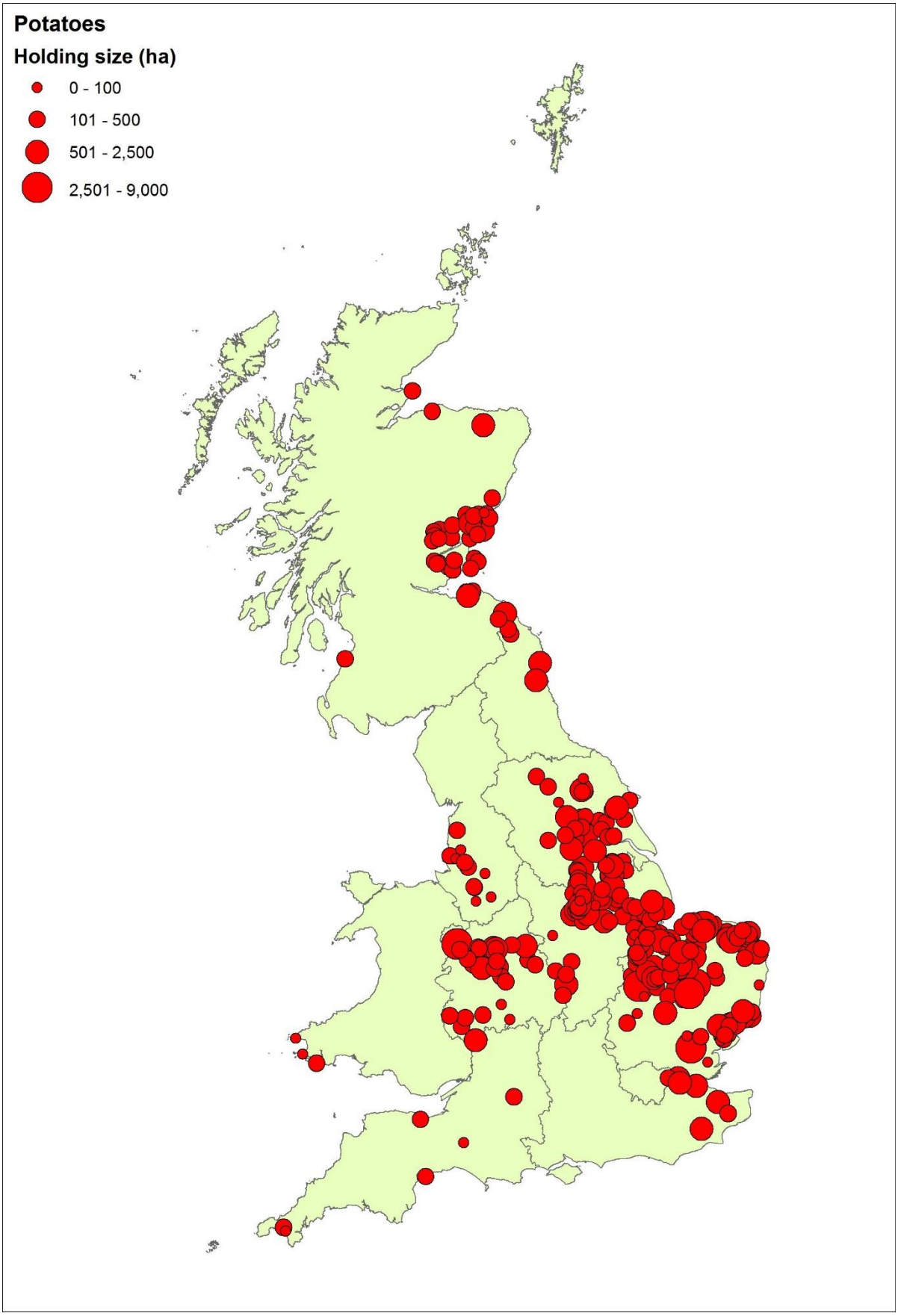


Figure 3. Locations and size ranges of holdings, for field horticulture growers.

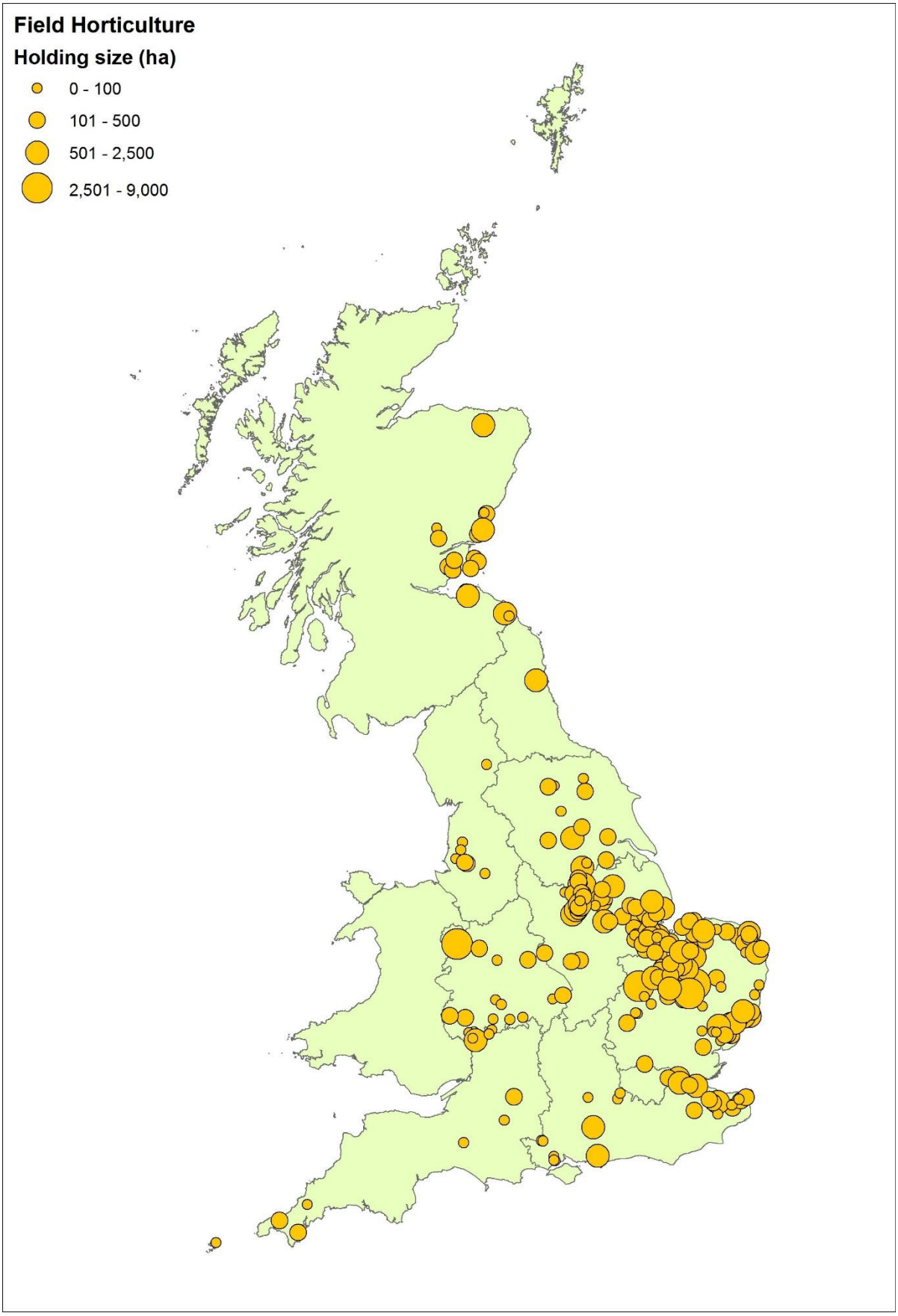


Figure 4. Locations and size ranges of holdings, for protected horticulture growers.

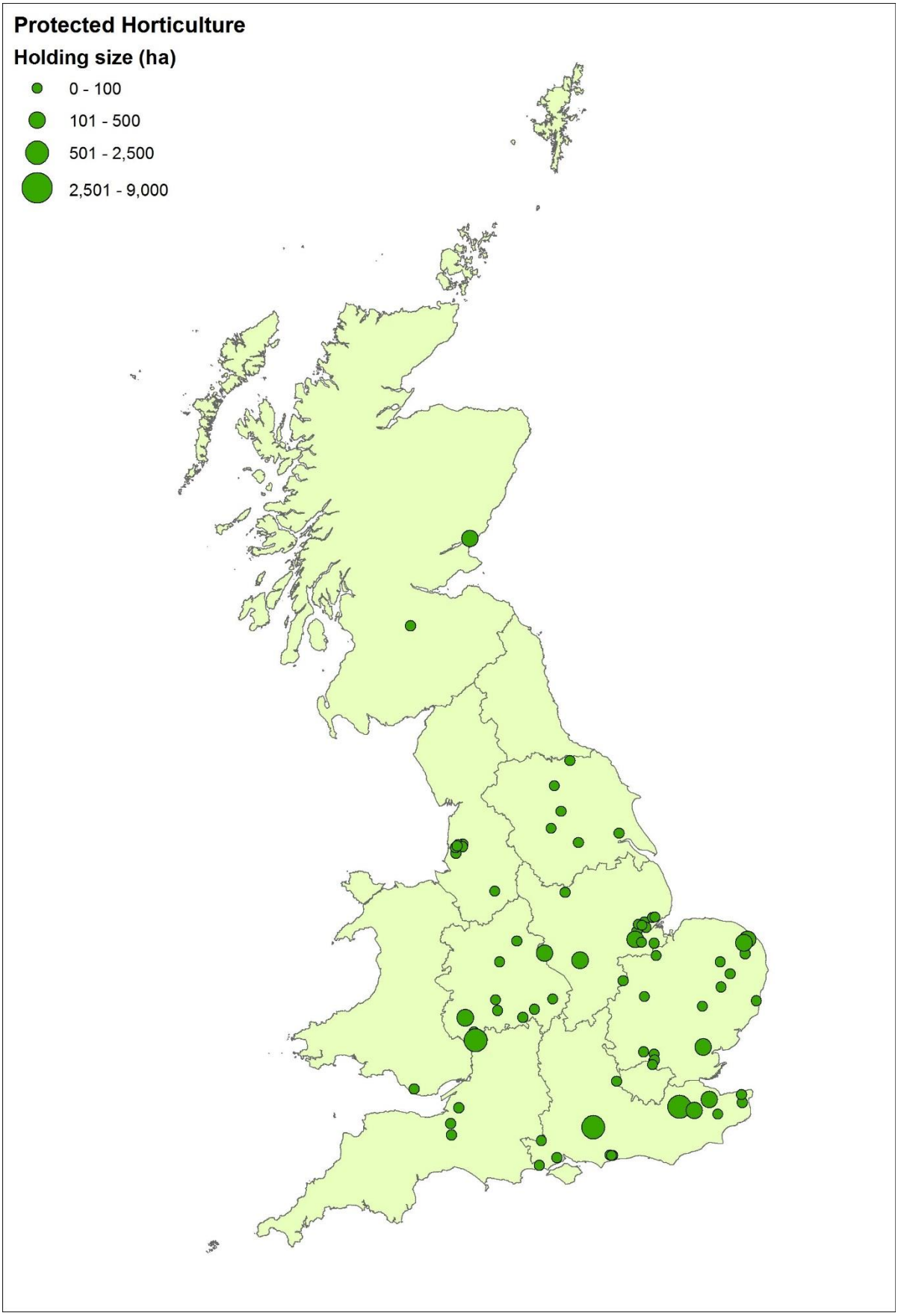


Figure 5. Locations and size ranges of holdings, for growers of outdoor containerised plants.

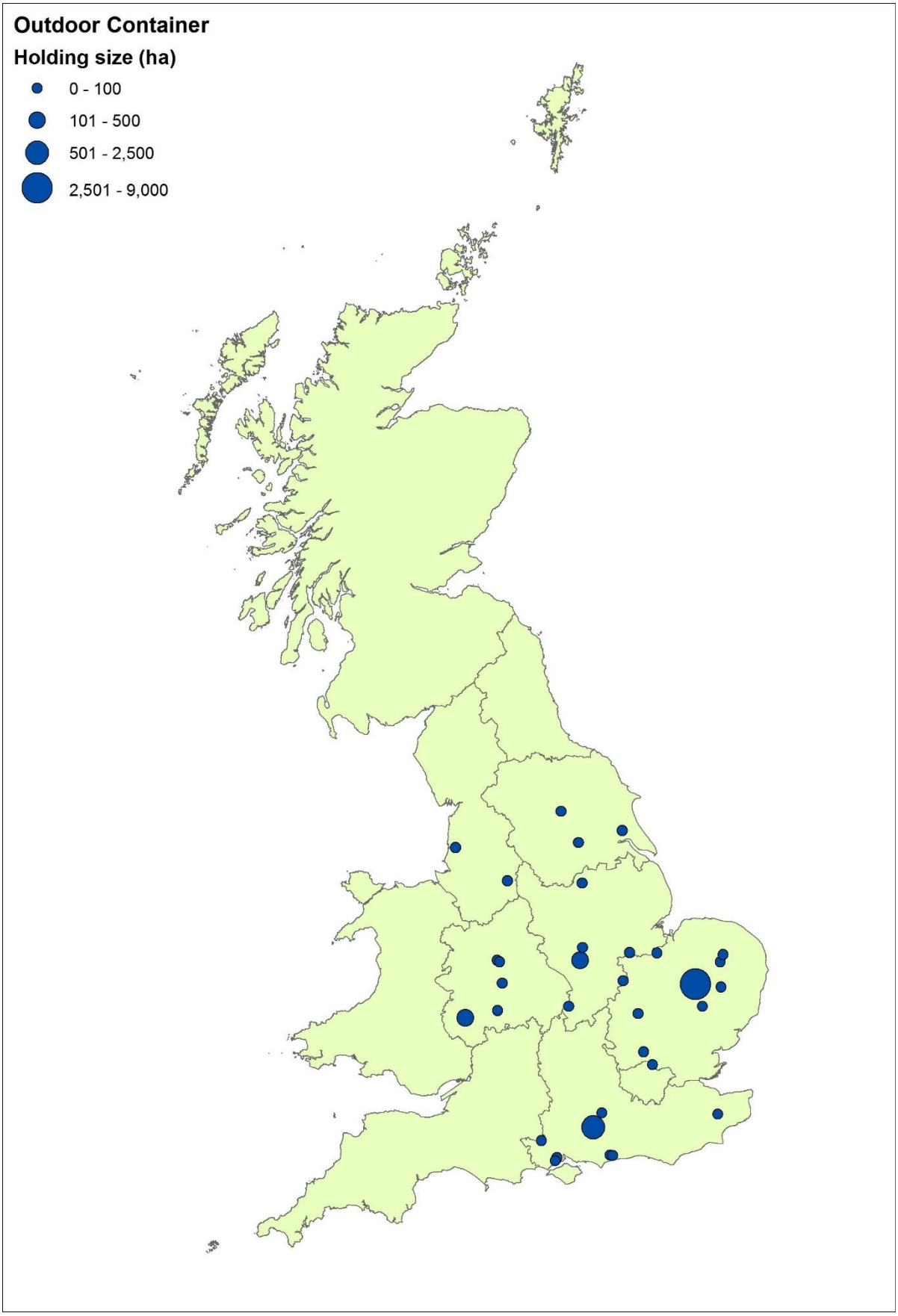
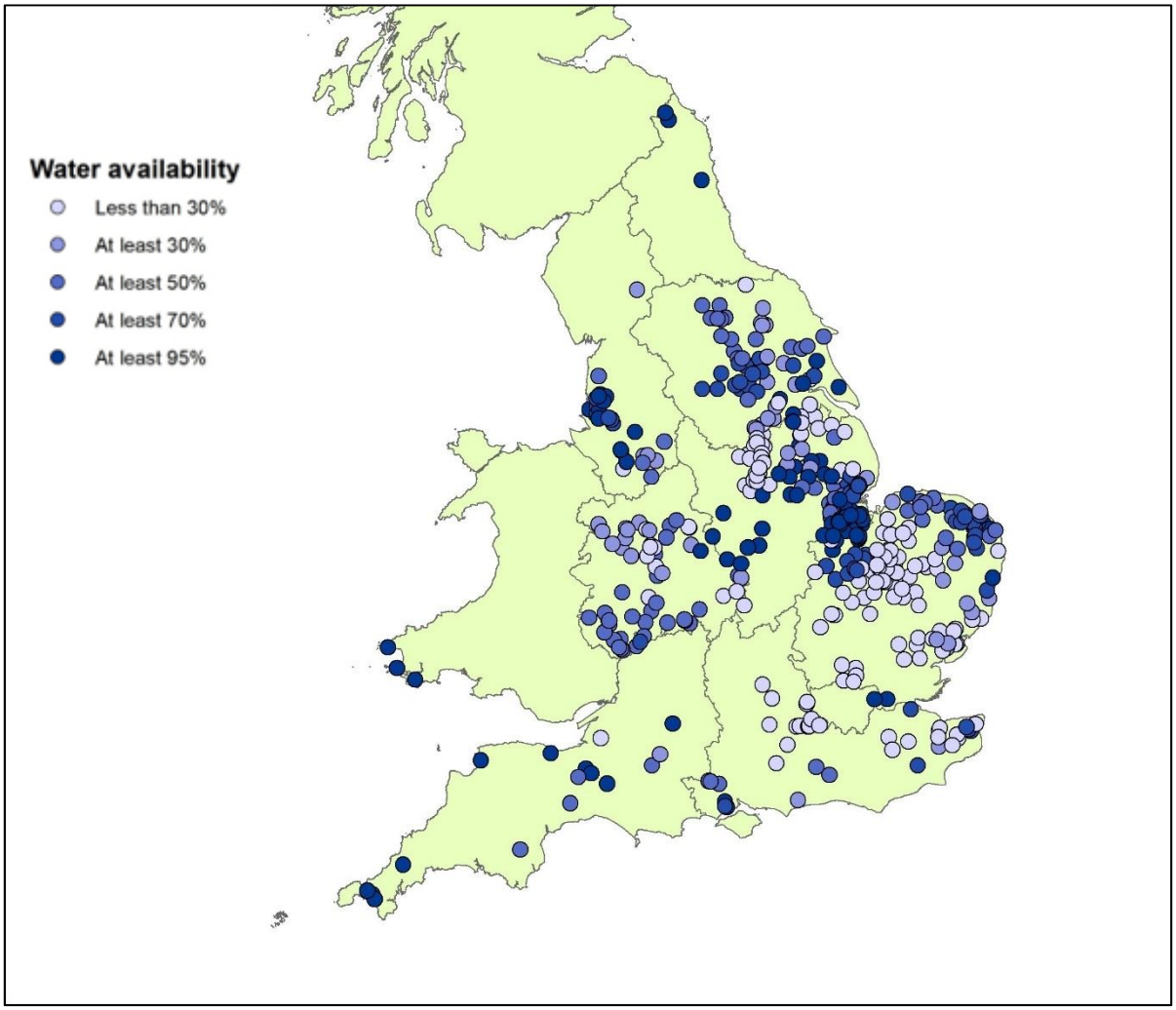


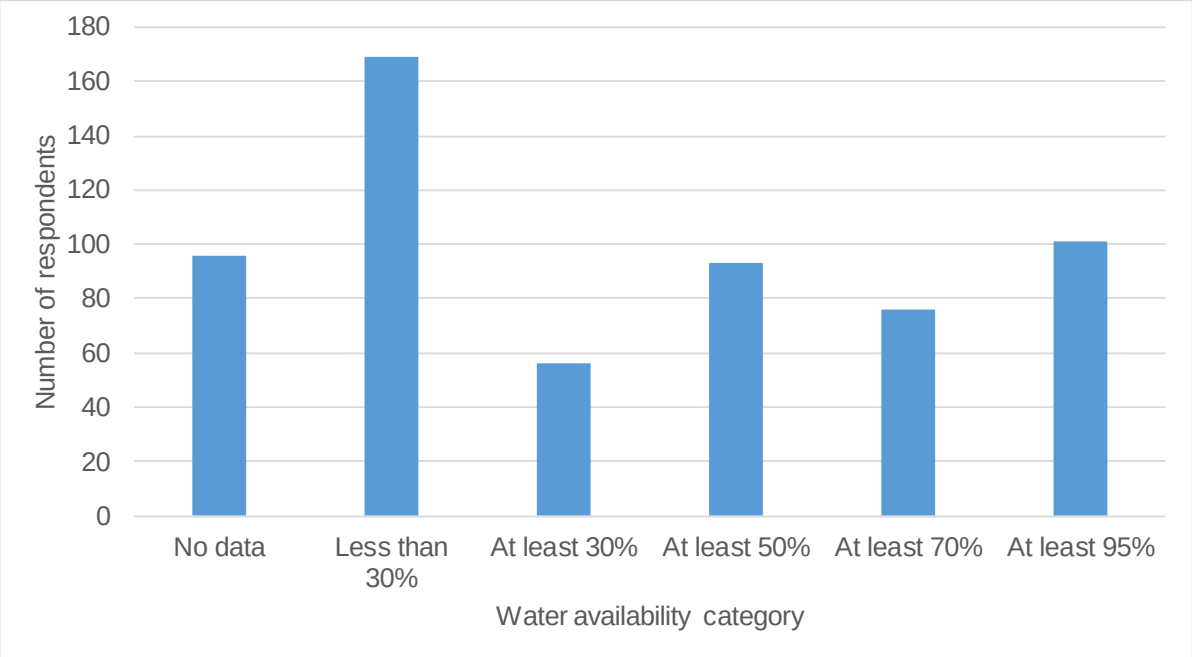
Figure 6. Locations of responding growers with indication of water availability category (see text for explanation of categories); this map excludes respondents from locations (including all of Scotland) where we had no data on water availability.



