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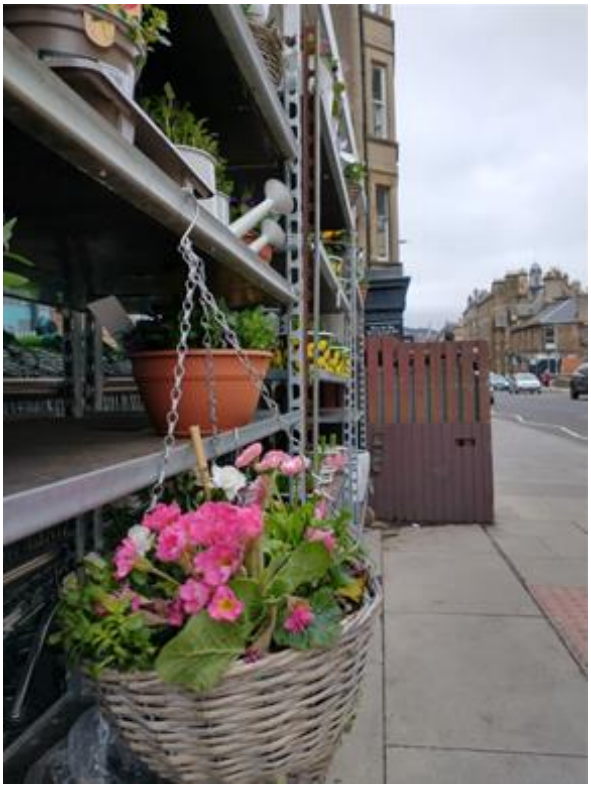
Assessment of large-scale plant biosecurity risks to Scotland from non-specialist and online horticultural sales

PHC2019/04: Project Final Report



Forest Research

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Content

1 Executive Summary

This research report focuses on an initial exploration of tree and plant biosecurity risks to Scotland arising from large-scale movement of plants and trees via non-specialist and online plant retailers. We define non-specialist plant retailers as those for which plants and trees are not their primary product type for sale, and include supermarkets, DIY stores and lifestyle stores. Online retailers are any type of specialist (e.g. garden centre, nursery) or non-specialist retailer which sells plants through a website. By better understanding the characteristics of these retailer types, the plant health behaviours they undertake, and the challenges they face, we hope to offer potential avenues for greater engagement and collaboration on biosecurity with this important but understudied and hard to reach sector.

There was a lack of existing biosecurity behavioural knowledge data on these business types, partially due to their hard-to-reach characteristics, and there were significant difficulties with recruiting retailers made worse by COVID 19 related lockdown and EU exit. However, we conducted in-depth interviews with four large non-specialist retail chains (also known as multiples) and a sector survey of 100 plant retailers who sell online. All interviewees and survey respondents were from businesses based or operating in Scotland. Data were collected on the themes of plant product flows and types, pest and disease knowledge and awareness, plant procurement, identifying and dealing with plant health issues within a business' supply chain, and the role of industry assurance or certification schemes. Survey results were analysed quantitatively to reveal trends in biosecurity behaviours associated with retailer type, location of business (based within or out with Scotland), and proportion of sales made online. Together, the interview and survey data form the basis of our findings for non-specialist and online retailers, respectively.

Overall conclusions *and recommendations* derived from the study:

- Both knowledge of and concern for specific pests and diseases appears to be related to the presence of the pest or disease in the region, rather than the potential threat posed. *Further engagement with retailers is necessary as well as providing focussed plant health information through trusted sources and through multiple channels, particularly focussing on those pests and diseases which are of a high risk to the plant trade such as Xylella fastidiosa.*

- Online retailers have the potential to maintain minimal contact with both plant and customer, which could influence their biosecurity behaviours. However, biosecurity behaviours are not consistently predictable through the proportion of sales made online alone. The progress made by this study has further highlighted the knowledge gap in this area and a subsequent need for *research into understanding which characteristics of online plant retailers predict good or poor biosecurity behaviours.*

- The concepts of pest- or disease-free and high quality are distinct but entangled. Whilst further research would help understand the differences, *using the concept of quality (rather than biosecurity or plant health) could help drive better biosecure buy-in and behaviour change amongst retailers and customers.*

- Within a number of large businesses, knowledge and responsibility for biosecurity is potentially distributed between several roles, and plant health processes may well be unique to each business. It can therefore be difficult to pin down where risk dialogue should be targeted. We have found that non-specialist retailers can be disengaged from research and discussions on

biosecurity. However, non-specialist multiples retailers could become biosecurity influencers both with their suppliers and customers. *Scottish government should work with Scottish Plant Health Centre and trade bodies to lead a series of focussed events and campaigns on plant health, including the potential for multiples to become plant health influencers.*

- Biosecurity is often a low priority for many businesses, both as a preferred characteristic in a supplier and when assessing risks to their business. The uncertainty of Covid-19 and EU exit impacts are of greater concern to retailers. There is potential to *consider further research into the impact on biosecurity behaviours of economic, legislation, or societal shocks, with the aim of increasing resilience of biosecurity behaviours in Scotland.*

- Over 50% of retailers were planning on taking the Plant Healthy self-assessment in the next two years, and over 70% were either participating or willing to participate in the scheme. The major barrier was perceived as low uptake by other businesses. Non-specialist multiples rely on their suppliers to maintain high standards and work closely with them to achieve it but without independent auditing. *Further promotion to increase uptake of businesses joining the Plant Healthy Certification Scheme (including large retailers), would raise awareness of biosecurity issues and lead to an industry-led biosecurity standard. More work is needed however to address perceived challenges and concerns amongst all business types and sizes.*

2 Introduction

Retail horticulture in Scotland alone has been estimated to be worth £300 million to the economy (Scottish Horticulture Panel 2018). Plant pests and diseases are a threat not only to horticulture and to wider agriculture, but also to Scotland's natural habitats. Large-scale movement of live plants for trade purposes has been the cause of the introduction and spread of pests and diseases to the UK, such as ash dieback and *Phytophthora spp*.

Businesses throughout the horticultural industry supply chain are key allies in tackling the threats of plant pests and diseases in Scotland. Businesses located or operating in Scotland form a network through which live plants will move, carrying a risk of transportation of pests and pathogens to surrounding parks and gardens, agricultural systems, woodlands, forests, and the wider environment. The diversity of the plant material in trade and the multitude of suppliers and recipients based both in Scotland, the wider UK and internationally, creates a major challenge for managing biosecurity beyond the border. The processes and decision-making within these businesses can be points of both weakness and strength in developing greater biosecurity to protect Scotland's plants.

Previous research in the UK has focussed on mainstream plant retailers such as garden centres and nurseries. However, there is increasing awareness that plants are sold at a large scale through both non-specialist 'multiples' retailers such as supermarkets, DIY stores and lifestyle stores, and through online stores of specialist and non-specialist retailers alike (Oxford Economics 2018). These businesses are typically 'hard-to-reach' as they potentially fall outwith established research networks built around collaboration with the specialist horticultural trade (for example the Horticultural Trade Association, HTA). Thus, there is a current knowledge gap about the plant health attitudes and behaviours of these businesses and on the scale of plant movements as a whole, which severely hampers evidence-based decision making both for government and industry. The key knowledge gaps surrounding non-specialist and online horticultural sales identified by the Scottish Plant Health Centre include:

- the flows of plants into and out of Scotland
- the degree to which biosecurity is visible and important in key business operations and decisions (e.g. awareness)
- the importance of biosecurity in the procurement process
- the degree to which biosecurity procedures are in place
- the efficacy of any biosecurity implementation
- the main barriers to increasing biosecurity and decreasing plant health risks

This research project concentrated on identifying the attitudes and behaviours of these two (partially overlapping) types of stakeholder: non-specialist multiples retailers, and online retailers in order to:

1. Identify decision-makers, their knowledge, attitudes and behaviours relating to plant health
2. Assess opportunities for and barriers to better plant biosecurity
3. Assess the potential role of assurance schemes for plant health

Surveys and semi-structured interviews were conducted with these businesses to elicit information on pest and disease knowledge and awareness, plant procurement, identifying and dealing with plant health issues within a business' supply chain, and the role of industry assurance or certification schemes. Opportunities and barriers to developing better biosecurity behaviours in Scotland were identified and recommendations developed for tackling challenges associated with non-specialist and online plant retailers.