Split across water availability data

The number of responses received in each of the water availability categories is shown in Figure 7 and had a range of 56 to 167 respondents, disregarding the no data category. Some growers were in areas for which we did not have water availability category data, including all growers in Scotland. An explanation of the water availability categories is given in the Materials and methods section above.

Figure 7. The split of respondents (count) across water availability categories (see Materials and methods section for an explanation of the water availability categories).



For those growers that were allocated a water availability category, the differences in the number of respondents between categories (Figure 7), followed a similar pattern to the differences between categories in the number of growers in the AHDB database. Therefore, the percentages of growers in the AHDB database that responded to the survey did not differ greatly between categories (range 14.6% to 19.0%).

Statistical validity

An important aspect of this survey was to ensure that the sample of respondents provided a robust and accurate representation of the population as a whole. This meant that consideration was needed in order to determine the required number of survey respondents from each agriculture group and water availability category. As discussed previously, the

target sample size was calculated using a statistical equation based on the specified confidence level and margin of error.

The target numbers for potatoes were calculated using a confidence interval of 90% and a margin of error of 15%. The other three categories were calculated using a confidence interval of 95% and a margin of error of 10%.

Table 7 shows the target survey numbers for each combination of crop category and water category.

Table 7. Target survey numbers vs. actual survey numbers.

	less than 30%	at least 30%	at least 50%	at least 70%	at least 95%	Totals
Potatoes	28	27	28	27	28	138
Field Hort	67	38	53	49	53	260
Protected Hort	53	29	35	26	45	188
OCP	47	27	34	17	36	161
						747

Achieving the target number of respondents in each category was challenging. The target number of respondents was far exceeded in some categories; in other categories where the population size was smaller, the target number was not reached. Wherever possible, the project team telephoned respondents in the categories where target numbers were not reached in order to gain additional respondents in those categories.

Overall, the total number of respondents who provided a comprehensive response to this survey was an impressive 594, which, once taking into account the fact that many responses covered multiple crops, equated to 1043 observations across all the different crop and water categories (i.e. there is double counting between categories).

The challenge with this study was that because the overall sample needed to be broken down into so many sub-categories, a large total sample size was required so that each sub-category would have sufficient numbers for analysis. Given the good response to the survey overall, we can be confident that the level of accuracy in the results is high. Calculating the exact level of accuracy overall is not possible given the uncertainty in the population size and the

variety of questions asked; however, in categories where the target response rate was achieved, we can estimate that the confidence level is about 95% (90% for potatoes) with a margin of error of 10% (15% for potatoes).

Even in categories where the target sample size was not reached, the level of confidence for some questions could actually still be high. The necessary sample size depends on both the degree of accuracy required, and the extent to which there is variation in the population in regard to the key characteristics of the study. So for questions where it is likely that the responses have a low degree of variability, the level of confidence would be higher than anticipated given the smaller sample size.

Introduction to results by question

Question 1 was mandatory and used to gather contact details. Responses are confidential and not reported here.

The sections below provide an overview of responses to questions 2 to 21. In each case the question is given in italics, followed by a summary of the data gained from responses.

Questions 22 and 23 relate to the award of BASIS points as an incentive to participants. Responses are not summarised here.

Question 2: holding details

This question asked for further contact details additional to those asked in Question 1 (not reported). The sub-questions included a request for holding size in hectares.

The sum of holding size for all respondents totalled 164,434 ha. The area for each of the four main sectors of production is given in Table 8. There is double counting between main sectors because many growers grow in more than one sector.

Table 8. Total area of respondents' holdings (ha), by main production sector. Note: if a respondent grows crops in more than one main sector, their holding area will be included in the totals for more than one main sector.

Production sector	Total area of respondents' holdings (ha)
Potatoes	148,275
Field horticulture	100,567
Protected horticulture	5,982
Outdoor containerised plants	11,017

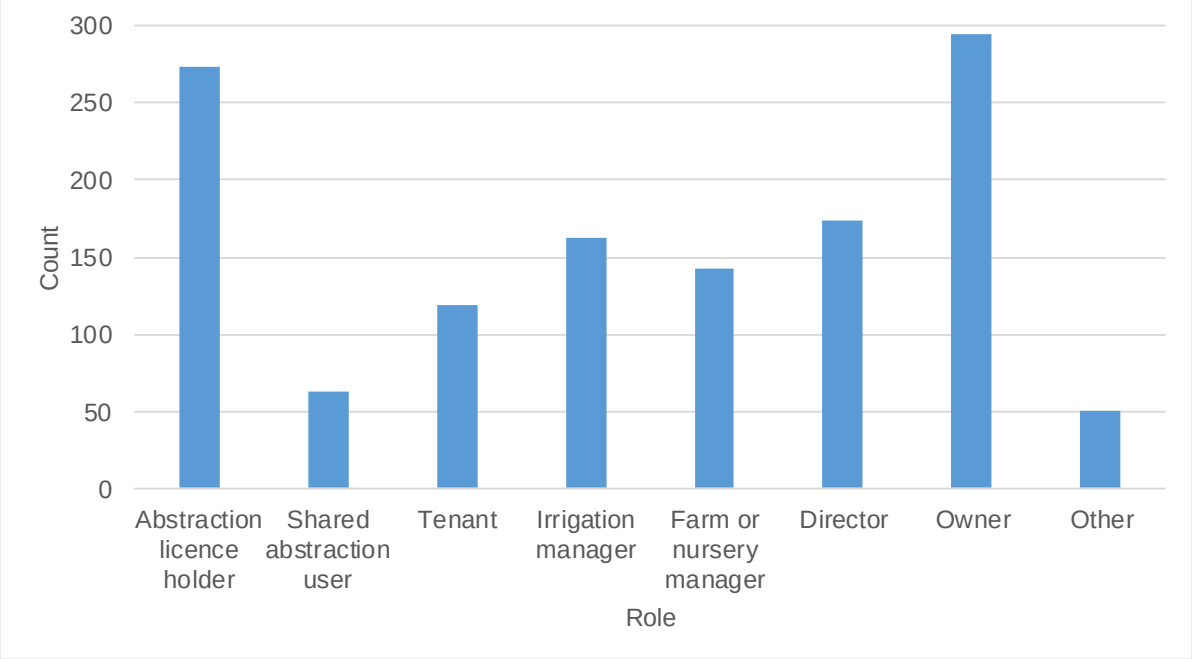
Question 3: role of respondent

Please state your role within the organisation. Please tick all that apply.

There were 590 responses to this question.

Figure 8 shows the roles of respondents, indicated by their selection of answers to this question. Respondents could select more than one option. The data show that large proportions of respondents were owners, directors, or managers. Approximately 20% were tenants. Approximately 46% identified themselves as abstraction licence holders. The “other” option was used to give a wide array of alternative job titles.

Figure 8. Roles of respondents.



Question 4: water sources for irrigation

Please state what water sources you use for irrigation. Please tick all that apply.

The options provided were:

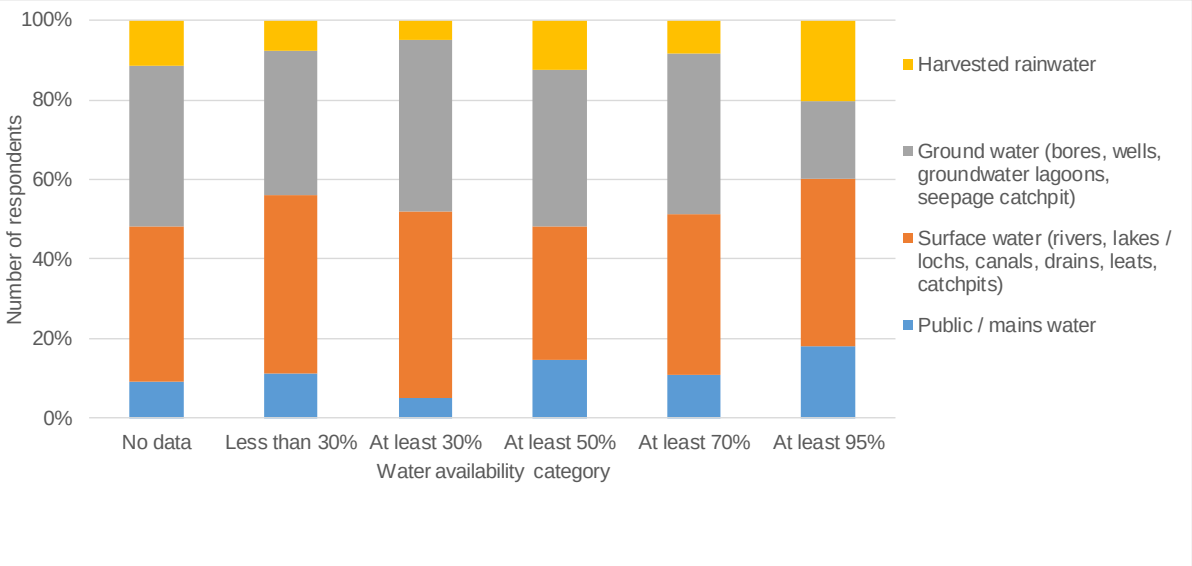
- Public / mains water
- Surface water (rivers, lakes / lochs, canals, drains, leats, catchpits)
- Ground water (bores, wells, groundwater lagoons, seepage catchpit)
- Harvested rainwater

- Other

There were 576 responses to this question.

Water sources used for irrigation are dominated by ground water and surface water, with no strong trends between water availability categories (Figure 9).

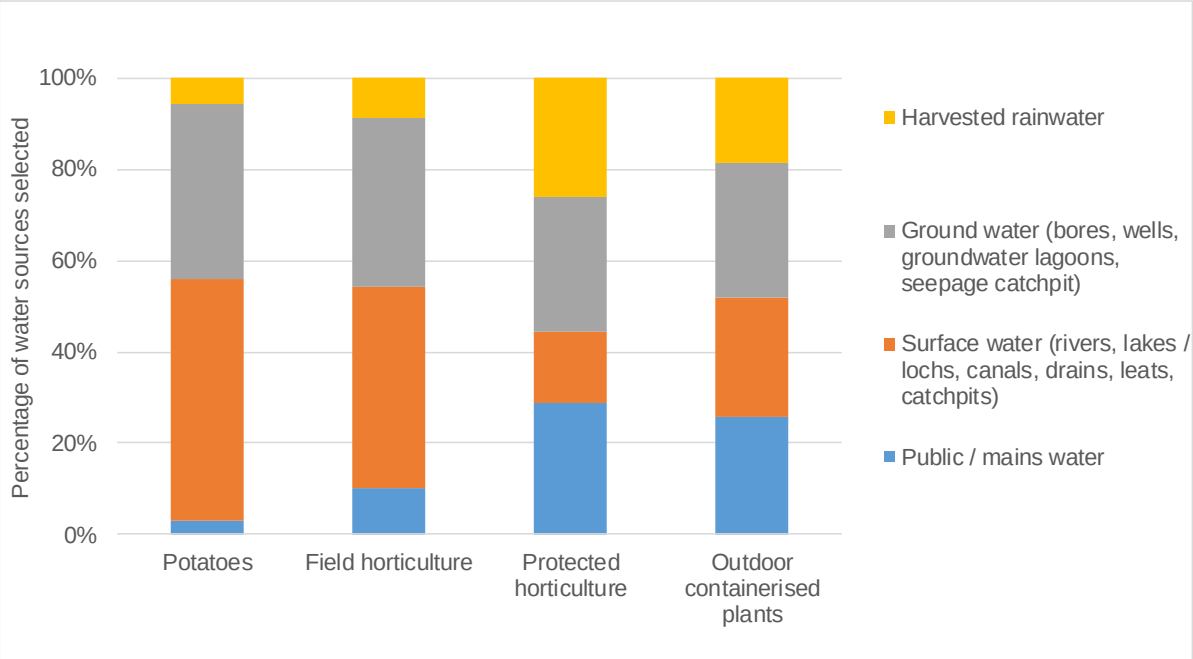
Figure 9. The number of water source options selected (excluding “other”, and shown as different colours), expressed as the percentage of the total number of selections within each water availability category.



The breakdown by production sector shows that mains water was considered the least important source of water for irrigation by respondents in the potato sector. For protected horticulture and outdoor containerised plants, mains water and harvested rain water were more important than in other sectors (Figure 10). Surface water was the source most frequently used for potato and field vegetable crops, and least used in protected horticulture. However, although surface water was the source most frequently used for potato and field vegetable crops, this does not provide information about the volume of water used from alternative sources. The responses to Question 11 (see relevant section below) show that licenced water abstraction volume was greater from ground water.

In some sectors of protected horticulture, water quality is highly important and surface water tends to have higher levels of microbial contamination than water from other sources.

Figure 10. The number of water source options selected (excluding “other”, and shown as different colours), expressed as the percentage of the total number of selections within each main production sector.



In Table 9 more detail is provided according to the production sector and water availability category. This detail is presented as the number of responses and as percentages within each sector and category.

Table 9. Water sources for irrigation, by production sector and water availability category.

	Number of respondents					Percentage of respondents				
	Mains water	**Surface water**	**Ground water**	**Harvested rainwater**	**Other**	**Mains water**	**Surface water**	**Ground water**	**Harvested rainwater**	**Other**
All responses	99	342	295	91	64	11	38	33	10	7
Production sectors										
Potatoes	14	258	187	28	42	3	49	35	5	8
Field horticulture	43	187	157	37	43	9	40	34	8	9
Protected horticulture	53	29	55	48	53	22	12	23	20	22
Outdoor containerised plants	21	21	24	15	21	21	21	24	15	21
Water availability categories										
No data	12	51	53	15	8	12	15	18	16	13
Less than 30%	28	114	92	19	16	28	33	31	21	25
At least 30%	4	37	34	4	6	4	11	12	4	9
At least 50%	20	46	54	17	5	20	13	18	19	8
At least 70%	9	34	34	7	16	9	10	12	8	25
At least 95%	26	60	28	29	13	26	18	9	32	20

The “other” category was used to provide more detail, and also included 30 instances of “do not irrigate. Many other comments were not directly relevant, dealing for example, with water recycling rather than the source.

Question 5: area of irrigable land

Please estimate the area of your irrigable land in hectares (ha) (1 ha = 2.47 acres).

Respondents were asked for:

- Total area of irrigable land:
- How much of the area specified above is leased/rented from others, or is managed by you under an agricultural / horticultural land licence?

There were 579 responses to this question.

The results are shown in Table 10: there is double counting between production sectors because many growers grow in more than one sector.

The total area of irrigable land was 149,235 ha, which is more than the Eurostat (Statistical Office of the European Communities) published estimate for 2013, of 115,400 ha.[6] This suggests error in the Eurostat estimate since we have found other data with greater estimates (268,894 ha estimated by the Food and Agriculture Organization of the United Nations (FAO)[7], but the year is not clearly stated, and is probably several years earlier than 2013). The irrigable area is different to the area actually irrigated (see question 6). We can conclude that the AHDB survey reported here represents a large part of the GB irrigable area, but we cannot accurately quantify the proportion of the total that is represented because of a lack of clear data on the total UK or GB irrigable area.

The area of irrigable land that is rented under a land licence was 31% of the total irrigable area reported by survey respondents (Table 10). It is not known how much of this area of irrigable land that is rented is with or without a water licence. Protected horticulture had the greatest percentage rented (44%) and outdoor containerised plants had the smallest percentage rented (7%). These two sectors use a smaller area of land relative to the potato and field horticulture sectors.

[6] http://ec.europa.eu/eurostat/statistics-explained/index.php/Agri-environmental_indicator_-_irrigation
[77] http://www.fao.org/nr/water/aquastat/irrigationmap/gbr/index.stm

Table 10. Area of irrigable land.

Sector or category	Area of irrigable land (ha)	Irrigable area leased/rented/ managed under a land licence (ha)	Percentage leased/rented/ managed under a land licence
All responses	149,235	46,897	31
Production sectors			
Potatoes	130,364	41,900	32
Field horticulture	91,752	28,282	31
Protected horticulture	4,100	1,818	44
Outdoor containerised plants	4,317	305	7
Water availability categories			
No data	19,053	8,268	43
Less than 30%	54,827	15,362	28
At least 30%	19,406	7,835	40
At least 50%	19,480	4,818	25
At least 70%	17,747	5,272	30
At least 95%	18,722	5,342	29

Questions 6 and 7: areas of crops grown (Question 6) and irrigated (Question 7)

Q6: For each of the following crops, please estimate the average area in hectares (ha) grown per year, over the last 5 years, irrigated or not (1 ha = 2.47 acres).

Q7: Please estimate the area in hectares (ha) of each crop that is irrigated annually (averaged over the last 5 years) (1 ha = 2.47 acres).

The selection of crops provided is the following list, which includes “other” as the last option. Respondents were able to enter area data for more than one crop.

- Packing potatoes
- Processing potatoes
- Seed potatoes
- Shallow rooted veg e.g. salads, leeks, onions
- Deep rooted field veg e.g. brassicas, carrots
- Field salad crops e.g. lettuce, herbs
- Field hardy nursery stock
- Field soft fruit
- Glasshouse / covered salad crops

- Glasshouse / tunnel soft fruit
- Tree fruit
- Stone fruit
- Bulbs and outdoor flowers
- Protected ornamentals
- Containerised outdoor nursery stock
- Containerised outdoor soft fruit
- Mushrooms
- Other

There were 571 responses to Question 6 and 485 responses to Question 7. The lower number of responses to Question 7 is probably because some respondents do not irrigate and chose to skip the question rather than enter zero values.

The responses are summarised in Table 11. These data give some context to the responses to other questions.

The areas of crops grown by respondents and irrigated are dominated by potatoes and field horticulture. This reflects the larger scale of land use in these sectors, but does not reflect the number or proportion of growers that responded by sector: for example, Table 7 shows that 26% of protected horticulture growers responded, compared with 18% of potato growers.

For some crops and sectors, it is expected that all crops are irrigated, because protected and containerised production is not possible without irrigation. However, in most of these cases the data show smaller areas (and number of positive entries) irrigated than grown. This indicates incomplete or inaccurate responses, perhaps in some cases a misunderstanding of the question.

No respondents grew mushrooms and this category, and “other” are not included in the table. Sixty-three respondents entered a positive value for other crops grown, and 52 entered a positive value for other crops irrigated. The sum of area grown was 5,398 ha and the sum of area irrigated was 2,416 ha. These numbers and areas are included in the first row of data (“All”) in Table 11.

Table 11. Crop sectors and crops grown and irrigated, by area grown and irrigated, and by number of responses.

Sector or category	Area grown (ha)	UK area* (ha; four main sectors only)	Area irrigated (ha)	% irrigated	Number growing	Number irrigating
All	64,075	249,100	40,312	63	571	485
Production sectors						
Potatoes	30,576	129,000	18,027	59	471	361
Field horticulture	24,078	117,680	16,655	70	432	350
Protected horticulture	1,280	2,420	834	65	104	97
Outdoor containerised plants	258	No data	230	89	48	45
Crops						
Packing potatoes	17,218	No data	9,259	54	208	171
Processing potatoes	11,608	No data	8,522	73	213	171
Seed potatoes	1,750	No data	246	14	50	19
Shallow rooted veg	6,822	No data	5,844	86	113	98
Deep rooted field veg	12,134	No data	7,629	63	153	132
Field salad crops	2,052	No data	1,846	84	44	42
Field hardy nursery stock	401	No data	139	35	19	12
Field soft fruit	690	No data	532	77	30	28
Glasshouse/ covered salads	407	No data	165	41	28	27
Glasshouse/ tunnel soft fruit	646	No data	446	69	24	19
Tree fruit	1,028	No data	592	58	33	24
Stone fruit	123	No data	73	59	17	14
Bulbs, outdoor flowers	828	No data	165	20	23	10
Protected ornamentals	227	No data	223	98	52	51
Containerised outdoor nursery stock	213	No data	185	87	43	40
Containerised outdoor soft fruit	45	No data	45	100	5	5

Notes: *UK area data sourced from Eurostat [ef_poirrig, 2010; 2013]

Question 8: annual volume of water applied

Application of water: please estimate your highest volume of irrigation water applied per annum from 2011 - 2015 by source, in cubic metres (1 cubic metre = 220 gallons).

There were 503 responses to this question.

The total volumes of water applied for each water source are given in Figure 11, and the grand total for all respondents was 52.7 million m^3, excluding watercress production. Water used for watercress production is considered non-consumptive because the water flows through the production system and most of the water is returned to the environment.

Of the total of 52.7 million m^3, most (30.4 million m^3, or 58%) was from ground water. However, by comparison, data from the Defra Farm Business Survey[8] show that, in 2010 for England, ground water accounted for 41% of the total volume of irrigation water and surface water accounted for 52%. This has remained almost unchanged compared to 2005 and 2001. The results from this AHDB survey are indicative and are likely to reflect the balance of type respondents from different production sectors and regions.

Disaggregation by production sector is shown in Figure 12, and the tabulated values are given in Table 12. The data by production sector must be used with caution because the production sectors are allocated to respondents by crops grown and irrigated, but the annual water of volume applied was not requested by crop or sector. Therefore, for example a grower may grow and irrigate both potatoes and field vegetables, but apply most of the water to crops in one of these sectors. The data presented here show the water applied in both production categories, double counting the quantity applied. However, the total data for all respondents does not include any double counting.

Most responses in “other” were intended by the respondents to give more detail of the source, but most did not actually give a source, but rather gave information about storage in a reservoir. These values were not therefore allocated to a source.

[8] Defra: Water Usage in Agriculture and Horticulture. Results from the Farm Business Survey 2009/10 and the Irrigation Survey 2010. Published 9 June 2011.

Figure 11. The highest volume of irrigation water applied per annum from 2011 - 2015 by source, in cubic metres (excluding unexplained outliers and watercress production). Where respondents grew crops in more than one production sector, their applied water quantity is counted in each of those production sectors.

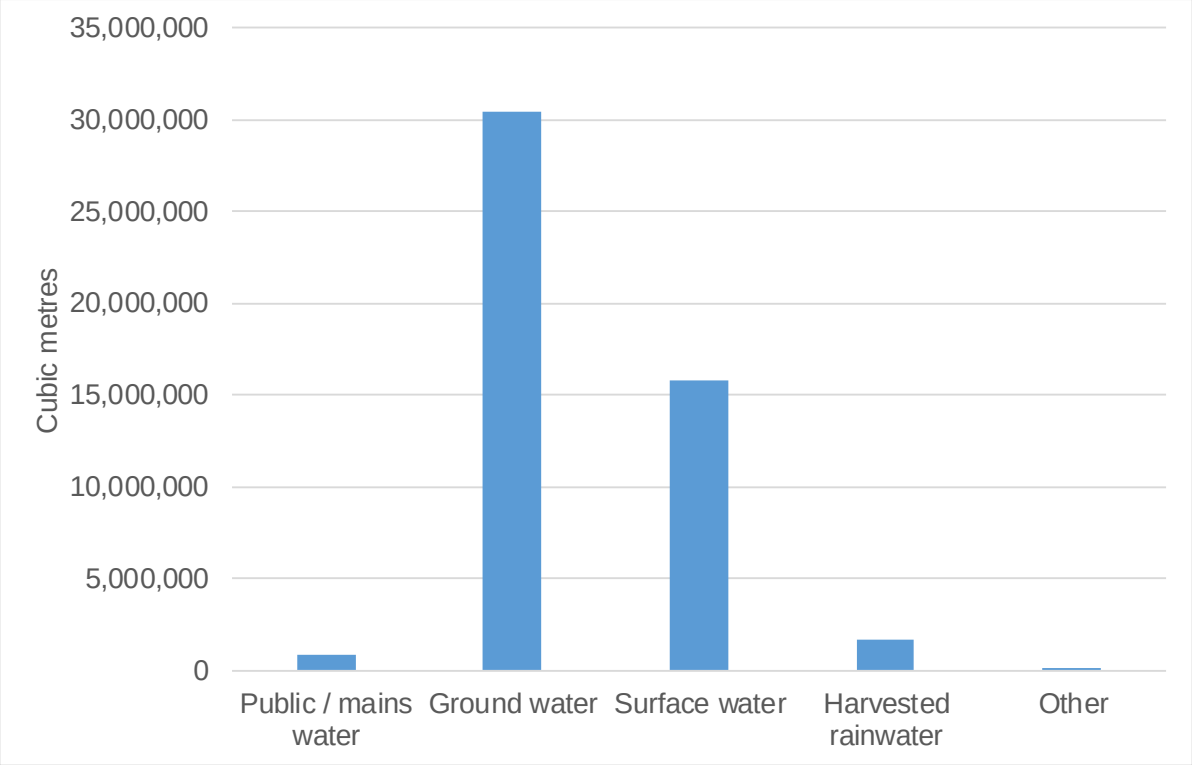


Figure 12. The highest volume of irrigation water applied per annum from 2011 - 2015 (excluding unexplained outliers and watercress production): percentage from each source within each main production sector.

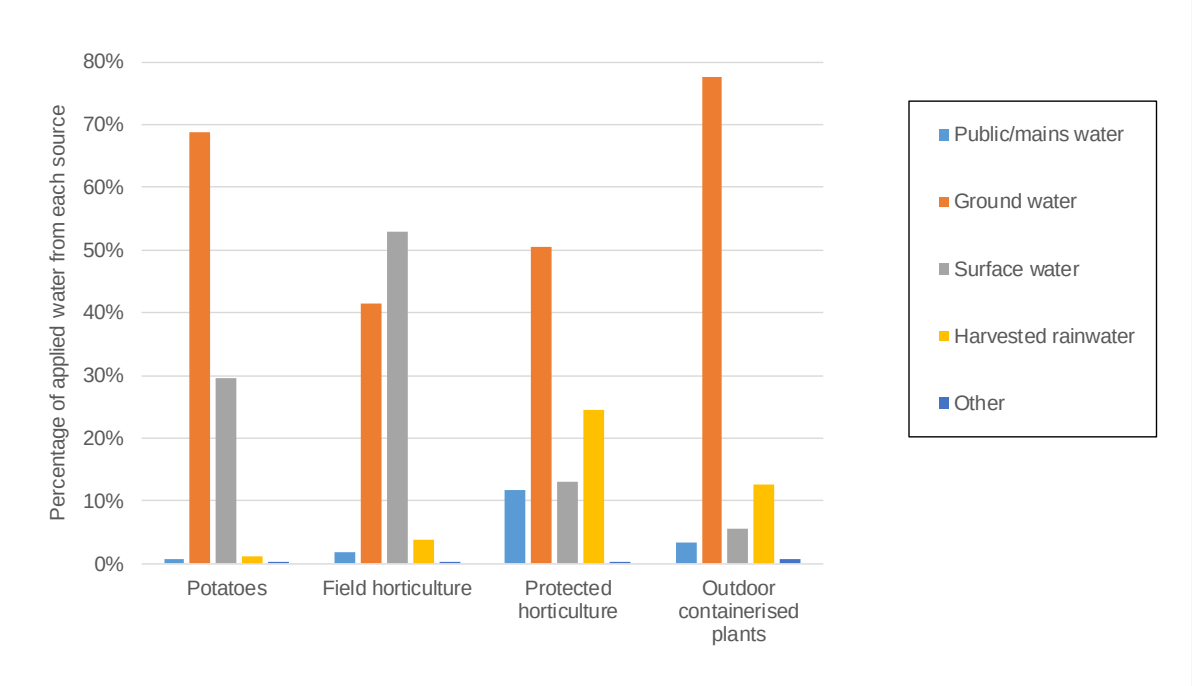


Table 12. The highest volume of irrigation water applied per annum from 2011 - 2015 by source and production sector, in cubic metres (excluding unexplained outliers and watercress production). Where respondents grow crops in more than one production sector, their water quantity applied is counted in each of those production sectors.

Sector or category	Public/ mains water	Ground water	Surface water	Harvested rainwater	Other
All responses	805,264	30,435,581	19,782,494	1,683,626	40,842
Production sectors					
Potatoes	247,353	26,997,642	11,590,705	448,290	10,000
Field horticulture	403,599	9,341,742	11,905,433	843,369	27,831
Protected horticulture	487,806	2,093,516	544,270	1,012,467	3,051
Outdoor containerised plants	135,811	3,086,588	224,069	496,950	27,698

Question 9: ownership of abstraction licences

Do you manage land with abstraction licences held by others?

There were 537 responses to this question, of which 31% were yes and 69% were no. The answers are given for each of the main sectors in Figure 13, and by each crop grown in Figure 14. There is double counting between production sectors and crops where respondents indicated that they grew in multiple sectors and/or grew multiple crop types.

The number of respondents managing land with abstraction licences held by others is greatest in field production (potatoes and field horticulture) and is relatively low in protected and containerised production.

Figure 13. Number of respondents managing land with abstraction licences held by others.

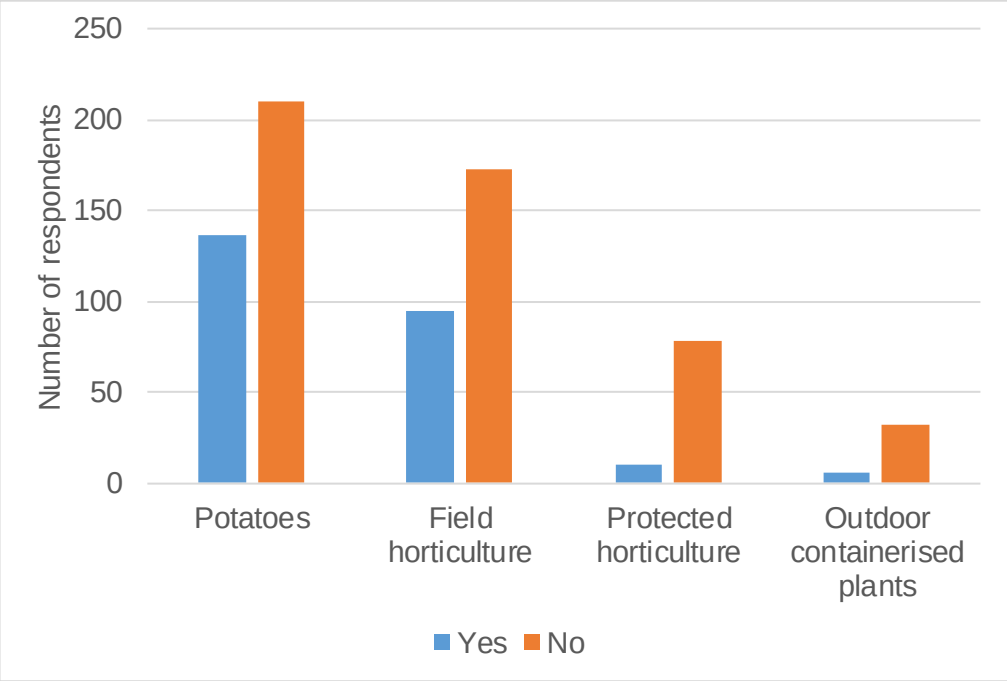
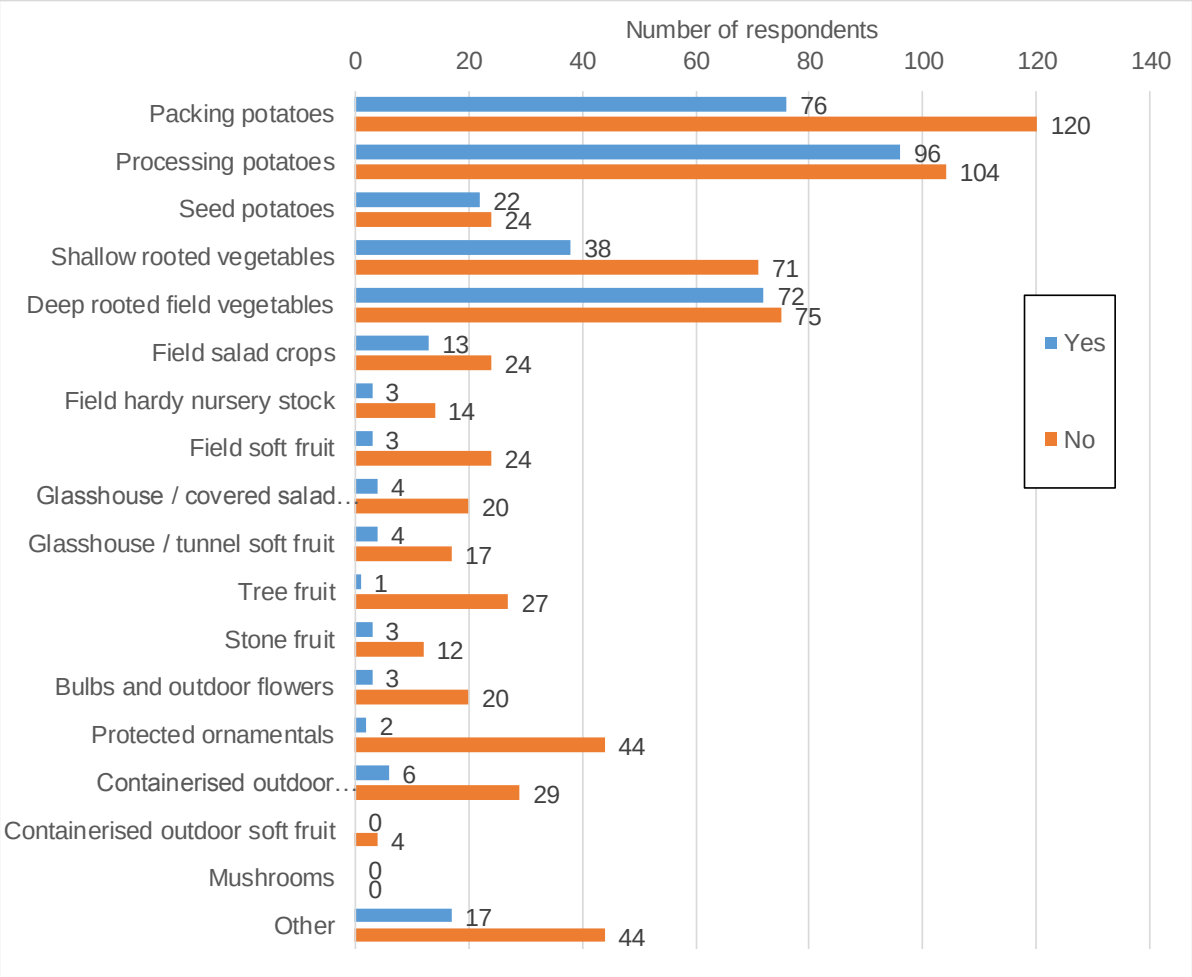


Figure 14. Number of respondents managing land with abstraction licences held by others.

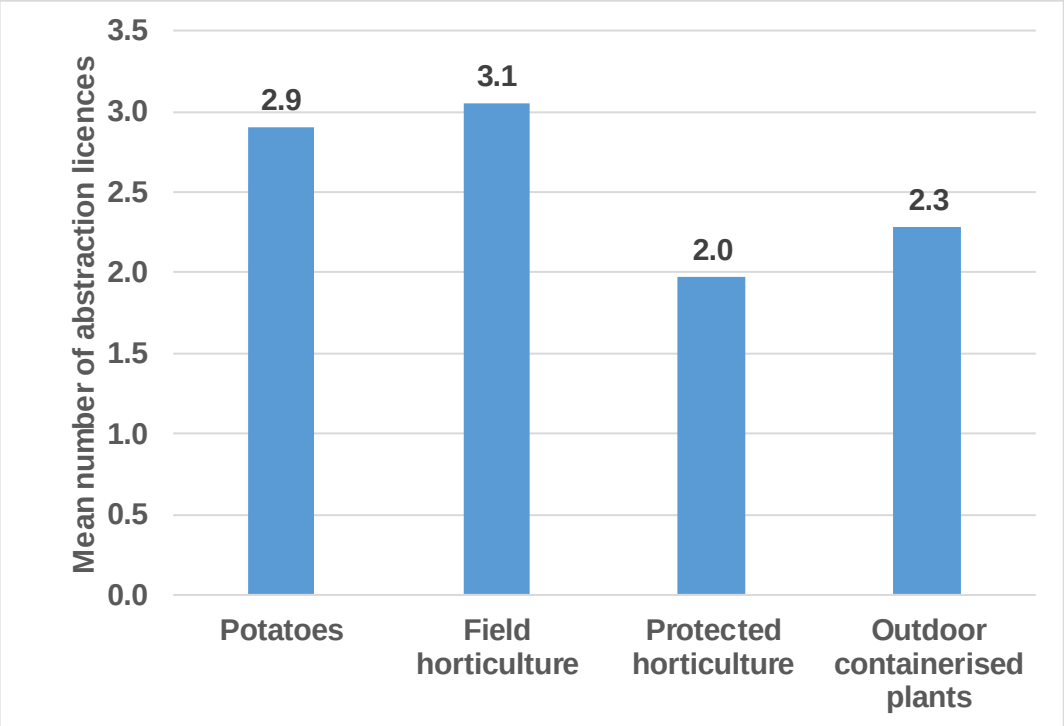


Question 10: number of abstraction licences held

Abstraction licenses held by you: how many licences do you have for this holding?

There were 487 responses to this question. In total, 946 licences were reported by respondents. To give an indication of the coverage of this survey, this total is 7.3% of the total number of licences for England and Wales, for spray irrigation plus agriculture excluding spray irrigation; total 12,980.[9] The mean number of licences per respondent as a total of all survey responses was 2.6; the respective mean number by production sector is shown in Figure 15.

Figure 15. Mean number of abstraction licences for each production sector.



[9] https://www.gov.uk/government/statistical-data-sets/env15-water-abstraction-tables

Question 11: licenced water abstraction volume

Please provide your current licenced abstraction volume per water source (in cubic metres). The farm site may have multiple licenses but please provide the total volume by source e.g. if you have three licences for ground water abstraction, add the volumes together to provide a single volume for ground water abstraction (1 cubic metre = 220 gallons).

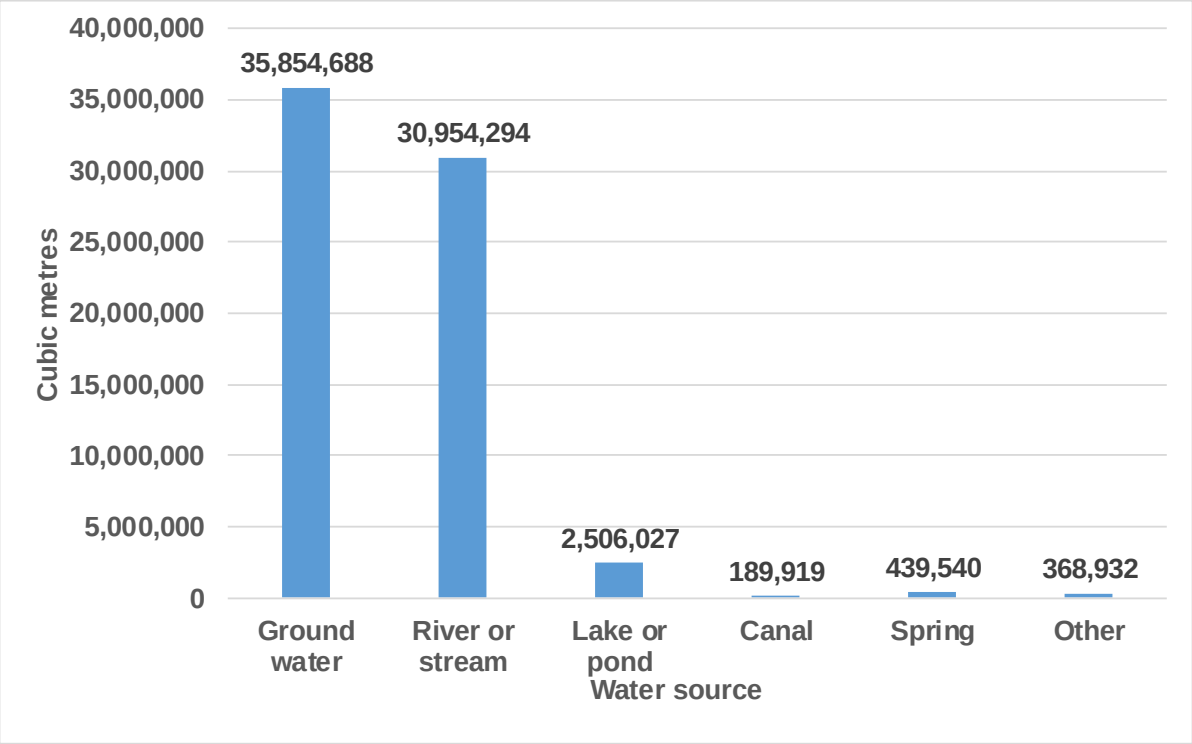
There were 371 responses to this question.

The licenced water abstraction volume total for all respondents was 127.0 million m^3, and was 70.3 million m^3 excluding watercress production. Water used for watercress production is considered non-consumptive because the water flows through the production system and most of the water is not evaporated and is returned to the environment.

The highest annual volume of water applied within 2011 to 2015, excluding mains and watercress, was 51.9 million m^3 (data from Question 8). This greatest reported annual usage is 73.9% of the licensed volume, so 'headroom' is 26.1% of licensed volume to cover a greater need of water than was experienced in the years 2011 to 2015. Growers use the term headroom to mean water that is not used in most years, but that is available for use in years when the need is greatest.

Licensed abstraction volume is greatest for ground water (Figure 16), and is about half of the total when watercress production is excluded.

Figure 16. Licenced abstraction volume by water sources (cubic metres).



In Figure 17 the data are visualised as percentages of the total licenced abstraction volume for each crop, with watercress entered as a separate bar. This shows that, aside from watercress, ground water is particularly important for field salad crops and containerised outdoor nursery stock. In the case of field salad crops this is because water quality is an important issue and the water must be clean to satisfy hygiene requirements. In the case of containerised outdoor nursery stock, this is likely to be related to availability of water at the location of the production sites.