3 Methods

3.1 Stakeholder mapping

As a key first step a list of major supermarkets, DIY, lifestyle and online plant retailers was compiled from web searches. Sources of data were predominantly market reports which ranked retailers by turnover. Individual businesses from the list were then checked to confirm they sold live plants for planting, and those which did not were excluded. Additional online retailers were added to the list if mentioned as potential participants by members of the research team or advisory group. This list of stakeholders (stakeholder map) was then used as the basis for recruitment for survey and interview. Where possible, an individual from each business was emailed. Individuals were identified either via known contacts or from the business's website. Where individuals could not be identified, initial contact emails were sent to business addresses.

3.2 Existing evidence review

Following on from the stakeholder mapping exercise, the research process included a review of existing datasets followed by interviews and a survey. The present study focusses on the intersection of stakeholder types of interest (non-specialist and online plant retailers), and the region of interest (Scotland). A rapid data review was undertaken to provide context and background to this intersection by collecting data on non-specialist and online retailers across the UK, and of all types of plant retailers in Scotland. The review additionally collected evidence of the views of UK plant retailers on plant health assurance schemes. The aim was to identify gaps in existing information and to avoid duplication of research effort. Data and reports for relevant research projects were identified in collaboration with the research team and advisory group. Websites of large non-specialist retailers identified in the stakeholder mapping (Section 3.1) were searched using terms "sustainability", "biosecurity", "certification" and "plant health" to identify publicly facing policies regarding biosecurity. Data sources identified were peer-reviewed and grey literature, retailer websites, trade organisation analyses, sector news media, and datasets from ongoing (as yet unpublished) plant health projects, with key results presented in Section 4.

3.3 Recruitment, data collection and analysis

3.3.1 Survey of online plant retailers

3.3.1.1 Recruitment

A sample (n=100) of online plant retailers were surveyed. In order to be eligible for the study sample, participants were required to 1) sell seeds, plants or trees online and 2) be based or have customers in Scotland. In addition to the initial production of the stakeholder map of online retailers (Section 3.1) efforts were made to recruit through a variety of channels: web searches and direct email; distribution of research advert through personal networks of the researchers and advisory group; emailing of research advert to mailing lists of trade organisations with large memberships (e.g. HTA, British Retail Consortium); promotion via various Forest Research group and scientist social media accounts (see Section 3.3.3 for recruitment challenges). The methods used and novel circumstances in the sector resulted in a very low response rate, even with two members of staff spending several weeks sending emails to prospective participants and using existing and new network opportunities to share the survey link. With limited staff resources on this project following the massive effort to

recruit via the sources and platforms above, a decision was made to contract a professional market research company to contact businesses and conduct the survey.

The market research contractor used the list produced by Forest Research (see section 3.2) and expanded for UK based companies. The following eligibility criteria were applied:

- Retail businesses which sell live plants for planting (i.e. not houseplants, but those for a garden, window-box, outdoor area, etc.) online
  AND
- Retail businesses with customers based in Scotland
  AND/OR
- Retail businesses based in Scotland

Two businesses which met the eligibility criteria but were based outside of mainland UK (one in Jersey and one in the Netherlands) were included in the sample. Businesses were initially contacted by phone to confirm eligibility, and to identify the correct individual at the business to complete the survey. Eligible participants who then agreed to take part in the survey were then given two options for completing the survey: 62 participants chose to answer questions over the phone; 38 participants chose to complete an online version of the survey. Data were collected from 22nd October to 30th November 2020.

3.3.1.2 Survey design

The survey consisted of 36 questions split into four key themes: business and trade background; plant product flows and types; risks to business and stock; and attitudes towards accreditation schemes. All participants gave their consent prior to completing the survey. For the full survey framework, see Supplementary Material.

3.3.1.3 Data management and analysis

Data were held by the market research company until the target of 100 responses was reached, when it was transferred to a Forest Research secure server. Data management, descriptive and test statistics, and plotting were carried out in R version 4.0.2 (R Core Team 2020). For statistical comparisons, Wicoxon rank-sum test (Figures 2, 3, 5, and 17) and linear regression (Figure 10) were used. Statistical methods were checked by Forest Research statisticians.

3.3.2 Semi-structured interviews with non-specialist multiple retailers

3.3.2.1 Recruitment

In order to reach individuals in identified businesses who would be willing and able to be interviewed for the study, multiple channels were utilised (see Section 3.3.3 for recruitment challenges). We used a contact hierarchy method, whereby we started exploring availability of recruitment channels using the following list:

- Personal networks of the researchers and advisory group
- Existing retailer contacts from previous Scottish Government research
- Where possible, a snowball sampling method was used, asking those interviewed to recommend or connect researchers with other potential participants.
- Membership organisation contacts (HTA UK-wide, HTA Scotland-focussed, BRC)
- Identification of individuals working as plant buyers at specific businesses (via web search)
- Identification of individuals working in corporate social responsibility at specific businesses (via web search)
- Identification of individuals working in sustainability at specific businesses (via web search)

- Identification of groceries Code of Compliance Officers for major UK supermarkets (via gov.uk)
- Direct contact with corporate social responsibility mailboxes and Twitter accounts of specific businesses

SASA made a concerted effort to assist in recruitment of multiple and non-specialist retailers, by personally contacting their links from major supermarket retailers and requesting their permission for researchers to contact them.

A total of 26 individuals, across 15 major businesses were contacted directly for potential recruitment, resulting in four semi-structured interviews. The most common response from businesses and individuals contacted was no reply. Individuals were contacted a second time within two months of the first email, if there was no reply. The small number of participants who replied but declined to take part, gave the reason that they did not feel qualified to answer the questions on the topics listed (e.g. they were operating in a different department). The participants interviewed were either currently or recently associated with supermarket or DIY multiples.

Interviews were conducted between the 5th November 2020 and the 1st February 2021.

3.3.2.2 Interview design

The interview schedule consisted of 34 questions split into four topics: business and trade background; plant product flows and types; risks to business and stock; and accreditation schemes. All participants gave their consent to being interviewed. For the full interview framework, see Supplementary Material.

3.3.2.3 Data management and analysis

Interviews were conducted over MS Teams, recorded verbatim and transcribed by a professional transcription company. Sound recording and transcripts are stored on a secure server at Forest Research in line with Forestry Commission Data Protection Policy. Analysis of transcripts was carried out using NVivo12 (QSR International).

3.3.3 Recruitment challenges

Recruiting individuals from qualifying businesses was a major challenge, with low numbers of responses from both the first wave of recruitment for online retailers and following extensive efforts to reach non-specialist retailers. The challenges of seeking to collect data from such a hard-to-reach sector were as follows:

- The information sought for one organisation was likely held by multiple individuals in more than one job role, and may be different between organisations of a similar type
- Identifying the correct roles, identities of individuals, and contact information was challenging without direct introduction
- Contacting without introduction required cold calling via personal or team email, phone, or through social media. Such an approach was a low yielding method – email may not even make it past IT security systems or junk mail filters
- Direct introductions were not always successful, due to how busy individuals were. Knowledge of responsibility division could help – questions split more accurately by role/responsibility would result in shorter interviews

Additionally, recruitment and responses were affected by Covid-19 lockdown. The live plant industry advice received early in the first period of lockdown in the UK was not to seek contact due to massive uncertainty and potentially catastrophic impacts on the industry. This was later relaxed as industry gained some certainty, and recruitment efforts were stepped up. There remained uncertainty in the industry during the data collection period, due to the prospect of additional Covid-19 lockdowns and regarding the upcoming EU Exit.

4 Background & context

The following section summarises relevant social science evidence on the plant trade in Scotland and non-specialist and online plant retailers across the UK. It also includes evidence of the views of retailers towards potential biosecurity assurance schemes.

Along with much of UK retail, there are reports from both sector and mainstream media during the 2020 Covid-19 lockdown that indicate a large increase in online sales of plants and bulbs (Appleby 2020; Marsh 2020). The majority of data in the rapid review were collected before Covid-19 lockdown. It is not yet known if the unprecedented circumstances will change retailer and consumer behaviour in the long term.

4.1 Plant trade in Scotland

There are limited data describing the volume and characteristics of plant movements between Scotland from the rest of the UK. Four interviews were conducted with businesses based in Scotland for two plant health projects: the Phytothreats project (www.forestresearch.gov.uk/research/global-threats-from-phytophthora-spp/) which was completed in December 2019 and the BRIGIT Project (www.jic.ac.uk/brigit/ Pérez-sierra et al. 2019) which is due for completion in 2021. These data suggest that movement of plants between business into and out of Scotland from the rest of the UK is commonplace. For example, one Scotland based wholesaler describes suppliers and customers all over the UK (although the latter mostly in Scotland), for supply of lavender (BRIGIT 2021). Another tree grower based in Scotland sold more to southern England than the typical Scottish grower, as there is a greater desire for broad-leaf trees (their speciality) in England than in Scotland (Dunn and Marzano 2019). The same grower also buys in from across the UK, and sometimes from beyond the UK. One further Scotland-based wholesaler supplied customers across Scotland and the North of England (Dunn and Marzano 2019).