Values are tabulated in Table 13, by water source, sector and crop. Answers in the “other category were numerical, with no added descriptions.

Figure 17. Percentages from each source, of licenced abstraction volume for each crop.

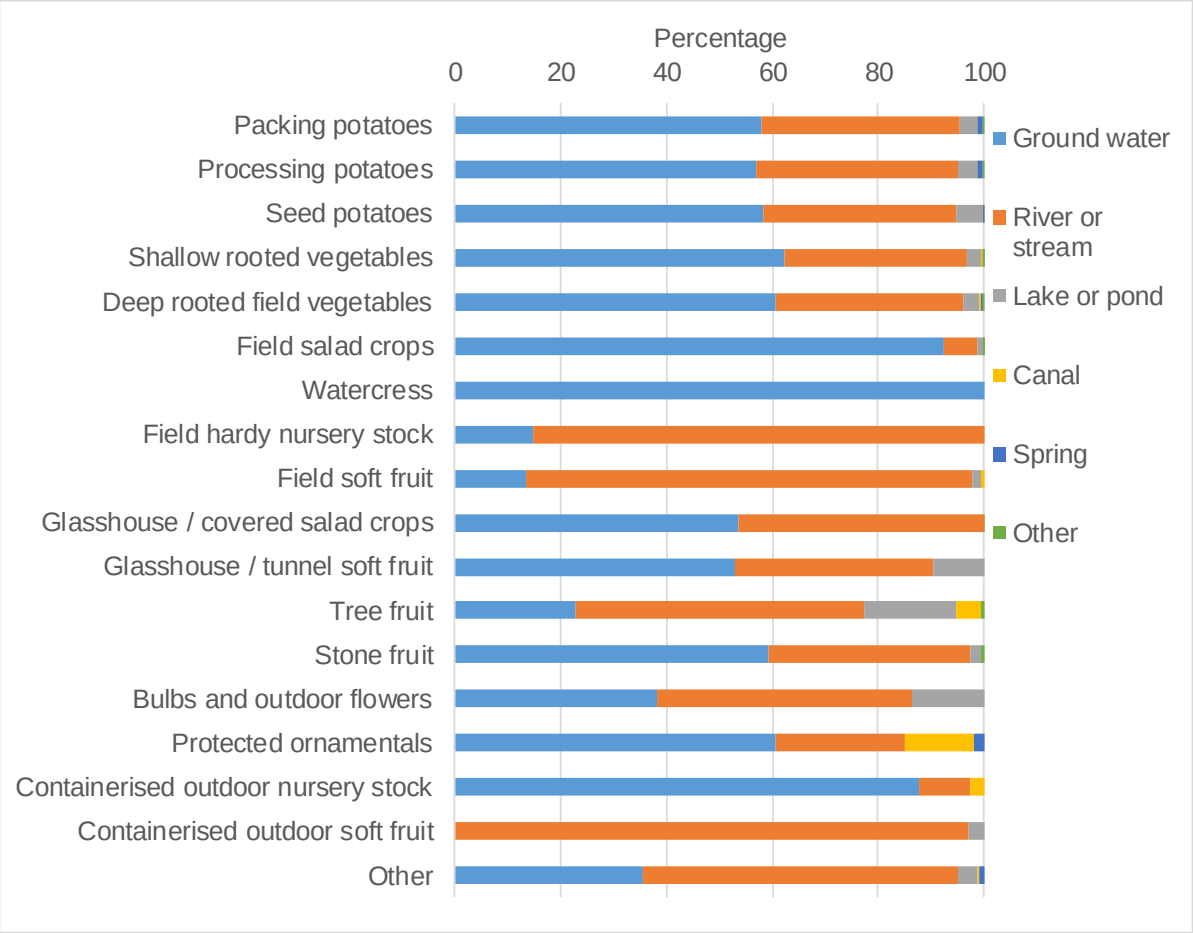


Table 13. Licenced abstraction volume by water sources, production sectors and crops (Million cubic metres).

Sector or category	Ground water	River or stream	Lake or pond	Canal	Spring	Other
All	92.58*	30.95	2.51	0.19	0.44	0.37
Production sectors						
Potatoes	33.03	24.65	2.13	0.04	0.43	0.30
Field horticulture	26.28**	22.28	1.97	0.10	0.20	0.16
Protected horticulture	1.22	0.75	0.12	0.09	0.01	0.00
Outdoor containerised plants	3.09	0.38	0.00	0.09	0.00	0.00
Crops						
Packing potatoes	23.73	15.34	1.39	0.04	0.29	0.16
Processing potatoes	22.95	15.34	1.45	0.04	0.34	0.14
Seed potatoes	8.49	5.31	0.74	0.02	0.01	0.00
Shallow rooted veg	21.77	12.06	0.99	0.05	0.01	0.08
Deep rooted field veg	26.09	15.31	1.41	0.07	0.20	0.08
Field salad crops	56.19	3.77	0.62	0.02	0.05	0.07
Watercress	56.73	0.00	0.00	0.00	0.00	0.00
Field hardy nursery stock	0.04	0.21	0.00	0.00	0.00	0.00
Field soft fruit	0.73	4.52	0.10	0.03	0.00	0.00
Glasshouse/ covered salads	0.12	0.10	0.00	0.00	0.00	0.00
Glasshouse/ tunnel soft fruit	0.67	0.48	0.12	0.00	0.00	0.00
Tree fruit	0.12	0.29	0.09	0.03	0.00	0.00
Stone fruit	0.23	0.15	0.01	0.00	0.00	0.00
Bulbs, outdoor flowers	0.39	0.49	0.14	0.00	0.00	0.00
Protected ornamentals	0.43	0.17	0.00	0.09	0.01	0.00
Containerised outdoor nursery stock	3.11	0.34	0.00	0.09	0.00	0.00
Containerised outdoor soft fruit	0.00	0.05	0.00	0.00	0.00	0.00
Other	4.00	6.75	0.42	0.02	0.12	0.00

*Includes watercress; **Excludes watercress.

Question 12: water application method

Please estimate the percentage (%) of your irrigated water that each of the following systems supply. Please complete all those that are applicable.

There were 509 responses to this question.

Data are presented as number of non-zero responses (Figure 18) and the mean percentage (mean of non-zero responses; Figure 19). The data show that rain guns/booms are the dominant application method (Figure 18), especially for potato production and field horticulture. Protected horticulture and outdoor containerised plants use mainly sprinklers and trickle/drip. Answers in the "other category were mainly numerical, with no added descriptions.

Figure 18. Number of non-zero responses.

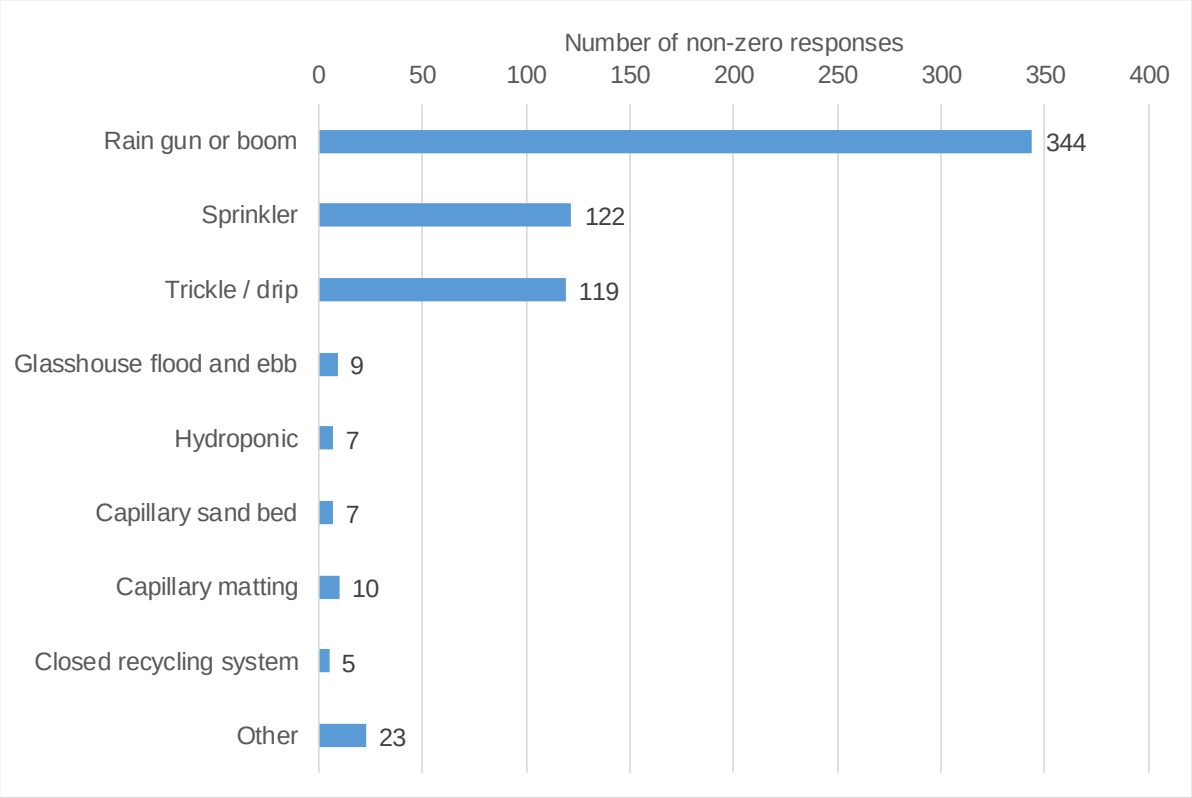
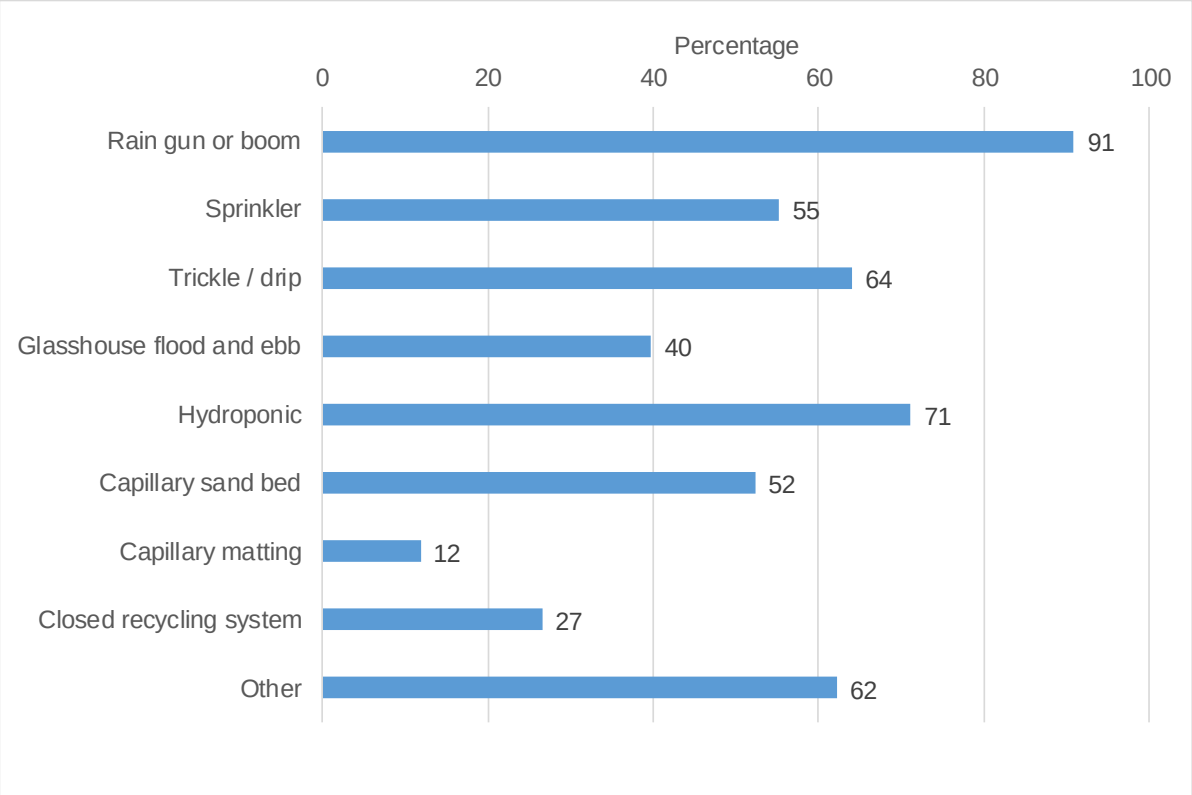


Figure 19. Mean percentages of irrigated water supplied by each system, calculated as mean of non-zero responses.



Question 13: trickle/drip application volume

If you use a trickle / drip irrigation system, do you use more than 20 cubic meters per day?

There were 215 responses to this question. However, Question 12 answers indicated that there were 119 users of trickle/drip, not 215; it is likely that some who did not use trickle drip answered in error, and chose either “No” or “Don’t know”.

A total of 76 respondents indicated that they use more than 20 m^3 per day. The number of these “Yes” responses for each sector are expressed as percentages (Figure 20) of the total number of respondents in each production sector (Table 5). The percentage of trickle/drip users is greatest in protected horticulture and least in potato production. A breakdown by crop is shown in Figure 21 and this shows that the highest percentages are in the fruit industry, including soft fruit and tree fruit. Although this provides useful insight, caution is needed because respondents could choose multiple crops in Question 5, and some responses are therefore counted in multiple sectors and multiple crops. For example, if a potato grower used trickle/drip (more than 20 m^3 per day, answering “Yes”), and is also in field horticulture, the response to this question will be included in both sectors.

Figure 20. The number of “Yes” responses for each sector expressed as percentages of the number of respondents in each production sector.

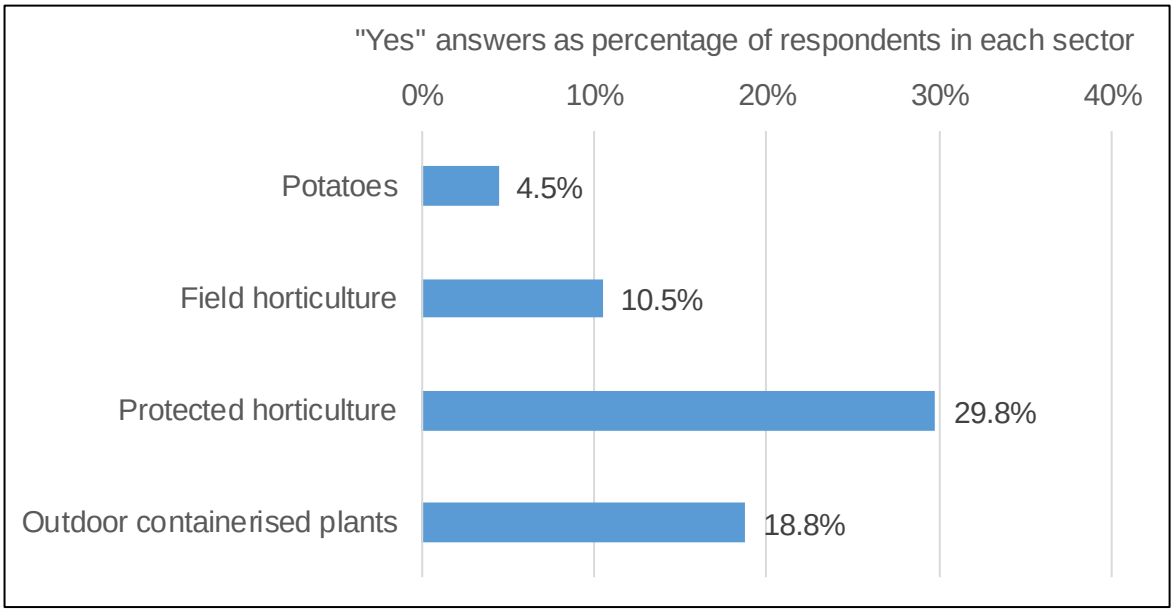
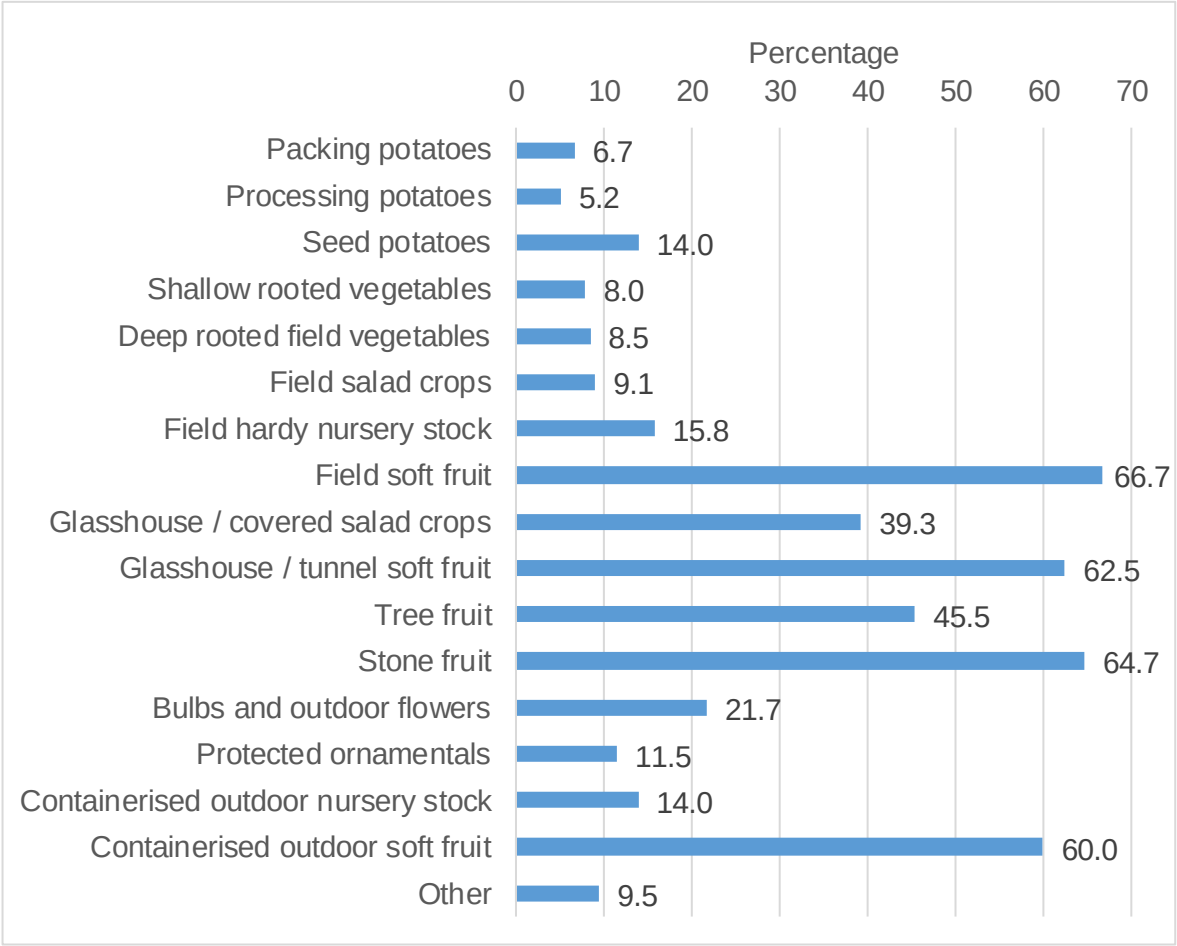


Figure 21. The number of “Yes” responses for each crop type, expressed as percentages of the number of respondents growing that crop type (Question 5).



Question 14: water storage facilities

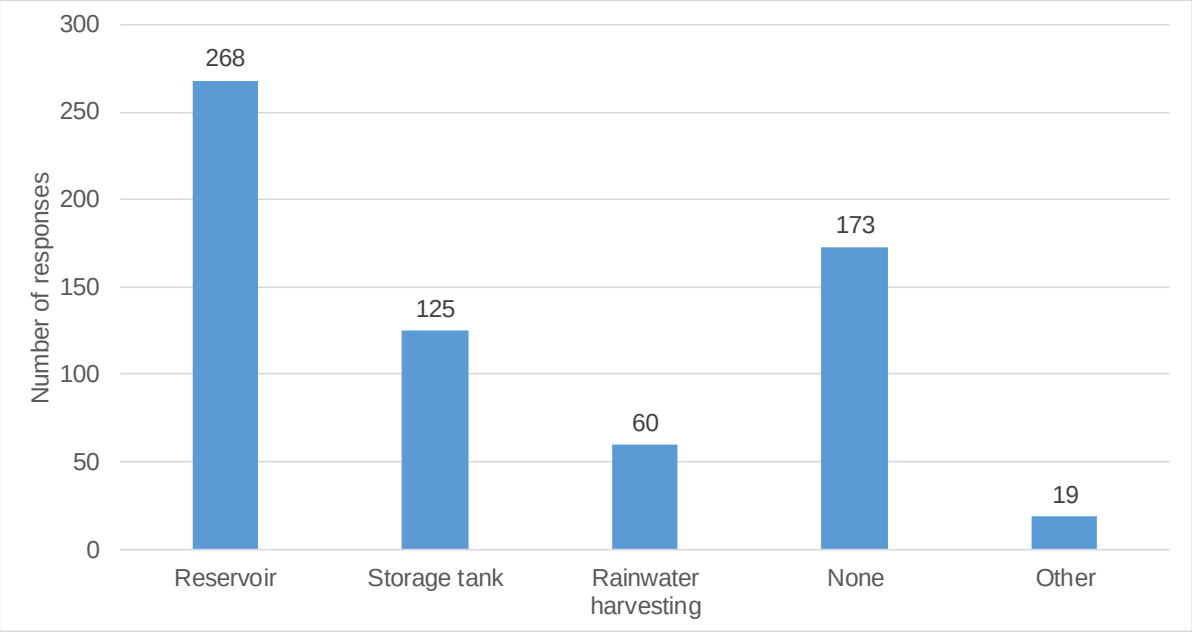
What storage facilities are available to you? This question relates to all land that you manage, rent or own. Please tick all that apply.

The options provided were:

- Reservoir
- Storage tank
- Rainwater harvesting facility
- None
- Other (please specify)

There were 527 responses to this question and of these 173 answered “None”. Thus, 354 (67%) had storage facilities. Reservoirs was the most selected option by respondents (Figure 22), the majority of which were potato and field horticulture growers (Figure 23). For protected and containerised production the most common storage facility was a water tank.

Figure 22. Storage facilities, shown as overall number of options selected. Note that respondents could choose multiple options.



In Figure 24 the data are visualised as percentages of the sum of answers for each crop. There was a high degree of discrimination between crops. Answers in the other category were mainly added description. For example, to give the source of water that is stored.

Figure 23. Storage facilities for each main production sector, shown as number of options selected.

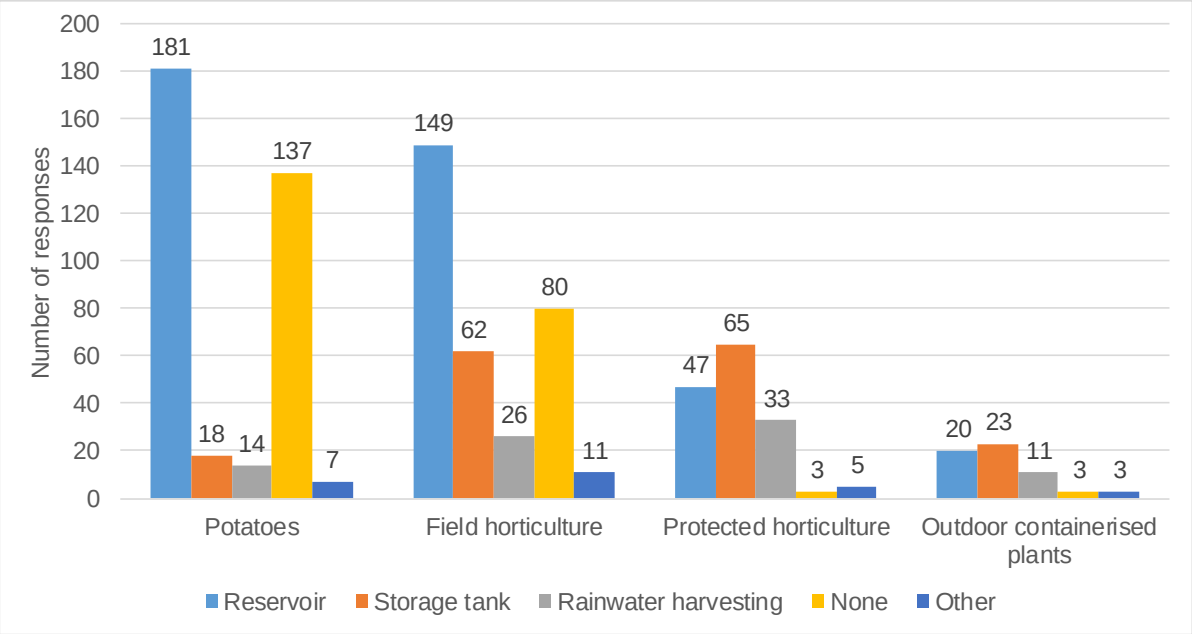
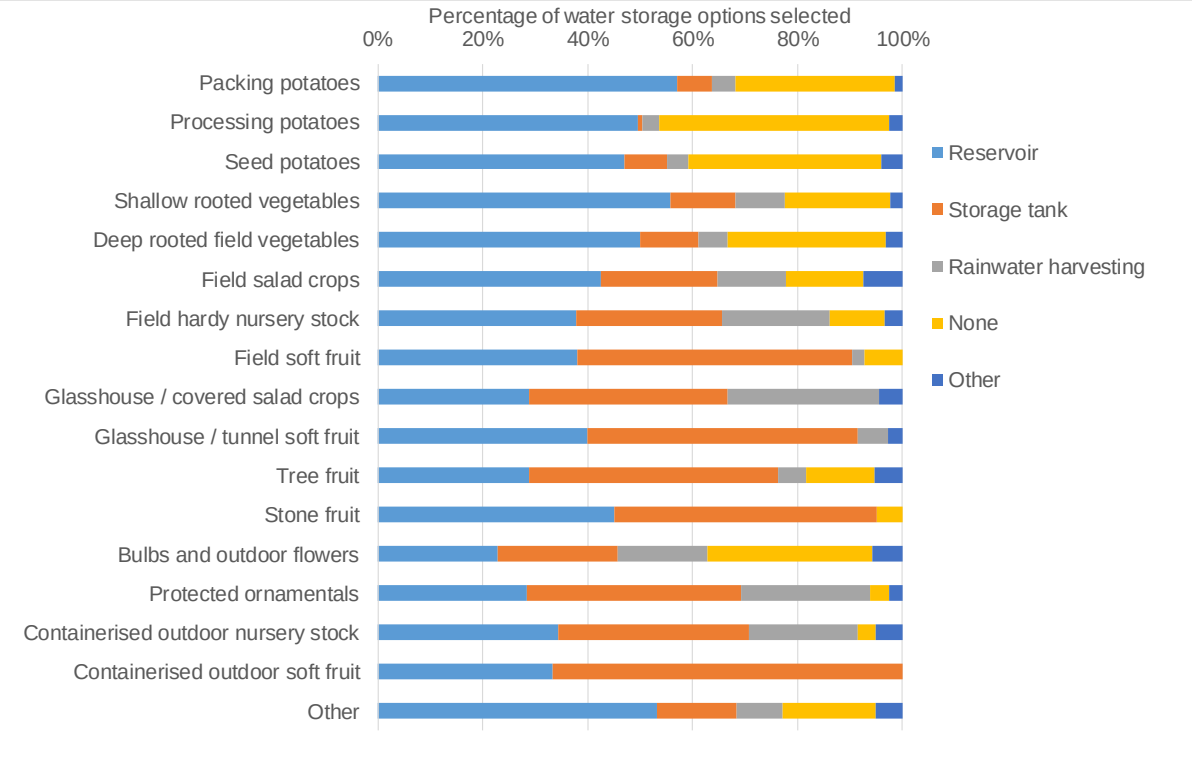


Figure 24. Water storage facilities for each crop, shown as the percentage of water storage options selected.



Question 15: water storage capacity

If you have storage facilities, please indicate the total estimated capacity by ticking the relevant range from the list below in units of cubic metres (1 cubic metre = 220 gallons).

The options provided were:

- No storage facilities
- 10-99 m^3
- 100-999 m^3
- 1,000-9,999 m^3
- 10,000-24,999 m^3
- 25,000-99,999 m^3
- 100,000-499,999 m^3

There were 428 responses to this question and, of these, 85 answered “No storage” (Figure 25), so 343 (80%) had storage facilities. This compares with 354 (67%) having storage facilities from answers to Question 14. The similarity between Questions 14 and 15 in the number of respondents having storage, and the lower response to Question 15 (99 fewer

than for Question 14) suggests that many growers who had no storage chose not to answer Question 15.

The most common size of storage facility was in the range of 25,000 to 99,999 m^3. Storage facilities tended to be larger for potato and field horticulture growers, compared with protected horticulture and outdoor containerised plant growers (Figure 26). Storage facilities also tended to be larger in the water availability category with lowest availability, compared with other categories (Figure 27).

Figure 25. Number of responses in each of the estimated storage capacity ranges.

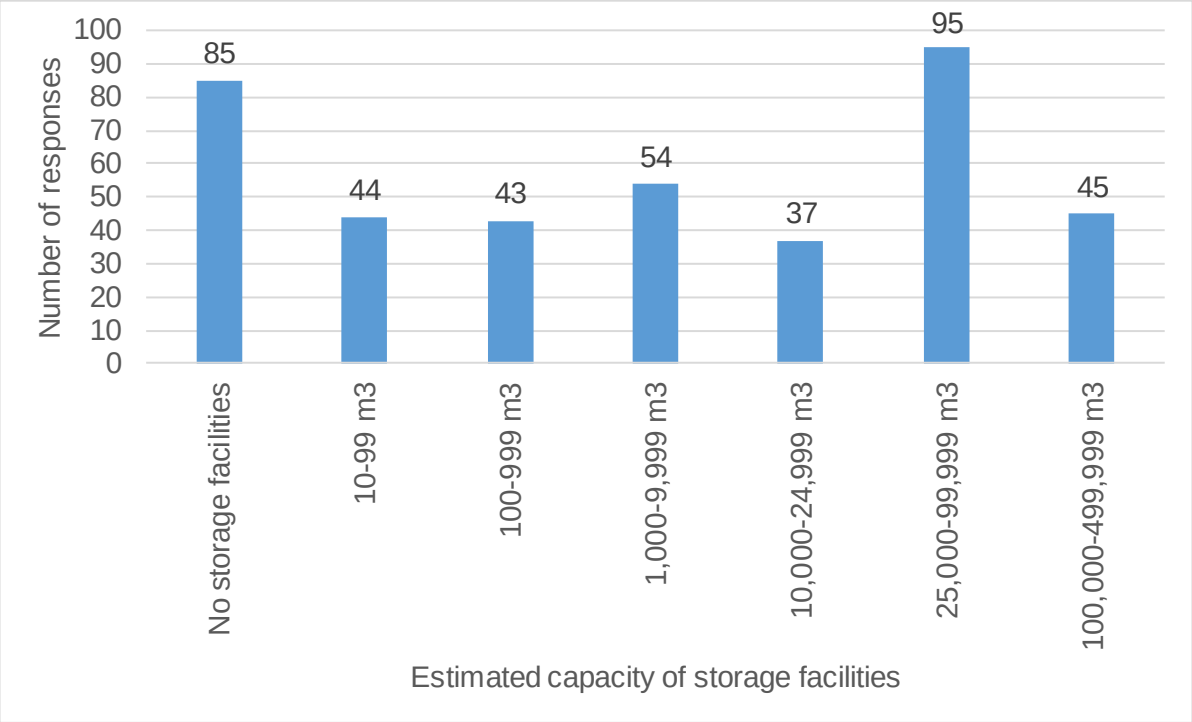


Figure 26. Storage capacity ranges (shown as different colours) for each main sector of production (bars). Data are: the number of options selected within each main production sector, expressed as the percentage of the total number of responses within each main production sector.

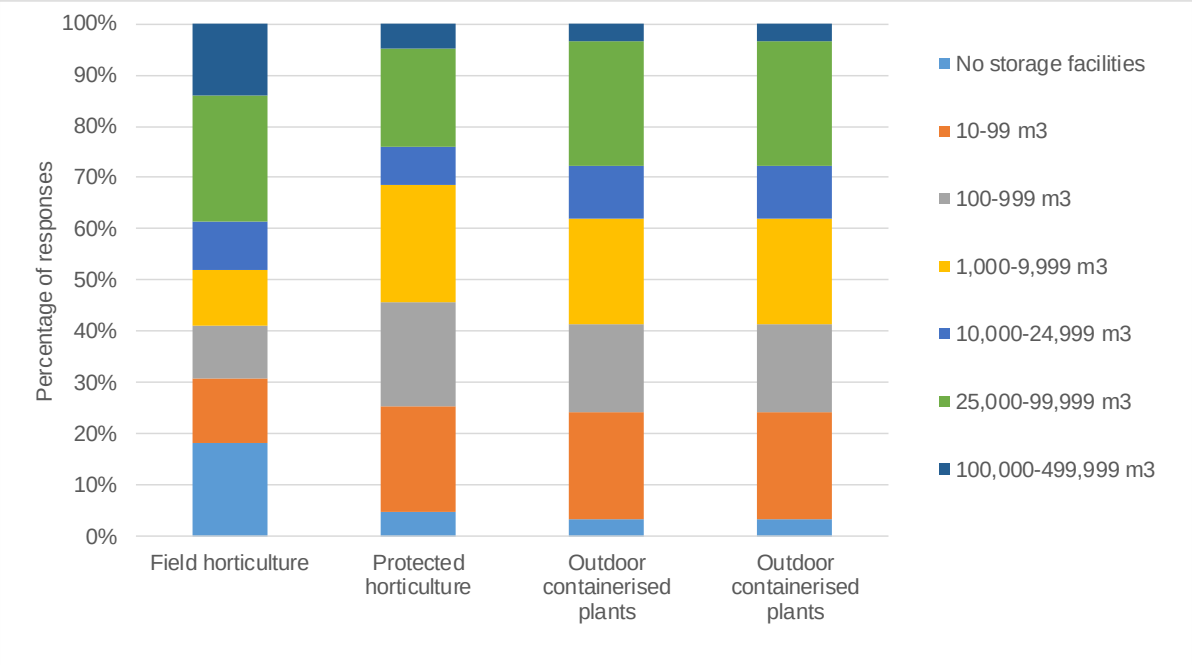
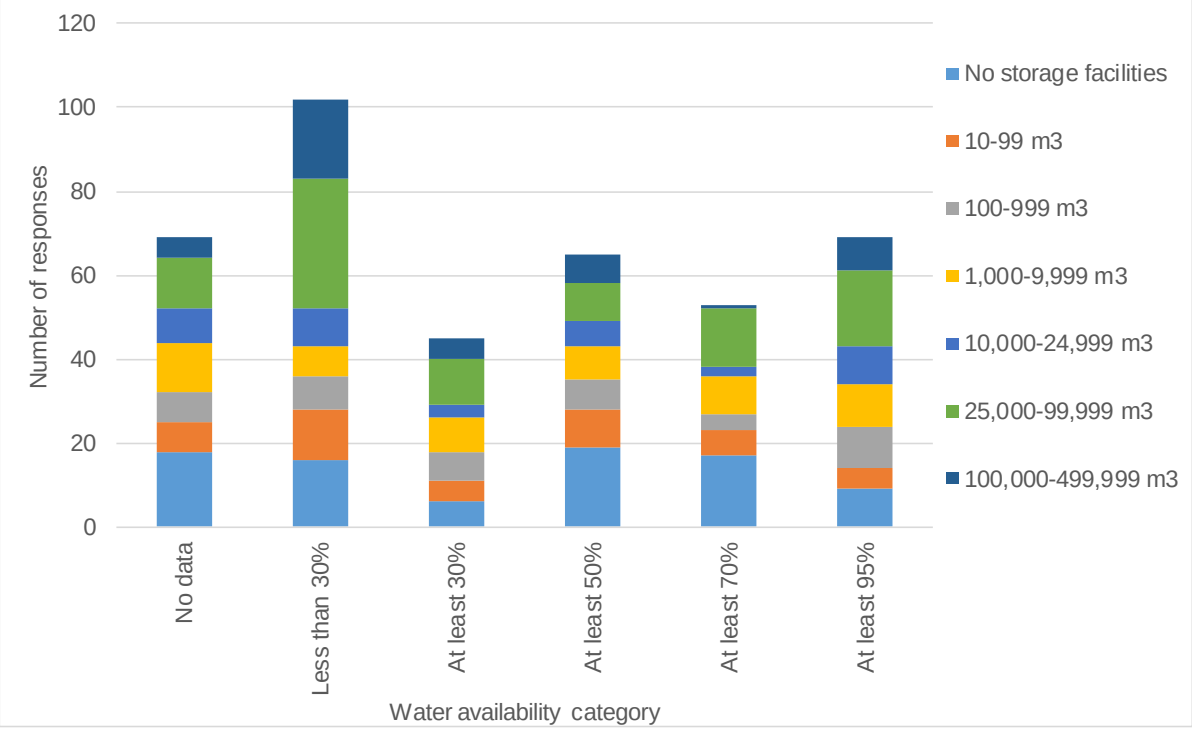


Figure 27. Percentages of responses in each of the estimated storage capacity ranges, for each water availability category.



Question 16: barriers to installation of water storage

If you have recently installed water storage or plan to install water storage, please rank in order of importance the challenges or barriers you feel you have encountered or may encounter. Please enter only one tick per row and only one tick per column.

The options provided were:

- Water shortages in your catchment
- Planning permission
- Land availability
- High capital costs
- Costs versus financial returns
- Soil type / geology / topography issues

There were 241 responses to this question, so it was skipped by many respondents.

Capital costs had the highest importance ranking overall (Figure 28).

Water shortages had greater importance for potato growers and field horticulture, compared with protected horticulture and outdoor containerised plants, reflecting the greater quantities of water used by potato growers and field horticulture (Figure 29). Land availability had greater importance for protected horticulture and outdoor containerised plants compared with potato growers and field horticulture, reflecting the smaller land areas typically available to businesses in protected horticulture and outdoor containerised plants. Costs *vs.* financial returns had greater importance for potato growers and field horticulture, compared with protected horticulture and outdoor containerised plants; for the latter two main sectors, irrigation is essential to business continuity, rather than a choice.

There were no strong patterns in the data for water availability categories (Figure 30).

Figure 28. Barriers to water storage: average importance ranking on a scale of 1 (least important) to 6 (most important).

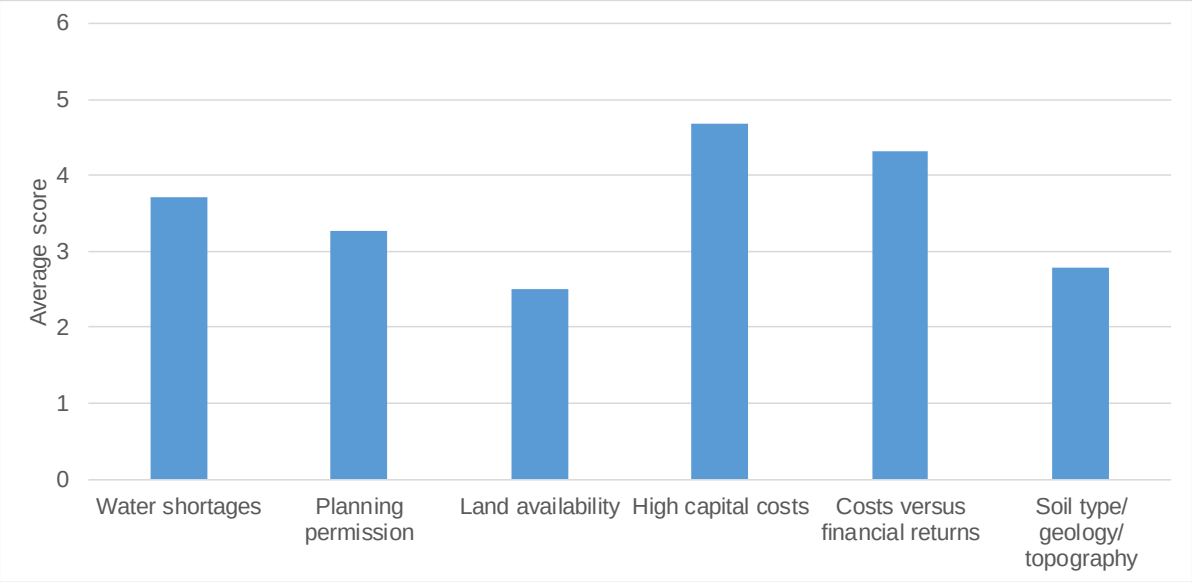


Figure 29. Barriers to water storage for each main production sector: average importance ranking on a scale of 1 (least important) to 6 (most important).