The additional costs associated with transporting plants and trees to Scotland from England, may influence both who a supplier accepts as a business customer and who a business customer will select as a supplier. A landscape contractor based in Scotland indicated that in their experience tree providers in the south of England would try to avoid small orders to customers in Scotland because of the logistical costs associated with a large distance. The landscape contractor in question got most of their trees from suppliers within their own region of Scotland, although they acknowledged that the trees were probably originally from further afield (BRIGIT 2021).

Consumer choices can drive the volumes and characteristics of plants businesses will stock, but no data was identified which separated the behaviours of consumers based in Scotland from those elsewhere in the UK. One large consumer survey of plant buyer behaviour (n=1500, Dunn et al. 2019) included 7% from Scotland (2011 UK census data has Scotland as 8% of UK population), but response data have not been segmented regionally to show if Scottish consumers behave differently from the UK averages.

The output of the flower and nursery sector (flowers and bulb, hardy ornamental stock and bedding and pot plants) in Scotland for the five years 2014-2018 was £168.5m, accounting for 3% of the UK total (Scottish Plant Health Project, 2020). However, the lack of more detailed Scotland specific economic data was highlighted in an industry report (Scottish Horticulture

Panel 2018) which also included a strong call for collection and analysis of data on the economic value of horticulture, landscaping, garden tourism, and other sectors of the Scottish economy reliant on live plants. Such data would give a better baseline understanding of the horticultural sector in Scotland, allowing behavioural research to be better placed in context at a national scale.

4.2 Non-specialist & online sectors

There are currently limited data on the two stakeholder types of interest, non-specialist retailers, and online retailers. Without data on the scale and characteristics of either of these areas of the sector, it is difficult to assess their respective plant health impact.

Regarding the scale of online plant retail, industry research from 2018 showed approximately 10% of expenditure on garden plants was spent online (Oxford Economics 2018), with increases in line with growing online sales in other sectors. Online sales were estimated to account for 18% of all gardening products, including horticulture, garden buildings, chemical and equipment, in 2019, with sales forecast to increase to 32-33% by 2024 (AMA Research, via www.amaresearch.co.uk) An increase in online sales potentially impacts the trading pathways for plants, which become less bound by the requirement of customers to travel to a physical site. In contrast, alternative market data suggest consumers prefer in-person shopping for garden goods with one study showing 64% consumers in DIY & garden centres are likely to choose a different brand of physical store if their normal shop closes rather than try online or travel further to the same brand of store (GlobalData, 2019 via sector news media www.bheta.co.uk). Interviews conducted in 2019 for the BRIGIT Project prior to the Covid-19 lockdown, showed the mixed intentions of bricks and mortar retailers to branch into online sales. One nursery was using online growth to meet increased demand, and another deciding to avoid online altogether. The move to online sales can also cause disruption of existing trading pathways, with one garden centre indicating they had lost an important supplier when that supplier had switched to online sales only (BRIGIT 2021). A large consumer survey (n=1500, Dunn et al. 2019) conducted pre-Covid-19 lockdown showed domestic online retailers as 7th most popular (>20% respondent bought plants from this type of retailer) and international online retailers as 13th (<5%). The study also showed international online retailers and domestic online retailers were rated as the first and third most risky respectively, with respect to biosecurity of all retailer types. Home delivery of plants was ranked low on a list of characteristics desired by general consumers (Dunn et al. 2019), although delivery may have become more desirable due to the impacts of Covid-19 lockdown (Porter and Stocker 2020). Over 40% of consumers surveyed sought advice for plant buying from online sources, although whether this was from sites which also sell plants was not apparent (Dunn et al. 2019). In addition to the general public, a landscape contractor described regular use of online plant retailers, particularly to source specialist plants (BRIGIT 2021).

In terms of non-specialist retailers (supermarkets, DIY, and lifestyle stores), the Phytothreats consumer research showed that whilst garden centres are the most popular place to buy plants (~80% respondents buy plants there), DIY stores (>55%) and supermarkets (>45%) are the next two most popular (Dunn et al. 2019). Nevertheless, consumers saw non-specialist retailers (especially those without a publicly accessible physical store) as higher risk with respect to the health of plants purchased with DIY and supermarkets were ranked as fourth and fifth most risky with respect to biosecurity (Dunn et al. 2019). Despite this ranking, one nursery owner interviewed in 2019 for the BRIGIT Project was sure that customers buying

from a non-specialist retailer have little knowledge of biosecurity risks. Dunn et al. (2019) found there was no relationship between the type of retailer used and a customer's awareness of pests and disease threats. Non-specialist retailers are also used by landscape contractors. One landscape contractor described using large DIY multiples to purchase a plant they couldn't find conveniently elsewhere (BRIGIT 2021).

4.3 Plant health accreditation schemes

Plant health accreditation schemes could provide a minimum standard for biosecurity practices which businesses must achieve in order become certified. Encouraging voluntary certification has been an industry led strategy to increase standards in schemes such as the Ornamental Horticulture Assurance Scheme (OHAS; hta.org.uk/partnerships-groups/ohas) or the Plant Healthy Certification Scheme (PHCS; planthealthy.org.uk).

Dunn and Marzano (2019) conducted a survey of 100 nurseries and garden centres across the UK on a wide range of topics including accreditation. The majority of the businesses (92%) were independent, rather than part of a chain. Garden centre and nursery owners were shown to be strongly supportive of a hypothetical accreditation scheme, for reasons of safeguarding the wider landscape and ensuring a higher quality product for consumers (Dunn and Marzano 2019). Despite these perceived benefits, concerns were present (particularly among nurseries) regarding: the potential for costs to be incurred by growers and then consumers; interest from consumers in buying accredited products; and whether enough growers would seek to gain accredited status. Nurseries and garden centres were more unlikely than likely to join a hypothetical accreditation scheme, perhaps partially due to a lack of detail presented in such a hypothetical scheme. The stated concerns may be assuaged should new pest and disease risks appear, or if consumers held greater preference for such a scheme. Other factors impacting views of accreditation schemes were type of management practices required, how the scheme would be policed, and repercussions for failing to meet standards (Dunn and Marzano 2019).

Data available on accreditation from wholesalers and contractors interviewed for the BRIGIT project suggest a similar feeling to that from nurseries and garden centres. There was broad support in theory, but extra cost or bureaucracy, and lack of support from customers were concerns (BRIGIT 2021).

An online search of supermarket and DIY retailers for evidence of current participation in plant sourcing accreditation was conducted for this rapid review. Marks and Spencer, Lidl, and Sainsbury's stated they follow GlobalGAP and the British Ornamental Plant Producer's Certification Scheme (BOPP, which was renamed as Ornamental Horticulture Assurance Scheme (OHAS) in 2020). There was no mention of standards followed for Tesco, Aldi, Morrisons, or Asda, or for any of the DIY stores checked (B&Q, Wickes, Homebase, Wilko, B&M), although this does not mean that they do not use such accreditation standards.

5 Results

5.1 Survey of online retailers

This section describes the survey results from a sample of UK retailers which sold any live plants for planting online, from and/or into Scotland. The recruitment criteria allowed for specialist (e.g. garden centre, nursery) or non-specialist (e.g. supermarket), any business size or number of physical stores (including zero). In this section, the term 'plants' is used to mean seeds, and plants and trees for planting (i.e. not houseplants) unless otherwise stated.

5.1.1 Sample characteristics

Summary

- 100 surveys completed; 30% businesses based in Scotland
- 85 of 100 businesses were either a nursery, grower or garden centre
- Turnover attributed to plant sales ranged from £3.5k – £74.5M
- Online sales ranged from 10% - 100% of total turnover
- 60% of sales were from either hardy nursery stock or bedding plants / ornamentals

Approaches were made to a total of 191 businesses, resulting in 103 survey link emails being sent out. From these, 38 were completed online, 49 completed by follow-up phone interview, and 16 remained uncompleted despite repeated requests. A further 13 chose to be interviewed by phone immediately (i.e. without receiving the link). The total number of surveys completed was 100. Responses given for refusal to participate were: no reason (6 participants), we don't do surveys (3), no time (2), correct person is off sick (1). The remaining businesses who were contacted but did not complete the survey either said they would complete the survey or asked the recruitment company to call back at a later date, or both.