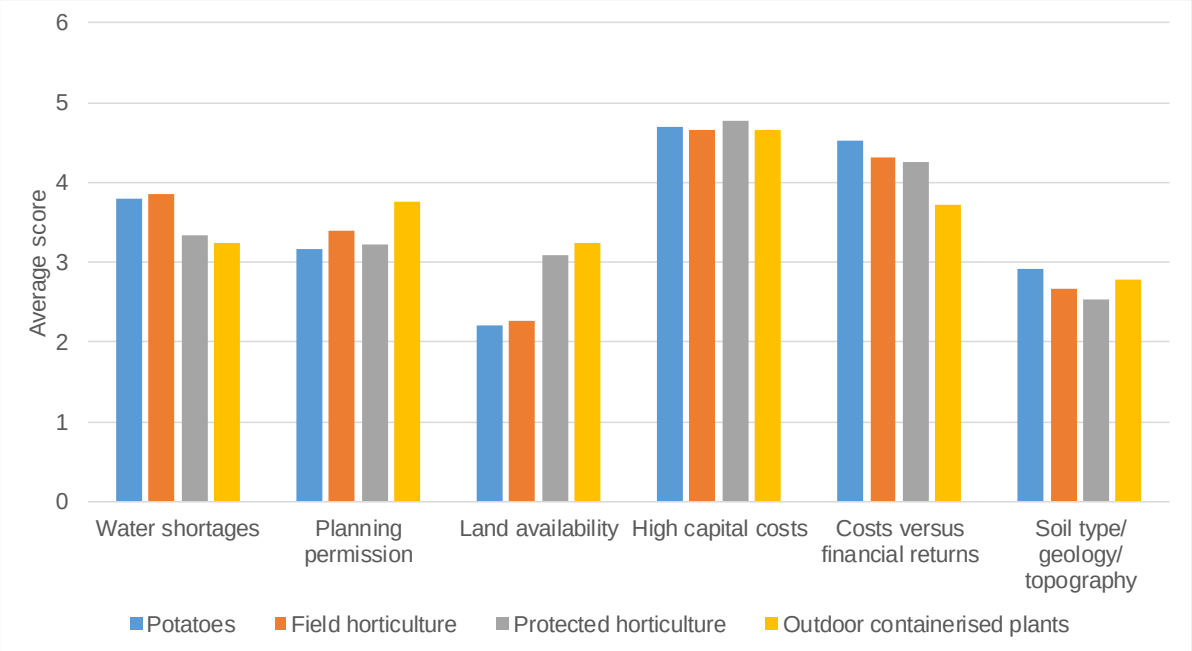
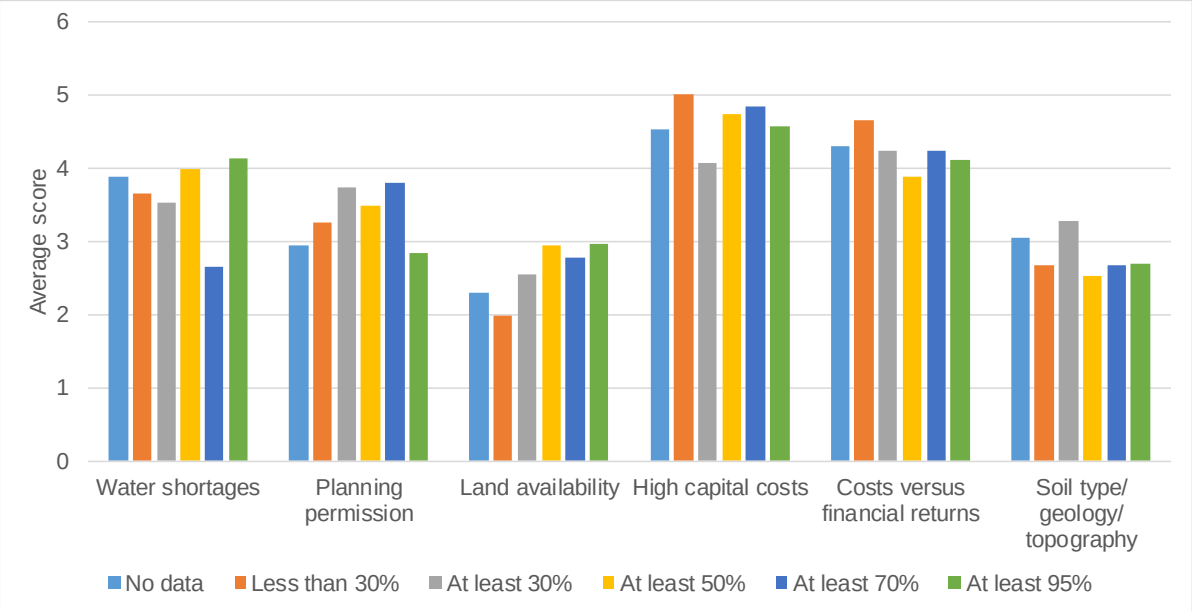


Figure 30. Barriers to water storage for each water availability category: average importance ranking on a scale of 1 (least important) to 6 (most important).



Question 17: restrictions to irrigation

In the last 5 years have you experienced any restrictions on your irrigation water use for any of the following reasons? Please tick all that apply.

The options provided were:

- Shortage of surface water
- Shortage of ground water
- Irrigation limited by cessation conditions on licences
- Irrigation limited by implementation of drought plans
- Irrigation restriction (voluntary)
- Yes, but unsure of the reason
- No restrictions experienced
- Other

There were 482 responses to this question, of which 220 (46%) experienced restrictions in the last five years. The two most common reasons for restrictions were shortage of surface water and cessation conditions on licences (Figure 31). More restrictions were experienced by potato growers and field horticulture businesses, compared with protected horticulture and outdoor containerised plant growers (Figure 32). There was a trend for more restrictions in catchments with least water availability (Figure 33).

Figure 31. Reasons for restrictions on irrigation water use: number of responses for each reason.

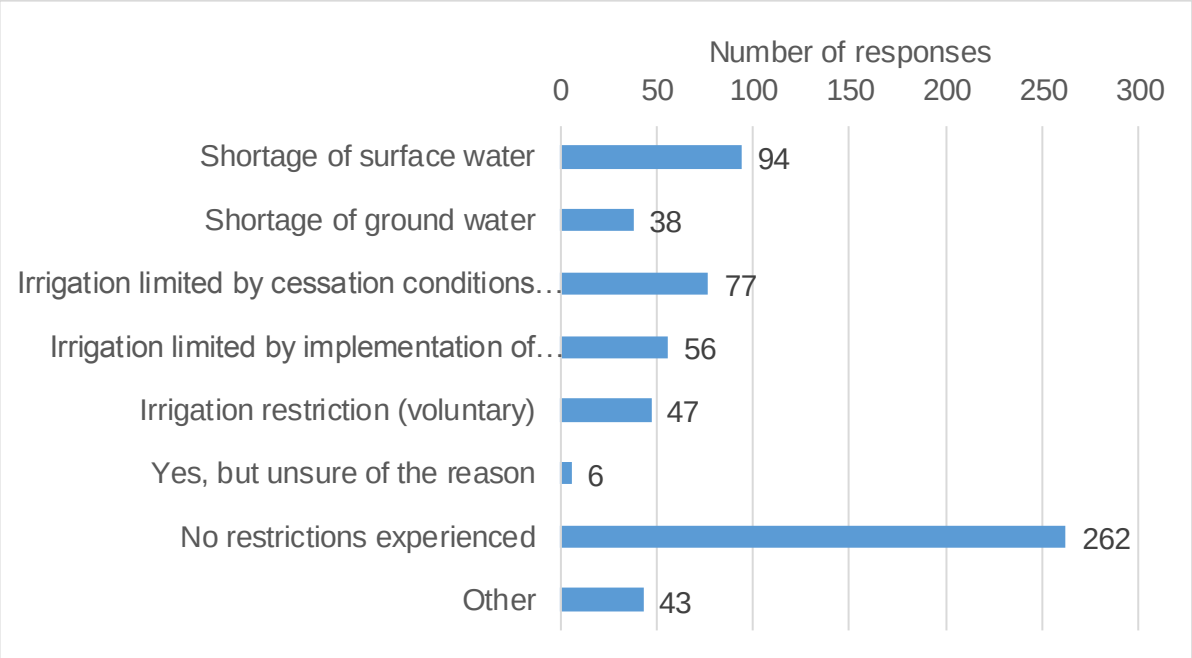


Figure 32. Reasons for restrictions on irrigation water use: number of responses for each reason, and for each main sector of production.

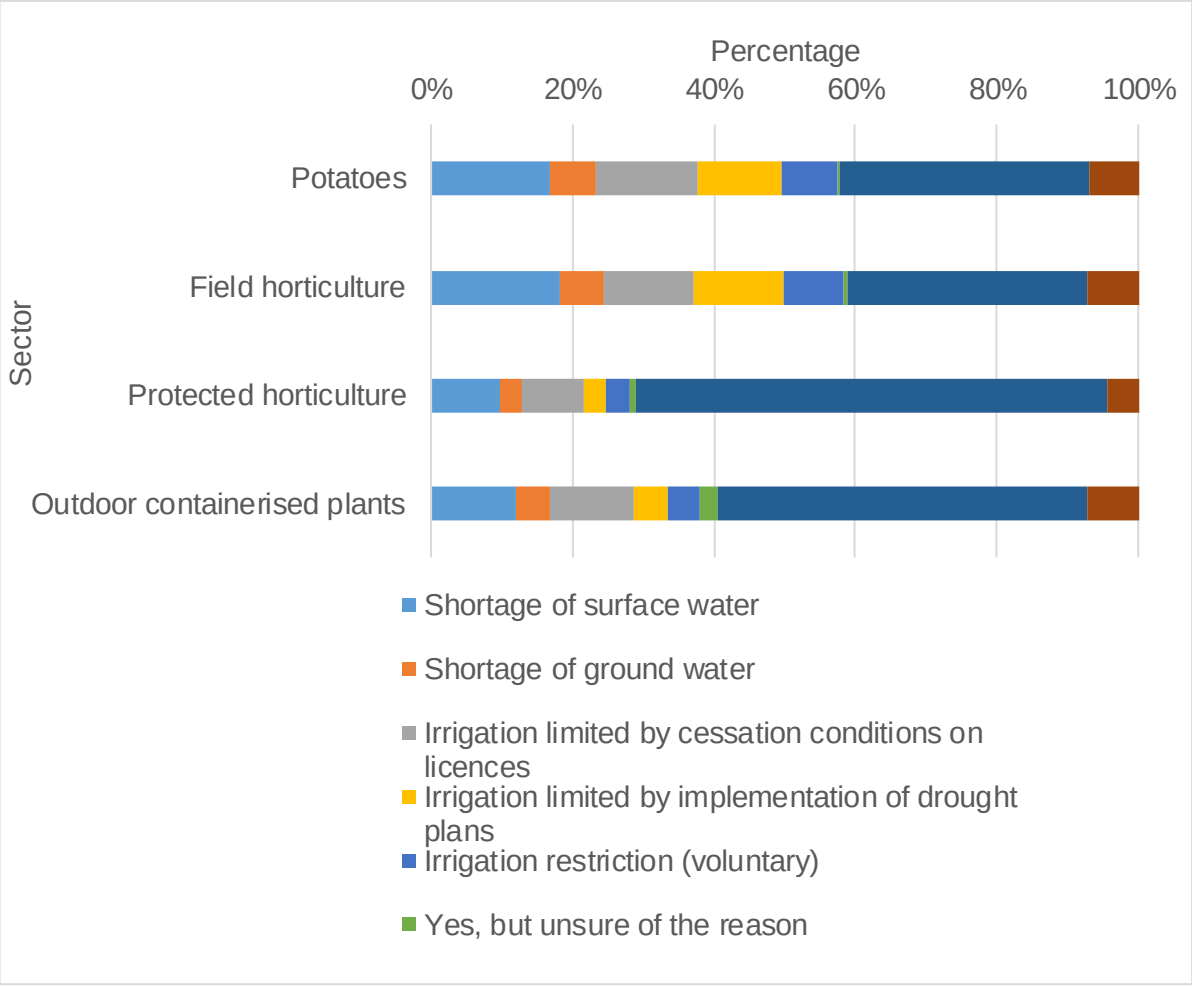
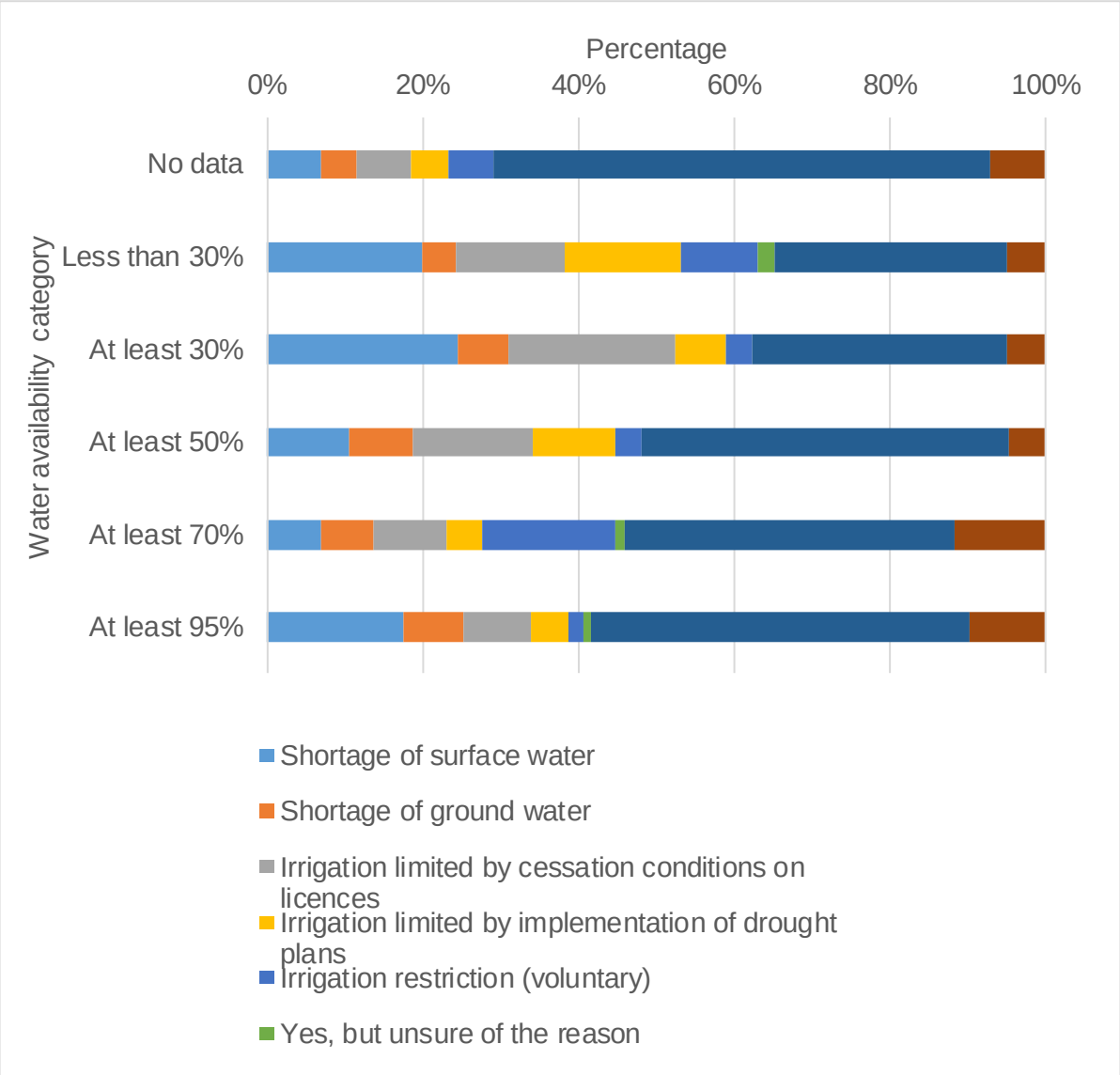


Figure 33. Reasons for restrictions on irrigation water use: number of responses for each reason, and for each water availability category.



Answers in the other category were mainly added description, or related to the question indirectly. Here are a few examples to give a flavour of the types of responses in this category.

- Need capital allowances for Reservoirs.
- No irrigation done in the last 10 years
- No restrictions apply to us as trickle irrigators
- Not applicable - Do not Irrigate
- SEPA introduced a rule whereby they could stop us irrigating if river levels drop. It has been in place for 1 year however it was not actioned last summer.
- Short on storage
- Too restrictive daily abstraction rate
- Total use of licence

- Warning letters received but not actioned as levels did not fall as low as had been anticipated

Question 18: technology for water management

Does the site currently use any of the following? Please tick all that apply.

The options provided were:

- Smart water meters
- Professional irrigation scheduling services / computer programme
- Timing systems
- Soil or substrate moisture monitoring
- Transpiration/humidity measurement
- Collection of drainage water for recirculation
- Drones (for crop / nutrient mapping)
- Other comments (box for free text)

There were 386 responses to this question. Most of these used professional irrigation scheduling services or software (65%). Since some technologies are used more in some sectors than others, and some are not appropriate to some sectors, the overall number of responses for each option (Figure 34) reflects the number of respondents in each sector. The percentages of responses for each option within main production sector (Figure 35) gives a better indication of uptake within sectors. The results show that there is the possibility of greater uptake of technologies for improved water management. Answers in the other category were mainly added description.

Figure 34. Technologies for water management: number of responses for each option.

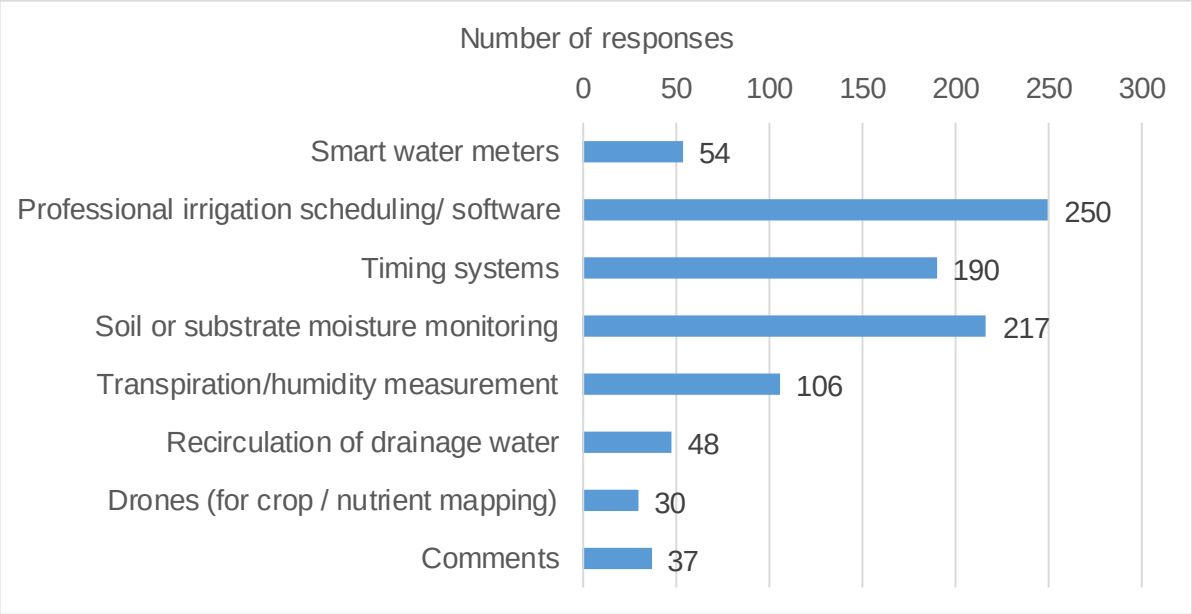
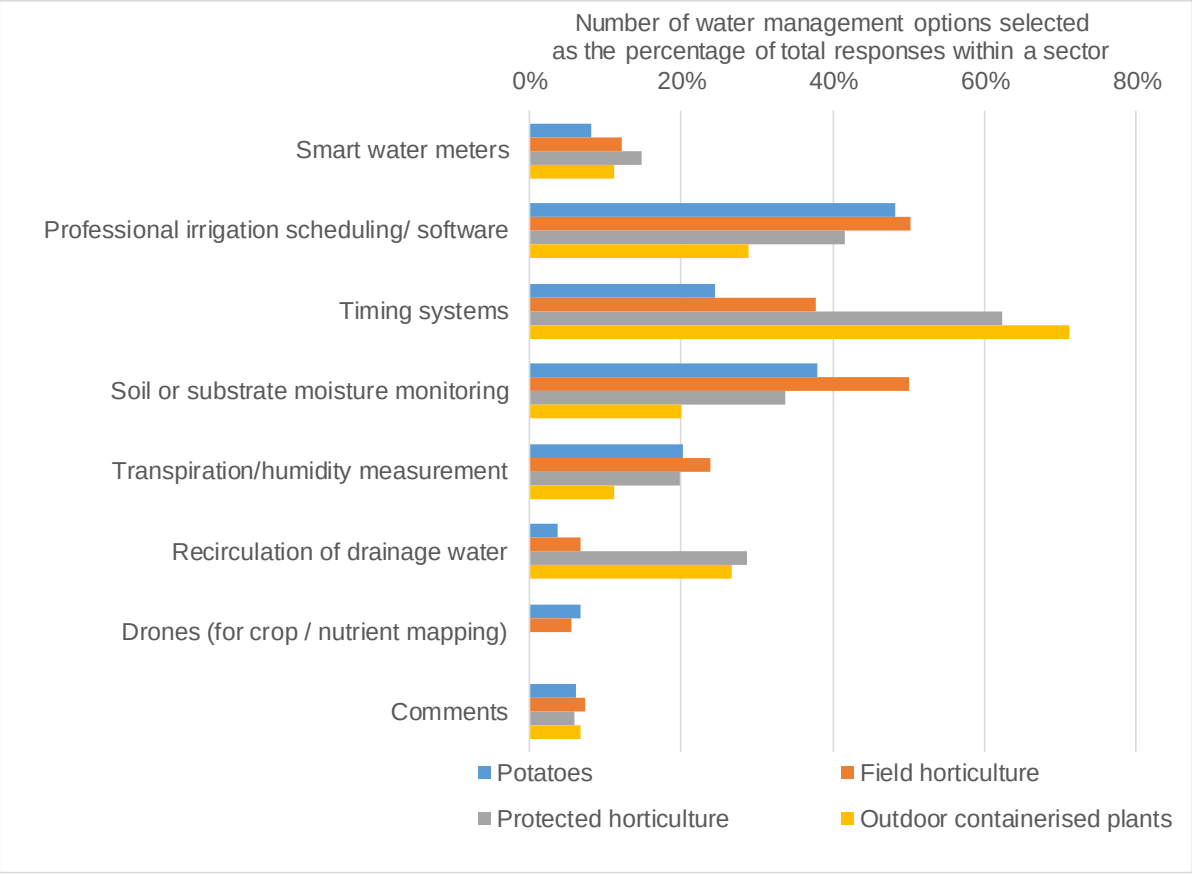


Figure 35. Technologies for water management: number of water management options selected as the percentage of total responses within main production sectors.