Participating retailers were mainly based in England (66%) and Scotland (30%), with all retailers selling to customers in Scotland (as per the inclusion criteria), as well as throughout Great Britain (Table 1). This is not a representative distribution across the UK, as businesses in Scotland were specifically targeted. The vast majority of participants in Scotland were nurseries, garden centres, and growers, similar to other locations (Figure 1).

Table 1 - Location of businesses surveyed and their customers

Location	**Location of respondent's business (%)**	**Proportion of businesses which sell to this location (%)**
England	66	100
Scotland	30	100
Wales	3	100
Northern Ireland	0	98
Other	1 Jersey	4 Mainland Europe 3 US 1 Japan 4 Anywhere / worldwide

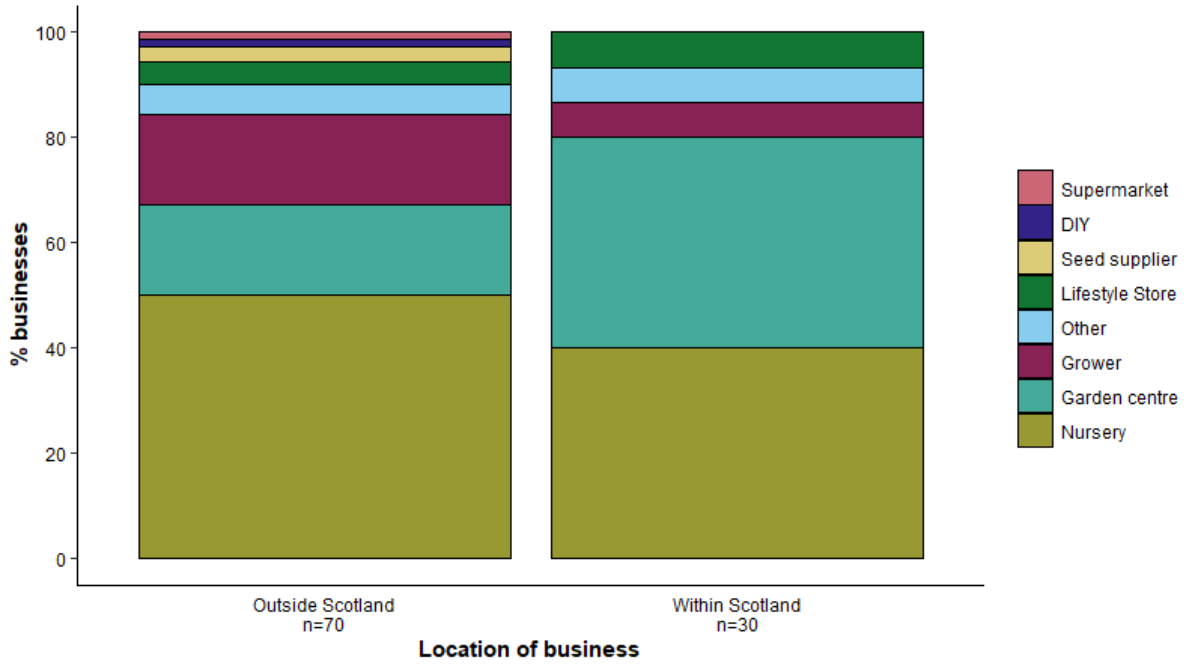

Figure 1 - Type of business by location. Descriptions given for 'Other' business type category were all online retailer/online nursery/ online plant shop/online garden centre

Of the participating retailers, the number of plants sold annually and the turnover generated from plant sales did not vary significantly between businesses based in Scotland and the other locations (Figure 2 and Figure 3, respectively). The turnover of businesses in the sample had a large range, from £10k to £74.5M annually, with the proportion of turnover from plants between 10% and 98% (Table 2). The total turnover and turnover attributable to plants of businesses sampled were £966M and £304M, respectively. Businesses with a larger turnover were overrepresented in the survey sample, when compared to industry turnover banding data (Table 3).

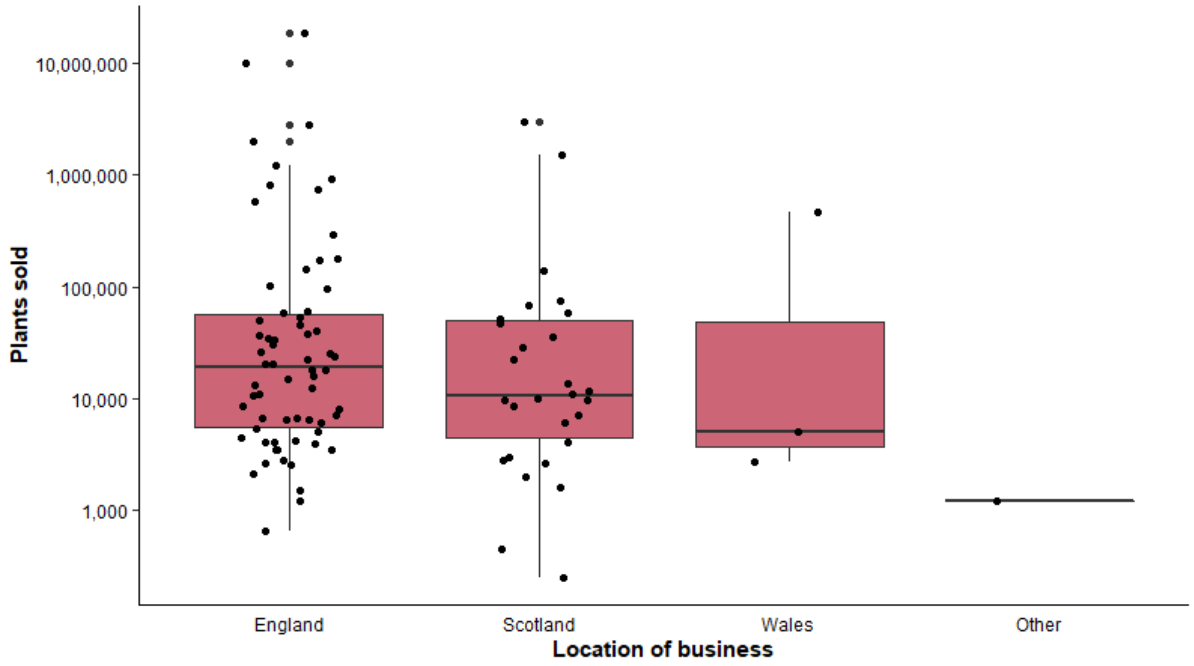

Figure 2 - Number of plants sold annually by businesses in each location. Y-axis is log10 scale. Boxes show median and upper and lower quartiles. Whiskers terminate at 1.5 x interquartile range beyond the quartile. n=96. No significant difference in volumes sold (P=0.36)

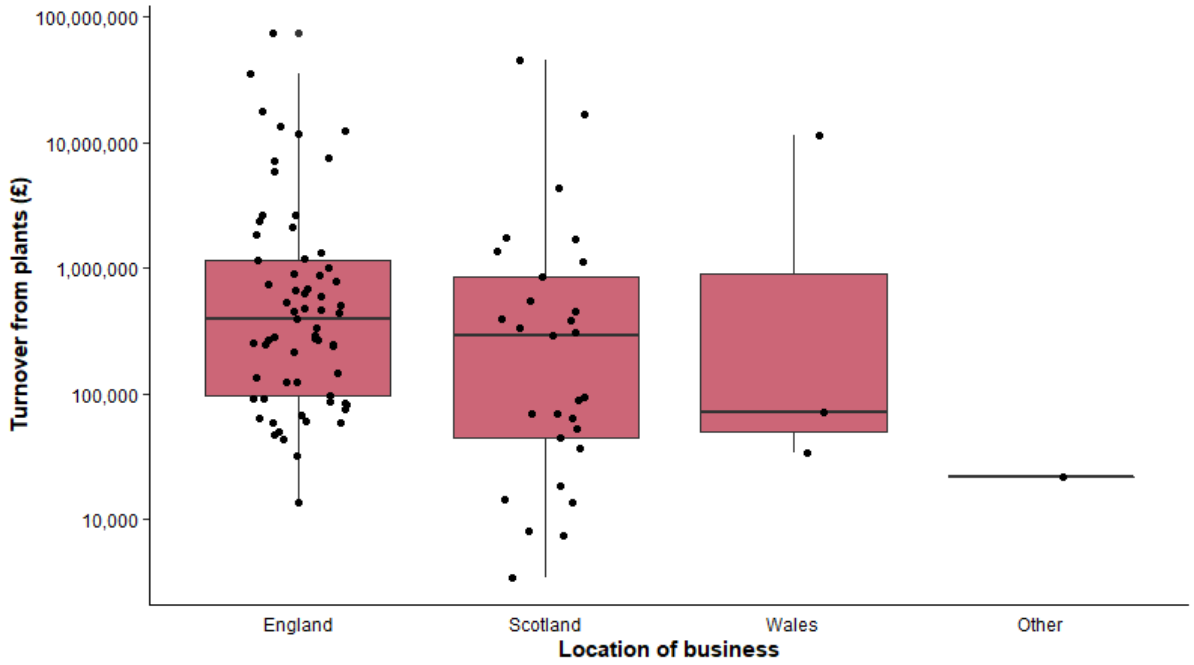

Figure 3 - Turnover attributed to plants. n=96. Turnover from plants is calculated by multiplying total turnover by proportion of turnover attributable to sales of plants. No significant difference in turnover between businesses located in England and Scotland (P=0.08)

Table 2 - Turnover and sales figures for plants from survey sample

Sales figure	Mean ± SD	Median	Min	Max
Annual turnover (£)	9.86M ± 53.12M	413k	10k	497M
Proportion of turnover from plant sales (%)	74.9 ± 19.5	80	10	98
Turnover from plant sales (£)	3.10M ± 9.82M	300k	3.5k	74.5M

Table 3 - Turnover of survey sample compared to industry data

	Turnover Size Band (£000's)									
	0-49	**50-99**	**100-249**	**250-499**	**500-999**	**1,000-1,999**	**2,000-4,999**	**5,000-9,999**	**10,000-49,999**	**50,000+**
Industry data[1] n=11,150	12.9%	15.4%	37.7%	14.8%	8.9%	4.7%	3.4%	1.3%	0.7%	0.2%
Study sample n=98[2]	10.2%	15.0%	13.3%	17.3%	15.3%	7.1%	7.1%	3.1%	7.1%	4.1%

[1]sum data from five categories which encompass similar UK businesses to those surveyed: Growing of other non-perennial crops (0119); Plant propagation (0130); Silviculture and other forestry activities (0210); Wholesale of flowers and plants (4622); Retail sale of flowers; plants; seeds; fertilisers; pet animals and pet food in specialised stores (4776), UK Business Registry. [2]Two businesses declined to supply turnover figure.

Participating retailers mostly sold hardy nursery stock and bedding/ornamental plants, with over 60% of sales being accounted for by these two categories, in both Scotland and elsewhere (Figure 4). Retailers recruited from Scotland and elsewhere attributed from 10% to 100% of their total sales as being from online sales. Sales from physical sites (i.e. bricks and mortar stores or shops) ranged from 0% to 90% of total sales. Of the three most common business types appearing in the survey, growers and nurseries both sold a significantly higher proportion of their sales online than did garden centres (Figure 5). The lowest and highest online proportion of sales was from individuals who chose lifestyle store or other, as their business type. When asked to specify for 'other', individuals responded as online retailer, online nursery, online plant shop, or online garden centre. There was no difference in the proportion of sales made online between businesses based in Scotland or England in our sample.

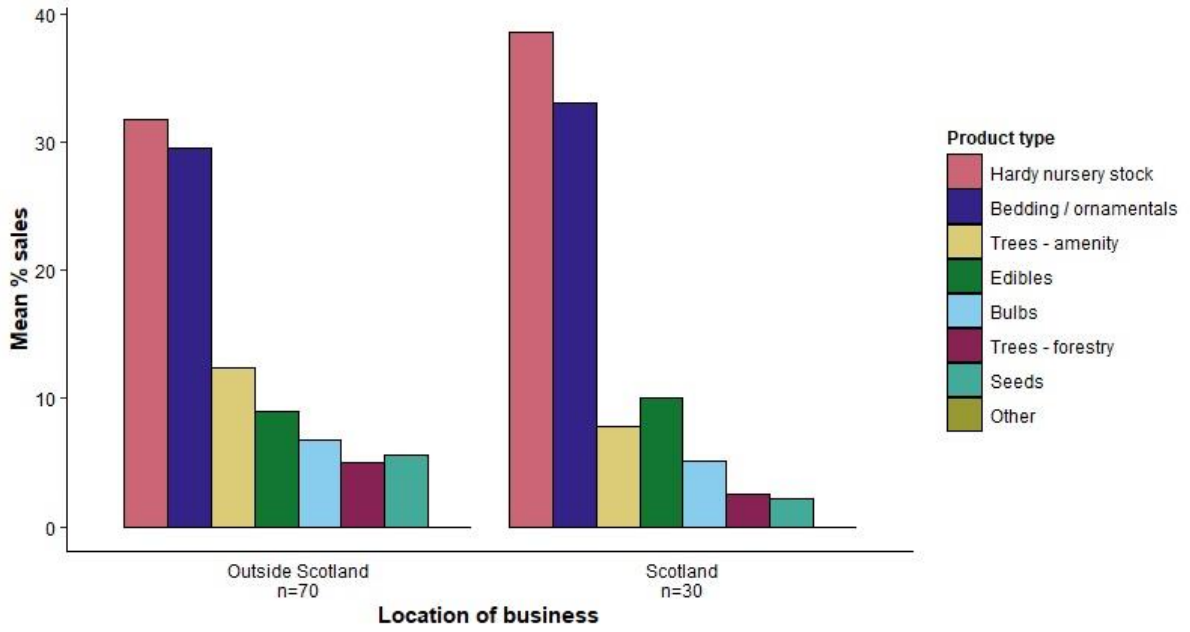

Figure 4 - Mean percentage sales based on product type.

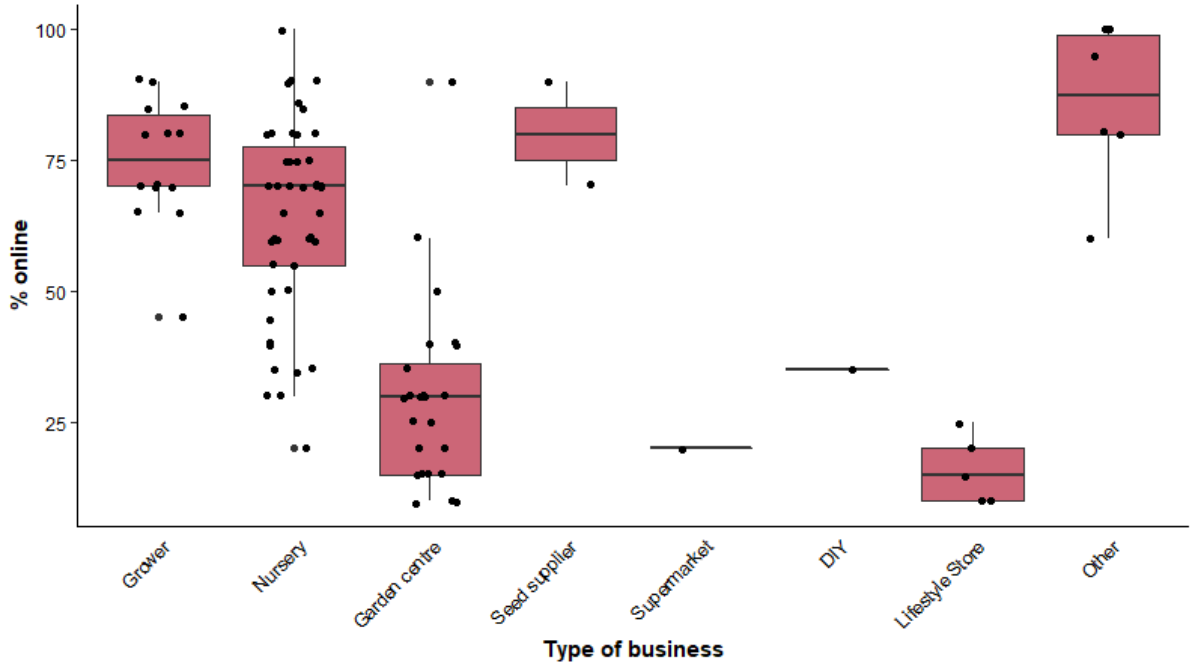

Figure 5 - Proportion of sales made online, by business type. n=100. Proportion of online sales of growers and nurseries are not significantly different (P=0.06), but garden centres have a significantly lower proportion of online sales than both growers (P<0.001) or nurseries (P<0.001).