Question 19: management of water

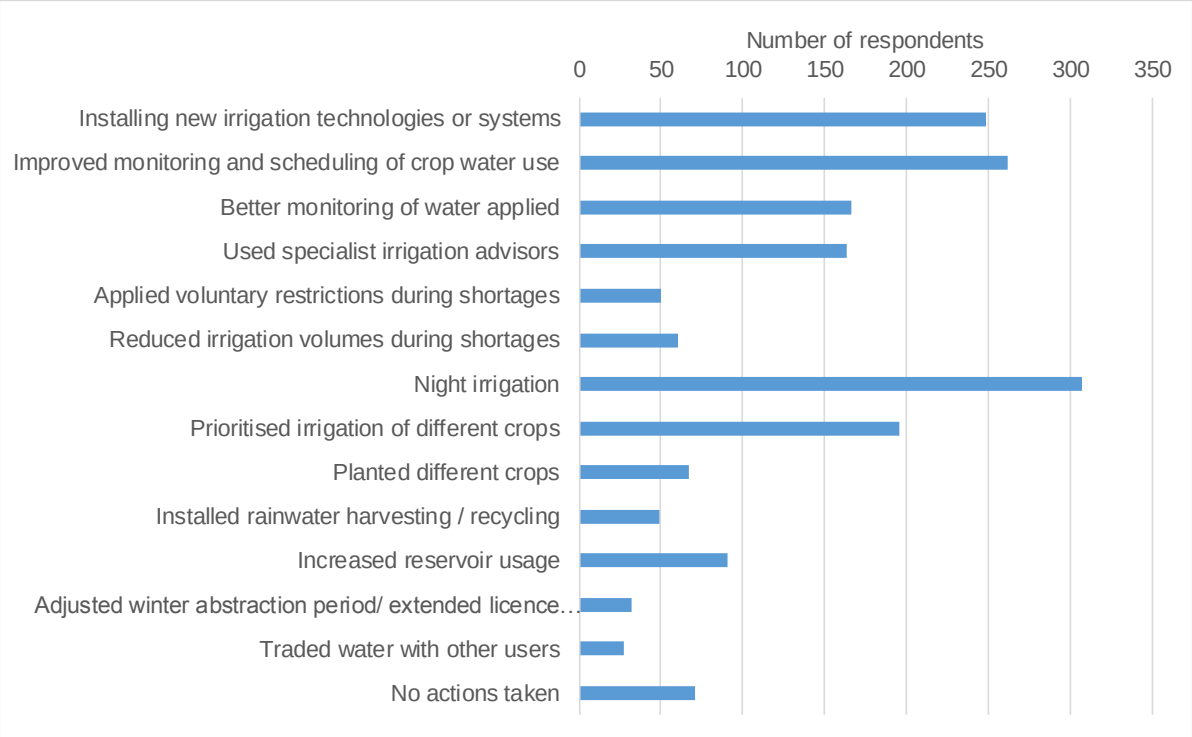
In the last 5 years, what actions have you taken to manage water shortages and/or improve your water use efficiency? Please tick all that apply.

The options provided were:

- Installing new irrigation technologies or systems
- Improved monitoring and scheduling of crop water use, e.g. through probes, transpiration monitoring, weather monitoring, or automated systems
- Better monitoring of water applied, e.g. by installing meters
- Used specialist irrigation advisors
- Applied voluntary restrictions during shortages
- Reduced irrigation volumes during shortages
- Night irrigation
- Prioritised irrigation of different crops
- Planted different crops
- Installed rainwater harvesting / recycling
- Increased reservoir usage
- Adjusted winter abstraction period / extended licence dates
- Traded water with other users
- No actions taken
- Other

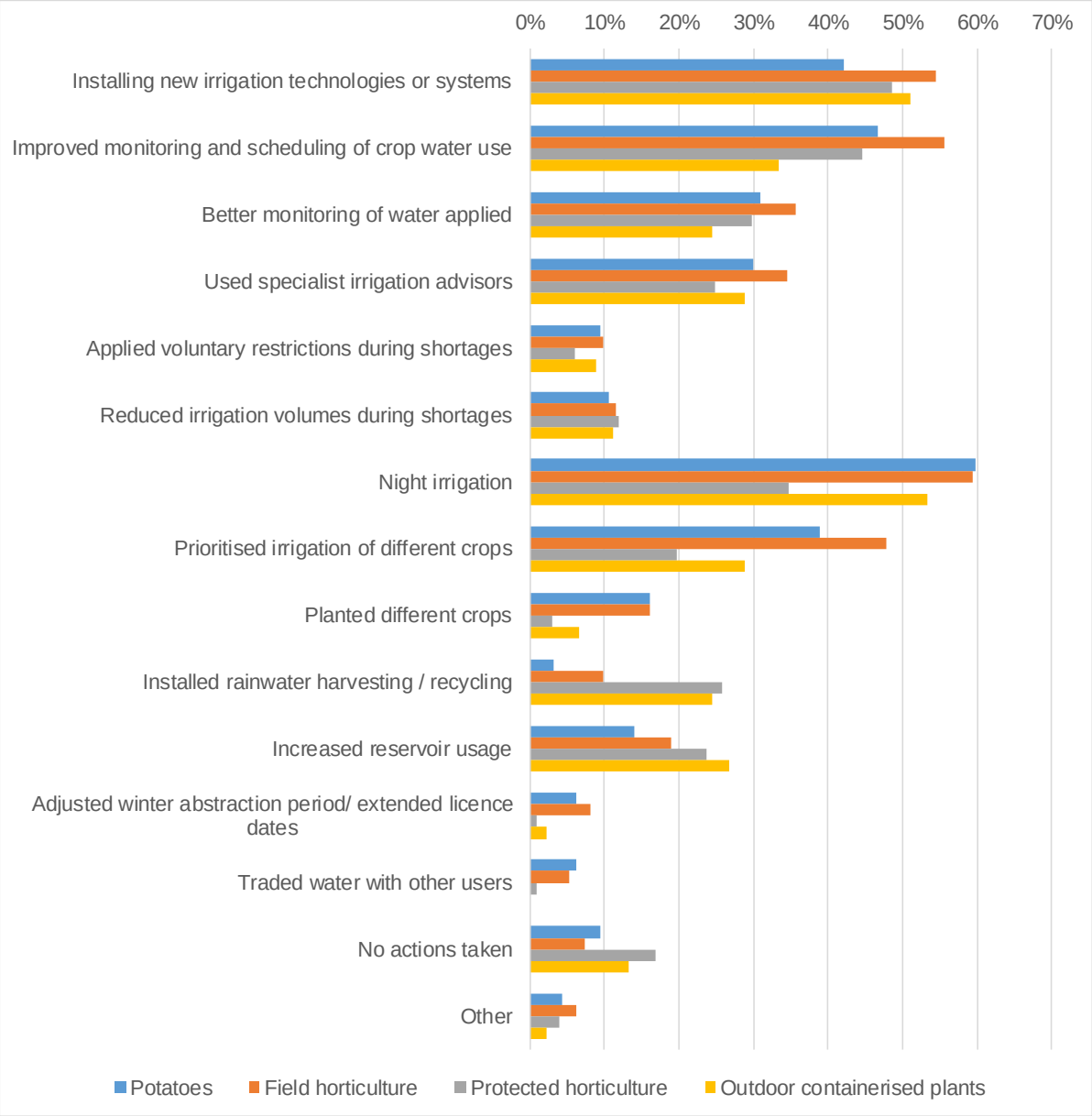
There were 503 responses to this question. Responses for each option are shown in Figure 36: actions with a high level of response included night irrigation, improved monitoring and scheduling of crop water use, installing new irrigation technologies or systems, and prioritising irrigation of different crops. Actions with a low level of response included trading water with other users, adjusting winter abstraction period / extending licence dates, installing rainwater harvesting / recycling, and applying voluntary restrictions during shortages. Since some actions are not appropriate to some sectors, the overall number of responses for each option reflects the number of respondents in each sector.

Figure 36. Actions to manage water shortages and/or improve water use efficiency: number of responses for each option.



The percentages of responses for each option within main production sector (Figure 37) gives a better indication of actions within sectors. The results show that, for example, rainwater harvesting has been adopted more in protected horticulture and outdoor containerised plant production compared with potato production and field horticulture. Care must be taken in the interpretation of these data because there is double counting between sectors where respondents produce in more than one sector.

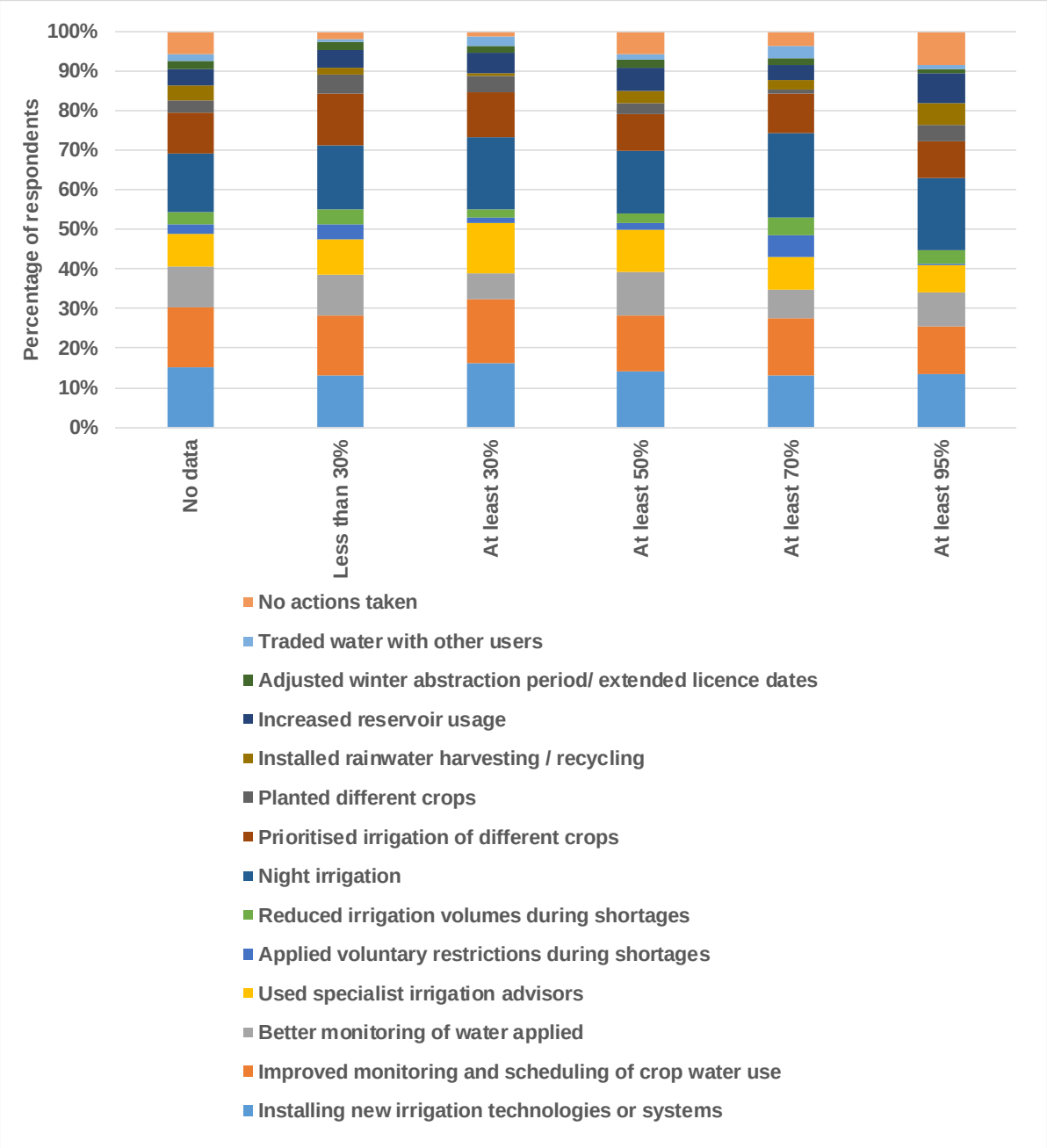
Figure 37. Actions to manage water shortages and/or improve water use efficiency: percentage of responses for each option within main production sectors.



The survey results show that most respondents (86%) had taken some action compared with the minority, which reported taking no action. In particular, it can be observed that fewer “no action” responses were reported by respondents in catchments with lower water availability (Figure 38).

These data suggest that there is potential for further uptake of actions, as would be expected. However, lack of uptake does not necessarily indicate scope for further uptake, and it is recognised that not all actions are appropriate for all businesses.

Figure 38. Actions to manage water shortages and/or improve water use efficiency: percentage of responses for each option within water availability category.



Answers in the other category were mainly added description. Here are a few examples to give a flavour of the types of responses in this category.

- Essential need for certain crops.
- Favouring booms for efficiency
- Have used several of the above but more than 5 years ago
- Installed new reservoir in 2015 to improve water security
- Keep up to date with current thinking and research.

Question 20: need for additional information or support

What additional information or support would be most useful to you? Please indicate level of importance with 1 being the least important and 5 most important. Please enter only one tick per row.

The options provided were:

- Regular updates on the planned changes as they are announced
- Information on potential removal of seasonal conditions, allowing abstraction at any time during the year when water is available
- information on potential abstraction restrictions when there are low water flows or levels
- Information on the potential ability to take more water than your permitted volume at high flows
- Information on the trading of water licences
- Advice on collaboration with Environment Agency, water companies and other growers, to optimise available supplies at a local catchment level
- Guidance on the installation of new reservoirs and water storage
- Guidance on the installation of rainwater harvesting and re-cycling systems
- Benchmarking of water use so that you can compare your water use with best practices in your sector
- Learning from the experiences of other growers
- Understanding new technologies and systems for water application
- Information about the usefulness of data from crop/soil monitoring and irrigation scheduling systems
- Training on how to maintain and optimise equipment use for best irrigation efficiency and productivity
- Information on water quality, including removal of plant pathogens
- Other

There were 488 responses to this question. Responses for each option are shown in Figure 39, and a breakdown by production sector is given in Figure 40. For reference, mean importance scores are given for each crop type in Table 14.

These results can be used to help guide knowledge exchange activity. It is important that the data are examined by crop type because the need for additional information or support varies between growers of different crops.

There was no clear pattern of differing needs between growers in different water availability categories.

Figure 39. Need for additional information or support: mean importance scores.

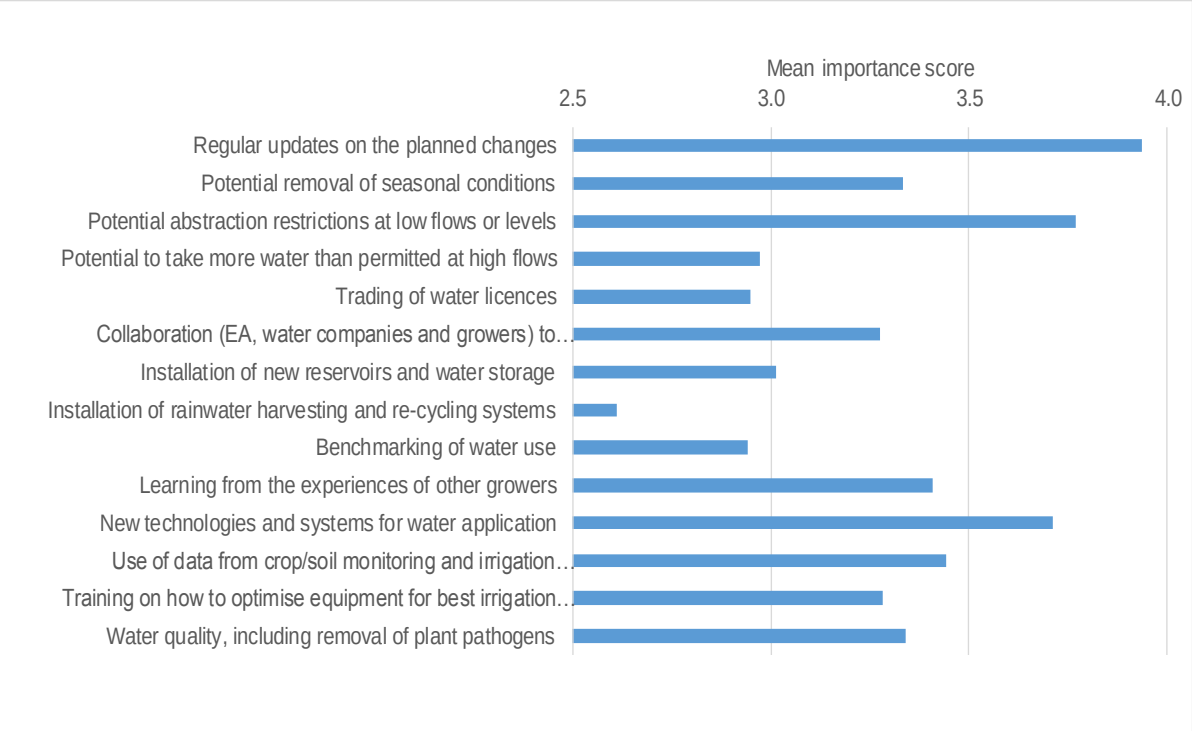


Figure 40. Need for additional information or support: mean importance scores for each option within main production sectors.

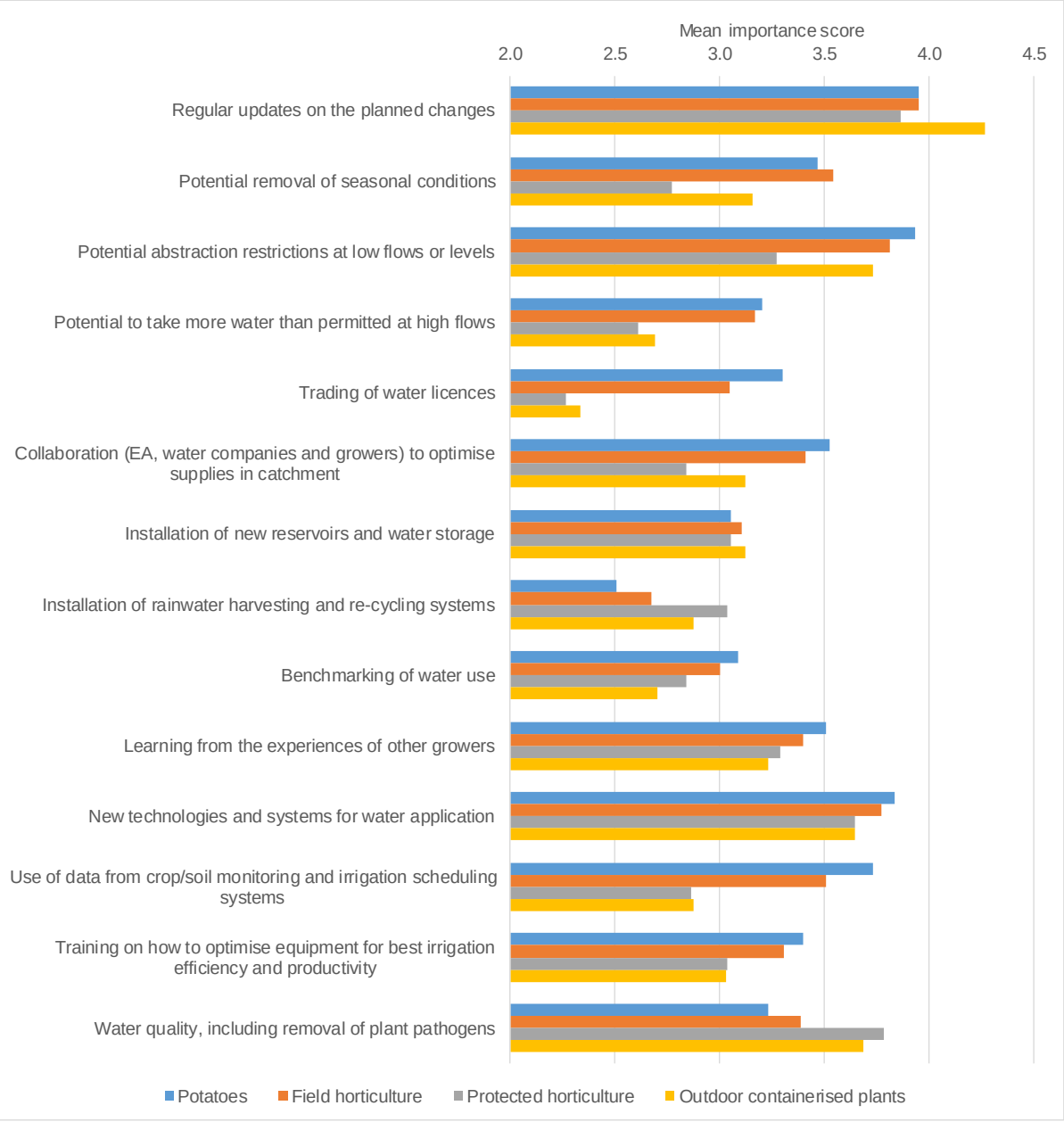


Table 14. Need for additional information or support: mean importance scores for each option, for each crop type.