5.1.2 Customers and products

Summary

- Retailers in Scotland sold more to England (40% of sales) than to Scotland (34%)
- All retailers had general public as customers; >50% had landscapers; >25% had local authorities
- Roses, geraniums, and bamboo were the top three best-selling plants
- Drivers for species offered for sale were an equal balance of customer demand and business drivers

Retailers based in Scotland make an average of 34% of their sales to customers based in Scotland, whereas retailers outside of Scotland only make an average of 12% of their sales in Scotland. Retailers based in Scotland had greater average sales to customers based in England (46%) than to customers based in Scotland (34%) (Figure 6). All retailers sampled sold plants to the general public, and over half sold to landscapers. There was little difference in the type of customer between retailers based in Scotland and those outside of Scotland (Figure 7).

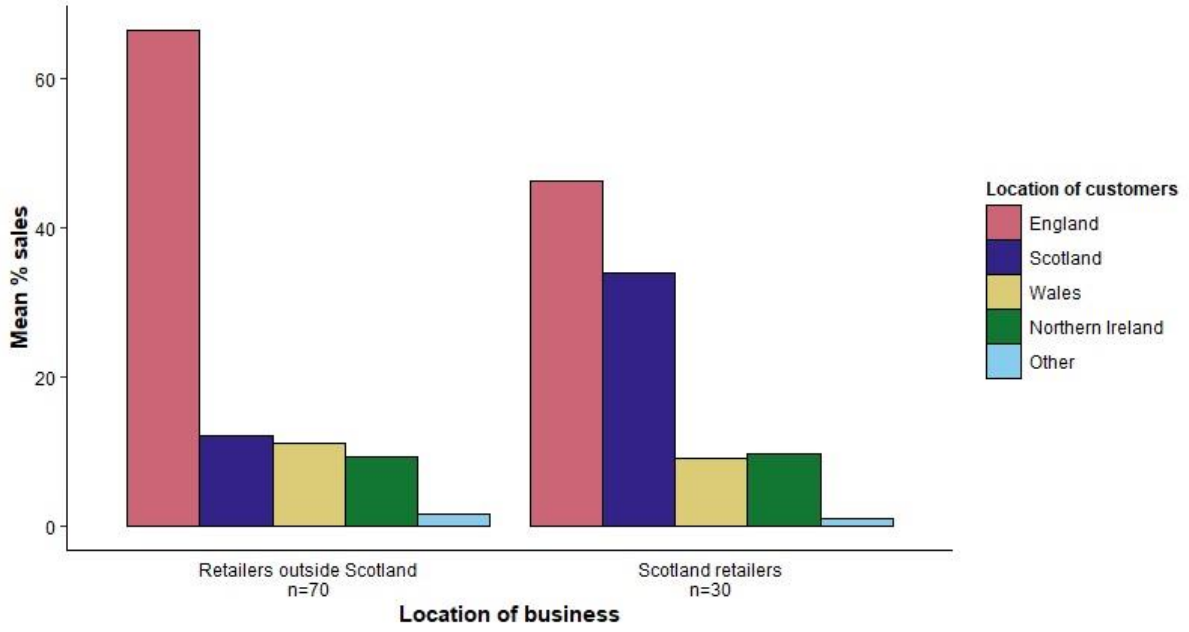

Figure 6 - Mean percentage turnover derived from customers in different locations

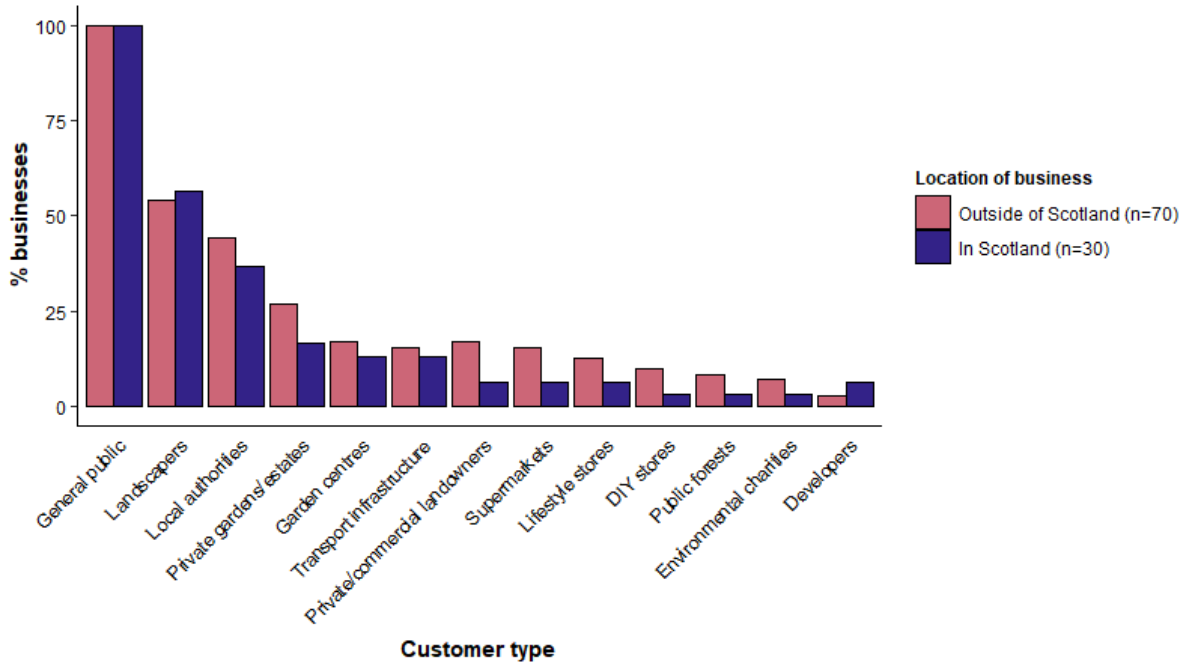

Figure 7 - Proportion of businesses selling to each customer type.

Retailers were asked to name their top three best-selling species of plants, by value. A total of 103 different species of plants were listed, with those most frequently listed by retailers being roses, geraniums and bamboo (Figure 8). When asked to name their top three best-selling species to customers based in Scotland specifically, almost two thirds (64%) of retailers indicated no difference between sales to customers based in Scotland and elsewhere. However, 24% of retailers surveyed didn't know the top three best-sellers to their Scotland based customers.

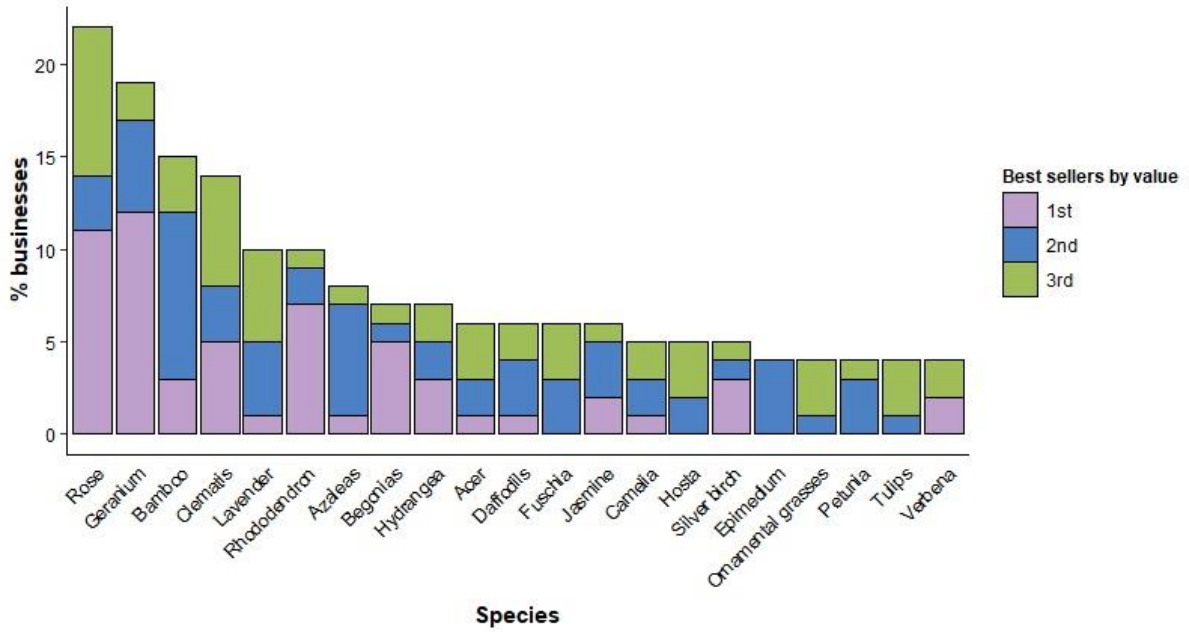

Figure 8 - Top three best-selling plants or trees. All species which were named by ≥4% of businesses are shown on the plot. n=100

The majority of retailers surveyed indicated that the decisions on what stock to carry (i.e. which plants to offer) were equally driven by the business themselves, and from customer feedback (Figure 9). On a Likert scale from 1 (entirely business driven stock decisions) to 7 (entirely customer driven stock decisions) no business selected category 1 and only one business selected category 2. There was no difference in the level of business/ customer driven stock decisions between businesses located in Scotland and those located elsewhere. There was no correlation between the level of business/ customer driven stock decisions and turnover (Figure 10).

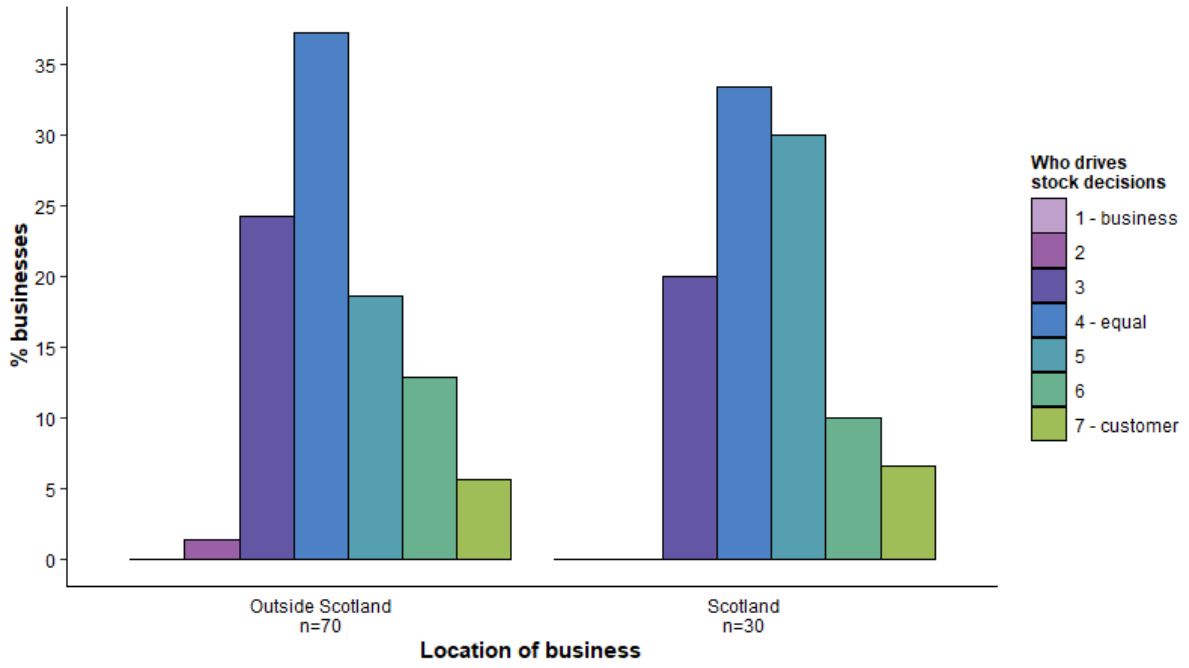

Figure 9 - Relative drivers of stocking decisions. Likert scale 1-7 (1 = stocking decisions are driven entirely by business, 3 = stocking decisions are driven equally by business and customer demand, 7 = stocking decisions are driven entirely by customer demand)

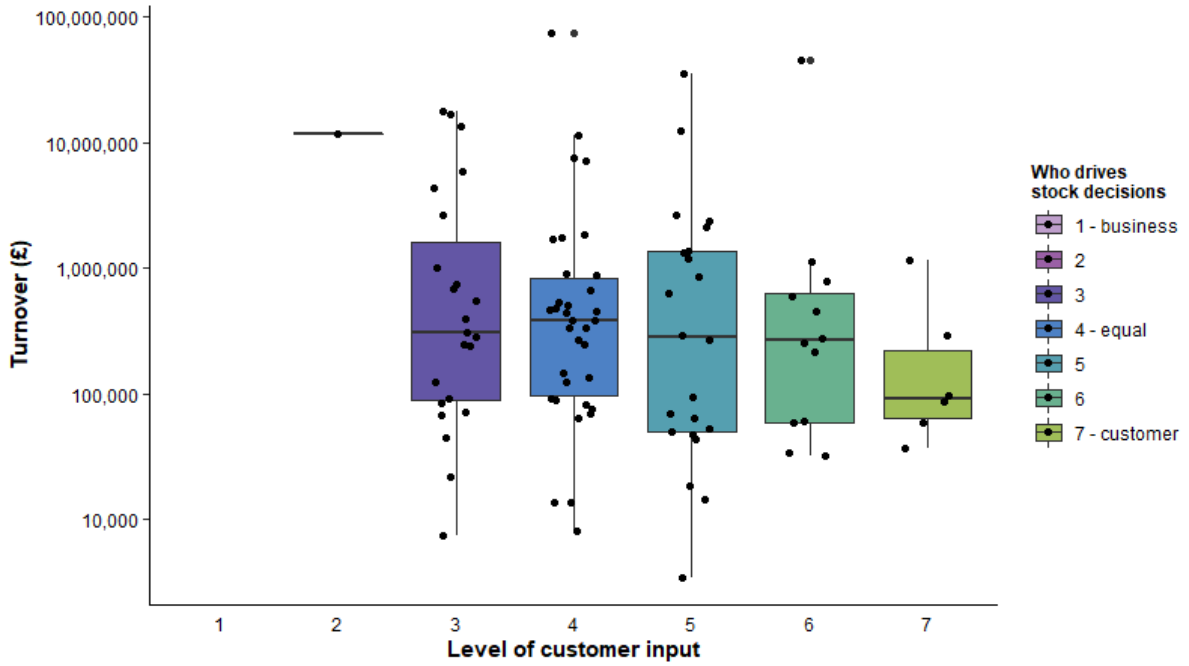

Figure 10 - Relative drivers of stocking decisions, by business turnover (y-axis is log_{10}). n=10. Likert scale 1-7 (1 = stocking decisions are driven entirely by business, 3 = stocking decisions are driven equally by business and customer demand, 7 = stocking decisions are driven entirely by customer demand). No significant correlation between turnover and level of customer input (P=0.70).

5.1.3 Supplier choice

Summary

- Growers and nurseries grow >60% of plants sold from seed
- Garden centres grew >40% from seed and >40% were sourced from growers
- Businesses based in Scotland source over 60% of plants they buy in from other Scotland-based businesses
- <20% plants were sourced from outside of the UK
- Plant quality was ranked as the most important characteristic when selecting a supplier by >50% of those surveyed
- Biosecurity was ranked least important by 23% of those surveyed, 7% ranked it as the most important

Approximately 60% of plants sold by retailers participating in the survey were grown from seed, over 25% purchased direct from the grower, and less than 10% from a wholesaler or trader (Figure 11). When buying in plants, Scotland-based businesses source the majority of their plants from suppliers also based in Scotland (Figure 12). More than 80% of plants sourced were from UK suppliers.

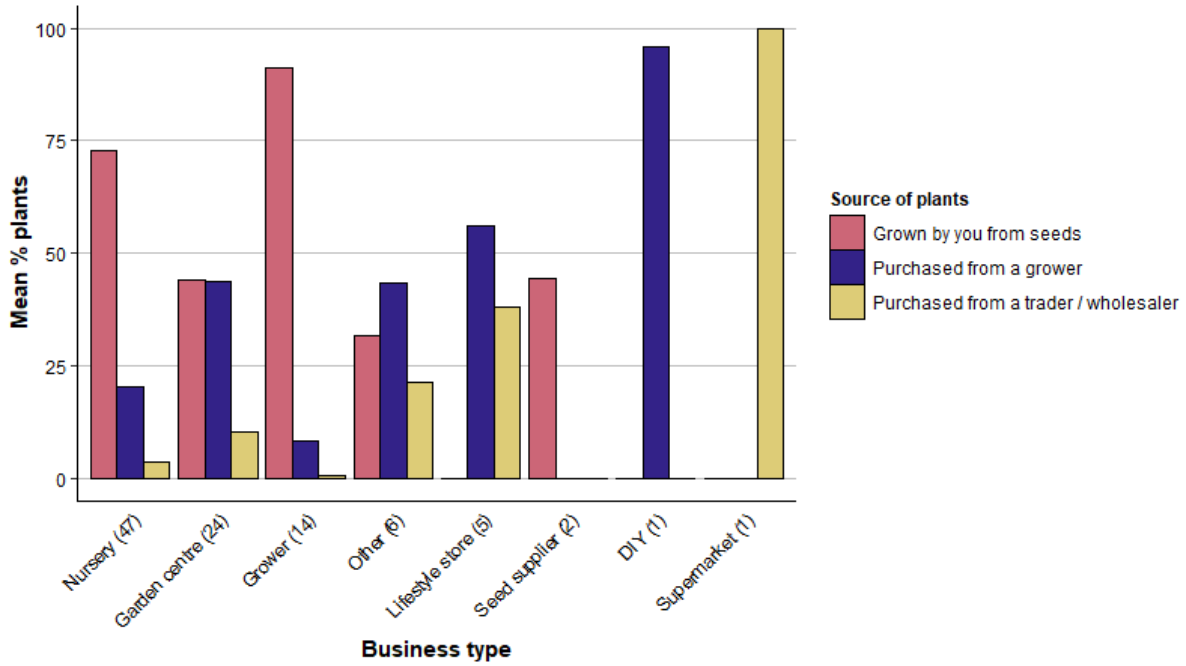

Figure 11 - Proportion of plants sold by business type and source. Values in parentheses are number of respondents of each business type. n=100