	Regular updates on the planned changes	Potential removal of seasonal conditions	Potential abstraction restrictions at low flows or levels	Potential to take more water than permitted at high flows	Trading of water licences	Collaboration (EA, water companies, growers) to optimise catchment supply	Installation of new reservoirs and water storage	Installation of rainwater harvesting and re-cycling systems	Benchmarking of water use	Learning from the experiences of other growers	New technologies and systems for water application	Use of data from crop/soil monitoring and irrigation scheduling systems	Training to optimise equipment for best irrigation efficiency and productivity	Water quality inc. removal of plant pathogens
Packing potatoes	3.9	3.5	3.9	3.3	3.0	3.4	3.0	2.5	2.8	3.4	3.8	3.6	3.3	3.4
Processing potatoes	4.0	3.5	4.0	3.2	3.6	3.8	3.3	2.6	3.3	3.6	3.9	3.9	3.5	3.1
Seed potatoes	3.9	3.6	3.9	3.3	3.2	3.4	2.8	2.4	2.9	3.4	3.7	3.2	3.1	3.1
Shallow rooted veg	4.0	3.6	3.8	3.4	3.1	3.5	3.2	2.6	2.9	3.2	3.6	3.4	3.2	3.4
Deep rooted field veg	4.0	3.6	4.0	3.3	3.3	3.7	3.3	2.7	3.2	3.6	4.0	3.8	3.6	3.5
Field salad crops	4.2	3.5	3.2	2.9	2.5	2.9	2.7	2.4	2.8	3.1	3.3	3.0	2.9	3.5
Field hardy nursery stock	3.4	3.2	4.1	3.1	2.4	2.4	2.6	2.3	2.0	3.2	3.4	2.8	2.9	3.6
Field soft fruit	3.8	3.4	3.6	3.0	2.7	3.1	3.0	3.3	3.3	3.6	3.8	3.9	3.5	4.0
Glasshouse/ covered salads	3.9	3.0	3.2	2.8	2.1	2.7	2.9	3.1	2.7	3.2	3.4	2.3	2.8	4.1
Glasshouse/ tunnel soft fruit	3.7	3.2	3.3	2.9	3.0	3.3	3.0	3.2	3.2	3.3	4.0	3.6	3.1	3.5
Tree fruit	3.8	3.3	3.4	2.4	2.3	2.9	3.0	2.8	3.0	3.4	3.5	3.3	3.0	2.8
Stone fruit	3.4	3.6	3.3	3.0	2.4	2.8	2.7	2.8	3.1	3.4	3.8	3.6	3.1	3.1
Bulbs, outdoor flowers	3.4	2.8	3.2	2.6	2.8	2.8	3.6	3.1	2.5	2.9	3.4	3.0	2.7	3.4
Protected ornamentals	3.9	2.5	3.4	2.4	2.0	2.8	3.2	3.0	2.8	3.4	3.7	2.8	3.1	3.9
Container outdoor nursery stock	4.4	3.3	3.9	2.7	2.5	3.2	3.2	3.0	2.8	3.4	3.7	2.8	3.1	3.9
Containerised outdoor soft fruit	3.8	2.5	3.0	2.8	2.0	2.8	3.5	3.0	2.8	2.8	3.8	3.8	3.0	2.8
Other	4.1	3.7	4.0	3.0	2.8	3.2	3.2	2.8	2.9	3.5	3.6	3.5	3.3	3.2

Below are the comments received in the “other“ category.

- Acceptable salinity levels
- As we are only tenants we have very little control over what irrigation facilities are installed on site
- Have a maximum irrigation application rate chart for different soil type so we do not waste water
- Help putting in efficient irrigation systems and reservoir construction
- I have indicated option number 5 to the last question - Information on water quality, including removal of plant pathogens - but I refer specifically to salinity.
- I would like to point out that the above choices do not reflect lack of interest in certain topics. I may tick some items as not being of great importance because I feel I may already be well informed on a certain item and don't require to know more at this time.
- Information on water quality with regard to Salinity.
- irrigation for the purpose of crop hydration is not relevant to me at all
- N/A
- Reservoirs currently un-used.

Question 21: free text comments

Do you have any comments on the current abstraction licencing system, or the planned changes?

Free text comments were used to help guide the interpretation of results and also to provide insight for the stakeholder document that is produced separately by this project.

Conclusions

‘Headroom’ is a major concern

Licenced water abstraction volume total (excluding watercress; water used for watercress production is considered non-consumptive because the water flows through the production system and most of the water is not evaporated and is returned to the environment):

- 70.3 million m^3

Highest annual volume of water applied within 2011 to 2015, excluding mains and watercress:

- 51.9 million m^3

Usage and headroom

- Greatest annual usage is 73.9% of the licensed volume
- Headroom is 26.1% of licensed volume, to cover a greater need of water than was experienced in the years 2011 to 2015.

Storage

- carries high capital cost
- planning is perceived to be a major obstacle
- edible crop producers are concerned about water quality (potential pathogens)

The need for storage

- In protected and containerised production water is required every day
- Storage is necessary for some businesses to maintain supply continuously
- In some sectors (e.g. leafy salads) major growers already have storage

High capital cost of storage

- Licence durations are short and discourage investment in reservoirs
- In some sectors, installation of storage is not economically viable (e.g. cucumbers)
- A requirement for storage would lead to less UK production and more imports

Other barriers to storage

- Storage allows the user to change the time of abstraction but does not necessarily decrease water use – perceived problem in applying for grants
- In some sectors (mainly protected horticulture) availability of land is a barrier to storage

Trickle use

Significant (20% of responses), especially for fruit, container growing, protected production

- Perceived as expensive
- Perceived as practically difficult for potatoes and field horticulture
- For some field crops the crop duration is too short
- Perceived as not working well on light soil (sand land)

This method could increase water use!

- SMD may be maintained at a lower level, with greater water loss when it rains
- Irrigation less limited by equipment and labour
- Possibly more water use per ha, depending on management but not necessarily more water use per unit of production

Recirculation of water in glasshouses

- considerable potential
- levy payers would like technical information

Efficiency of water use for field production

- may increase water use

BUT…

- would also increase production per ha, either decreasing the area irrigated or benefiting the rural economy (e.g. by replacing imports)

Trading water

- An aspect of the proposed changes that concerns many growers
- It is perceived that trading licenced water as a commodity will increase cost because traders will take profit

Knowledge and Technology Transfer

The Knowledge and Technology Transfer activities done within this project, and anticipated, are listed below.

1.	Steering Group meetings	Three meetings were held with a project steering group appointed by AHDB, that included industry and government stakeholders (AHDB, NFU, EA, growers and their representatives). These meetings allowed interaction with stakeholders and some degree of knowledge transfer for survey results.
2.	Stakeholder Document	A stakeholder document has been provided to AHDB, separately to this report.
3.	Presentation to Defra	The Ricardo Project Manager presented survey results to a Defra-organised meeting about water abstraction on 10th October 2016
4.	Anticipated presentation	A further presentation of project results is anticipated in 2017, to be confirmed by AHDB.

Appendix 1: stakeholder interview notes

This appendix contains notes of interviews with stakeholders. In addition to these interviews, the Potato Processors' Association was also consulted.

British Leafy Salads Association

http://www.britishleafysalads.co.uk/

Represented by David Edwards of Anglia Salads, Angflor, and on the BLSA R&D outdoor committee

Key points

Industry trends (leafy salads)

- Total production area likely to remain static over the next few years
- Areas of individual crops will change as market demand changes
- Irrigation water use is likely to decline slightly with improved efficiency

Economic importance of irrigation

- Production would not be possible without water, so financial effects of water restriction on production are irrelevant

Abstraction licences

- Removal of seasonality conditions may be welcomed, depending on the detail of new conditions
- Removal of time limits on licences may be welcomed, depending on the detail of new conditions

Water sources and quality issues

- A majority of the water use in this sector is from ground water, and some is from rivers; this depends on location
- Water for leafy salads must be clean to avoid microbial contamination (e.g. E. coli)
- Ground water is cleaner than river water so is preferred
- Some production uses mains water, taken at agreed times and stored in reservoirs
- UV or chemical treatment is used to purify water
- Water purification methods work best if the water is already clean

- Sand filters are used by some protected crop growers but this method is not effective against human pathogens

Abstraction restrictions

- Restrictions are mainly for abstraction from rivers, then ground water but very unlikely on reservoirs.

Storage

- There has been considerable investment in reservoirs supported by government/EU funds
- All major growers have storage
- Licence durations are short and this does not encourage more investment

Application methods

- Rain guns and booms are the main application methods
- Mini sprinklers have been abandoned because of uneven water distribution
- Trickle/drip is not practical because of the short crop durations
- Use of water table to irrigate is very specialist and limited to suitable locations

New technology

- All growers schedule irrigation – the cost of getting irrigation wrong is too great not to schedule
- Crop monitoring techniques are used by all growers, usually by probes measuring soil moisture throughout the profile. Drones are of interest, but when dry patches are detectable it is too late – the damage is done; so it is more effective to pre-scan fields to enable any variations in soil or structure to be factored into irrigation, however future advancements will lead to greater use.

Knowledge transfer

- This is important and there is a lot of good KT activity
- Growers are not all making best use of the KT activity available to them
- Effort is needed to find the information or attend events

Cucumber Growers Association

http://www.cucumbergrowers.co.uk/

Represented by Derek Hargreaves, Technical Officer of the CGA

Key points

Industry trends (cucumbers)

- There are three main areas of production: north Kent (Thanet), Lea Valley and Yorkshire (north and east)
- Cropping runs from late December (Kent) and January elsewhere until mid November
- All crops are drip irrigated and water is needed continuously during daylight hours to allow production
- If water availability continues to be reliable, production trends will depend on price paid for the product
- There is opportunity for expansion if the price is right
- There has been contraction since the 1980s, from around 260 ha to around 100 ha now, alongside an increase in summer imports of cheaper cucumbers from Holland

Economic importance of irrigation

- Without irrigation continuously available to be applied during daylight hours, production is not possible
- A requirement to install water storage (e.g. to ensure supply if abstraction were to be interrupted during drought) would either increase production costs (in most cases making a business unviable), or will lead to a business leaving the protected salads industry

Abstraction licences

- Most businesses have an abstraction licence (usually for spray irrigation even though drip applied)
- There is concern about the proposed changes to licencing because cucumber growers need access to water continuously to maintain their crops and business

Water sources and quality issues

- Most business use borehole supplied ground water; a few use a public water supply, and some collect rain water to supplement borehole (ground water) supplies

- Rain water collection from the area of production (glasshouse roof) is not sufficient to fully supply the water needs
- Need clean water to avoid plant diseases; river water is usually not suitable for this reason – potential presence of either fungal and or viral pathogens

Storage

- Most growers are established businesses on sites with little or no spare land, so space for water storage is usually not available, except by pulling down glasshouses to make space
- Some newer facilities have storage (reservoir) as a requirement of local planning

New technology

- Recirculation of water would slightly decrease water use but not remove the need for abstraction as the majority of water is lost from the crop as transpiration; some growers already recirculate – but few on cucumbers
- Recirculation requires the used water to be "cleaned" before re-use. From the point of view of water volume use re-circulation would have little impact on overall volumes used

Application methods

- 100% Drip irrigation into a soil-less production system under heated glass. All application is by computerised weather controlled equipment

Knowledge transfer

- There is a need for information on recirculation and re-use of water

Horticultural Trades Association (HTA)

https://hta.org.uk/

Represented by John Adlam.

Key points

Industry trends

- Recession reduced production, but it is now expanding again, so water demand is increasing

- Growers are not making a lot of money, but are maximising use of area – e.g. adding polytunnels where there were outdoor beds, increasing production per unit area
- 92% of production is held by 8% of growers
- Defra surveys have a 10 ha threshold, so many growers excluded from surveys and Defra statistics

Economic importance of irrigation

- Water is cheap, leaks not taken seriously, but price will go up
- When using water from public water supply (mains), recycling pays back within 12 months
- Recycling of water allows a business to expand by making water go further; usually the licenced volume cannot be increased, so efficiency must be improved

Abstraction licences

- There is concern that Defra will base future needs on past needs, which is not appropriate
- There is no advantage in water trading for ground water users

Water sources and quality issues

- Phytophthora problems, chlorination is used for river water and this also avoids algae in pipes
- Water recirculation is usually done alongside rain water collection
- Plant protection issues are over-rated (e.g. herbicides in water is an overstated problem)
- 50% of small growers use public water supply (mains) only, representing only 10% of the production area, but many livelihoods

Abstraction restrictions

- Where river (surface) water is used the business must also have reservoir to maintain supply every day, even when there are restrictions
- The Spray Irrigation (Definition) Order 1992 ensures that irrigation of container-grown products and protected production are not subject to drought orders; there is concern to ensure that this continues

- A temporary user ban (TUB), also known as a hosepipe ban stops spray irrigation from public water supply (mains)

Storage

- Where river (surface) water is used the business must also have reservoir to maintain supply every day

Application methods

- Ebb and flow
- Capillary matting
- Sand beds
- Spray
- Trickle/drip

New technology

- All growers schedule irrigation – the cost of getting irrigation wrong is too great not to schedule
- Crop monitoring techniques are used by all growers, usually by probes measuring soil moisture throughout the profile
- Drones are of interest, but when dry patches are detectable it is too late – the damage is done; drones may be useful to pre scan fields to enable any variations in soil to be factored into irrigation scheduling
- Sensors used include humidity sensors, soil water sensors, turgor pressure sensors, multi sensors (e.g. humidity, light, soil water); sensors are used with software for glasshouse control or irrigation scheduling

Knowledge transfer needs

- Workshops on recycling – many don't do this well, and many are interested
- How to fill in a Defra grant application for reservoir construction
- Repair and maintenance workshops – filters, valves, etc., sprinklers…
- Energy use is complicated by many production systems in the same holding, with non-uniform crop layout; advice is needed on (for example) use of variable speed pumps that gear performance to irrigation need, using pressure sensors, variable speed controllers, and sensing of river water level to optimise abstraction

Tomato Growers Association

http://www.britishtomatoes.co.uk/

Represented by Dr Philip Morley, also of APS Salads

Key points

Industry trends

- All crops are drip irrigated and water is needed continuously during daylight hours to allow production
- TGA members cover 190 ha of production, 90% of growers
- Production is dispersed, with much of the production along the south coast, Isle of Wight, South East England, Thanet, and eastern England.
- 20% of tomatoes consumed in the UK are grown in the UK
- There is room for expansion of production
- Many growers have a CHP facility on site with electricity going to grid, heat and CO_2 to glasshouses
- Production is static at present, but retailers are showing greater interest in UK tomatoes

Economic importance of irrigation

- Without irrigation continuously available to be applied during daylight hours, production is not possible

Abstraction licences

- Many growers have historical exemption, and about 50% are unlicensed
- The reform is expected to have an impact on TGA members, who are being encouraged to keep records of water use to provide evidence of need
- Trading water is an aspect of the prosed changes that is of concern to tomato growers
- Growers perceive a danger from having universal rules that are not tailored to the needs of protected horticulture

Water sources and quality issues

- Mainly groundwater (borehole)

- On some nurseries rainwater is harvested from glasshouses and stored in reservoirs, to supplement abstracted water
- Very few growers use mains water
- Surface abstraction is rare, possibly not occurring at all
- Water cleaning – chemical, or UV. Sand filters are too slow

Abstraction restrictions

- This does not occur because abstraction is from ground water

Storage

- Reservoirs are used, with rainwater harvesting
- Physical space is a challenge for reservoir installation, and cost is high

Application methods

- Plants are mainly grown in Rockwool slabs, with precise irrigation by drip application
- Re-circulation of water occurs on some nurseries, and is being investigated on some others
- Drip
- On some sites roof sprays are used on unusually hot days to cool the air

New technology

- Recirculation is the biggest innovation and opportunity for improved efficiency, saving water and nutrients

Knowledge transfer needs

- Information on recirculation of water: how to install, and/or optimise
- Regular updates of progress with water abstraction management reform

UK Irrigation Association (UKIA)

http://www.ukia.org/

Represented by Melvin Kay, Executive Secretary

Key points

The UKIA

- Melvin is able to represent views on behalf of a broad membership, of approximately 60% farmers and growers, and the remainder made up of government (and agency) representatives, consultants, academics, industry stakeholders etc.
- UKIA is non-political and independent

Industry trends

- There is a trend for slight increases in water use, partially offset by improved irrigation practices that decrease water usage
- Expert opinion is that water use for irrigation will rise, driven by world events and demand for food

Economic importance of irrigation

- There is a need for realignment of production because of the impacts of water use where food is produced; this is a policy issue
- The cost of a drought is not recognised
- Irrigated crops are more important to the rural economy, and the national economy, than rain-fed crops
- Irrigated crops support jobs in agriculture and horticulture, and in the food industry
- Jobs in the value chain, supported by irrigated production, are often overlooked

Abstraction licences

- There is concern in the farming industry that the reform of abstraction will lead to less water availability rather than more; and that licences of right will be capped
- Example: in the Ely Ouse catchment abstractors pump groundwater; licences are up for renewal, stream flows are considered to be too low, and a cut in abstraction is feared by farmers/growers
- The environmental needs for water (minimum river flows etc.) are unknown, but estimates of this are used to help decide water availability for irrigation

Abstraction restrictions

- Those affected are mainly surface water users
- Nursery growers are highly sensitive to restrictions

Storage

- Currently available grant funding applications must show a 5% saving in water use, but this is a problem for UK applicants because the use of water shows high annual variation because it is supplementary to rainfall, so there is no sensible baseline
- A move from summer abstraction to winter abstraction should be encouraged without the need to show a 5% saving in water use

Application methods and new technology

- Application method has only a small effect on water demand for irrigation
- For farmers, fuel and energy costs are drivers for improvement, ahead of water quantity
- Water application costs, typically, £100 per 25 mm per ha and 60% of this cost is for energy
- Trickle irrigation is technically more difficult to manage than use of sprinklers
- Trickle cannot reduce crop water use, only reduce water which would be otherwise wasted.
- Potatoes – problem with scab in crops irrigated using trickle systems
- Trickle application is not restricted by availability of kit (use of rain guns is often restricted by the availability of equipment to cover the production area), so trickle systems may use more water because water supply to the plant can be optimal rather than suboptimal
- With a trickle system, soil moisture deficits can be kept at a lower level (wetter soil on average), leading to more loss of rain water, and less benefit from rain
- Aerial photography is useful to understand field variation

Knowledge transfer

- A centralised bank of knowledge is needed to make it easier for farmers/growers to find the information they need

Fresh Potato Suppliers Association

http://www.fpsa.org.uk/ (under construction)

Represented by Simon Taylor of the Fresh Potato Suppliers Association, representing fresh potato packing companies, and growers that supply these companies. Simon works for IPL, a fresh produce supply company owned by ASDA. Simon is also on the AHDB Steering Group for this project.

Key points

Industry trends

- There is a slight trend for a decrease in production, with some evidence that this trend is smaller in recent years (smaller decrease)
- There is room for growth in production
- The number of growers has greatly decreased in recent years, and size of farms has increased
- Western production (Herefordshire and west midlands) is declining and this area is less dependent on water than East Anglia
- There is a trend towards more irrigation, partly driven by quality (scab control)
- Approximately 80% of growers irrigate

Economic importance of irrigation

- The economic importance depends on soil type
- Irrigation is needed for yield and quality, and on light soils production wold not be economically viable without irrigation

Abstraction licences

- Growers are waiting to see what the changes will be

Water sources and quality issues

- Water sources are very variable and include surface water and ground water
- Water is taken directly from dykes in the fens
- Potatoes are classed as low risk from poor water quality as they are washed and cooked before consumption

Abstraction restrictions

- Restrictions occur and depend on the area

Storage

- Use of storage is very variable depending on area

Application methods

- There is a slight move from away from use of rain guns to use of booms
- Trickle is not widely used and application does not work well on light soil (sand land) or sloping fields, but on other soils there is no problem getting water to tuber zone for scab control
- Trickle gives future options for fertigation and crop protection
- Trickle can increase water efficiency (decrease losses), but can also increase water losses because soil moisture deficits tend to be kept at a lower level (wetter soils, so greater potential loss after heavy rain)
- Trickle can improve efficiency through being able to switch back on sooner after a rain event and apply small amounts

New technology

- Some growers are experimenting with drones
- Most growers use a scheduling service
- There is increasing potential to use Apps to control irrigation equipment from the office/home

Knowledge transfer needs

- AHDB Strategic Potato (SPot) Farms are being rolled out, and are well attended, and useful to growers
- Growers need help with use of social media