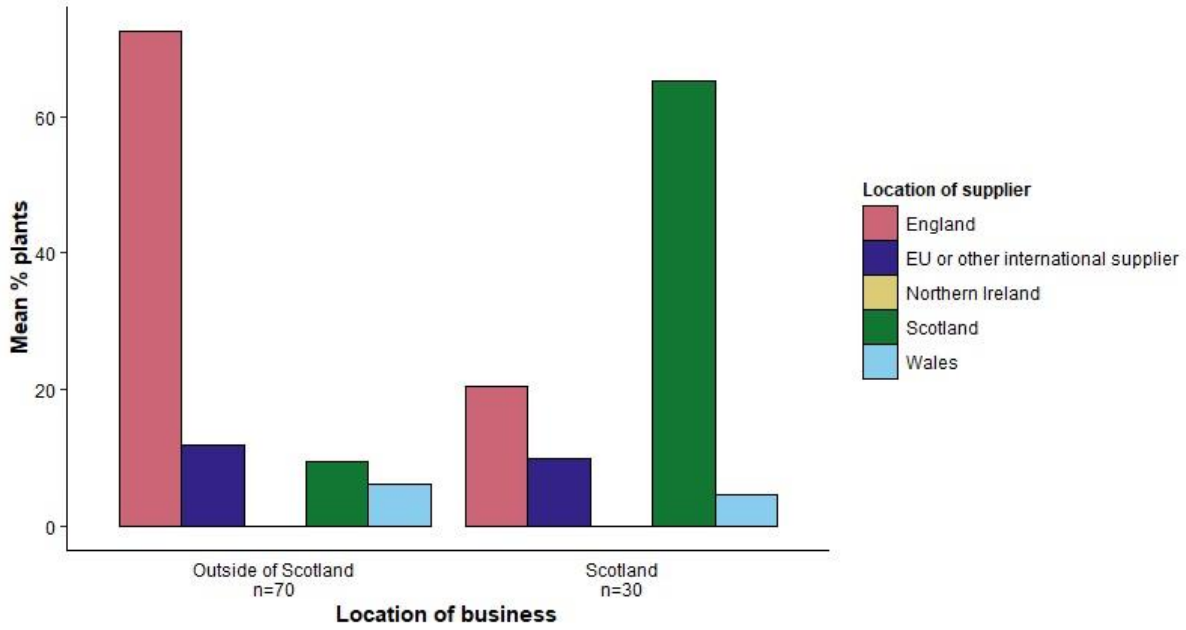

Figure 12 - Proportion of plants sold by location of supplier

Retailers who bought in any number of live plants were asked to rank nine characteristics (1 = most important, 9 = least important) which they take into account when selecting a plant supplier (Figure 13 and Table 4). The majority of participants selected quality plants as the most important characteristic. Quality was also the most selected characteristic at ranking position 2. Cost was the most selected characteristic at ranking position 3. Speed of delivery and suppliers acting in good faith were generally ranked lower.

The characteristic most frequently ranked at position 9 (least important) was biosecurity, by 23% of respondents. Between 7% and 13% of respondents ranked biosecurity at each of the other ranking levels. 7% of respondents ranked biosecurity as most important.

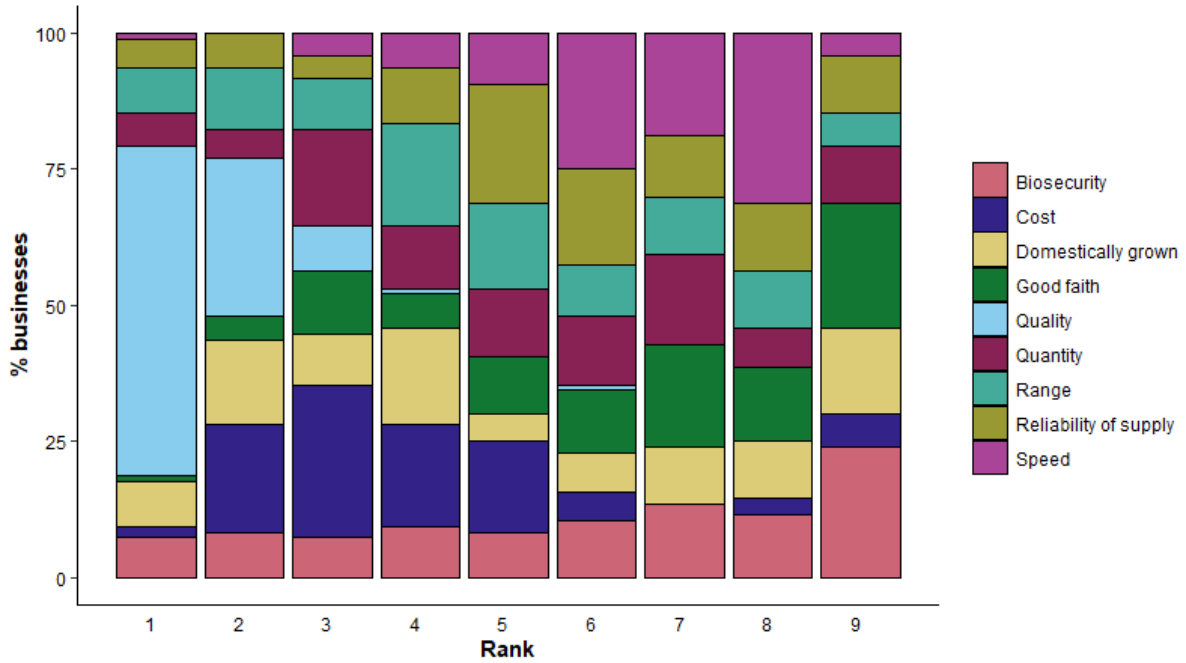

Figure 13 - Ranking of characteristics for selecting suppliers. Rank 1 = most important, 9=least important. n=96

Table 4 - Factors listed by businesses when considering a supplier, in addition to those listed in Figure 13 (coded free text responses)

Factor	Number of responses
Trust	7
I have no supplier	4
We share the same ethos	1
I have to do checks of each supplier	1
Supplier been in the business a long time	1

5.1.4 Pest & disease knowledge and information

Summary

- Knowledge and concern were higher for those pests and diseases already widely present in the UK (ash dieback and *Phytophthora ramorum*)
- Knowledge and concern were lower for pests and diseases not yet in the UK (Citrus longhorn beetle, emerald ash borer, and *Xylella fastidiosa*) and for Oak processionary moth (OPM) which is currently most prevalent in the South East of England
- >50% of those surveyed obtained pest and disease information from both government sources (e.g. APHA, Defra, SASA) and the Royal Horticultural Society; >20% obtained information from Horticultural Trade Association.

The survey asked for self-reported knowledge (using a simple 'none', 'some', 'a lot' categorisation) and concern about six important plant pests and diseases. All retailers reported they knew some or lots about ash dieback, but none knew lots about emerald ash borer. A smaller proportion of participants in Scotland felt they had the highest level of knowledge on Oak Processionary Moth (OPM) and *Phytophthora ramorum*, compared to participants outside of Scotland (Figure 14). Over half of all participants were unconcerned

about Citrus longhorn beetle, emerald ash borer, OPM or *Xylella fastidiosa* (Table 5). Scotland-based businesses were less concerned with OPM or *Xylella fastidiosa*, than those businesses located elsewhere.

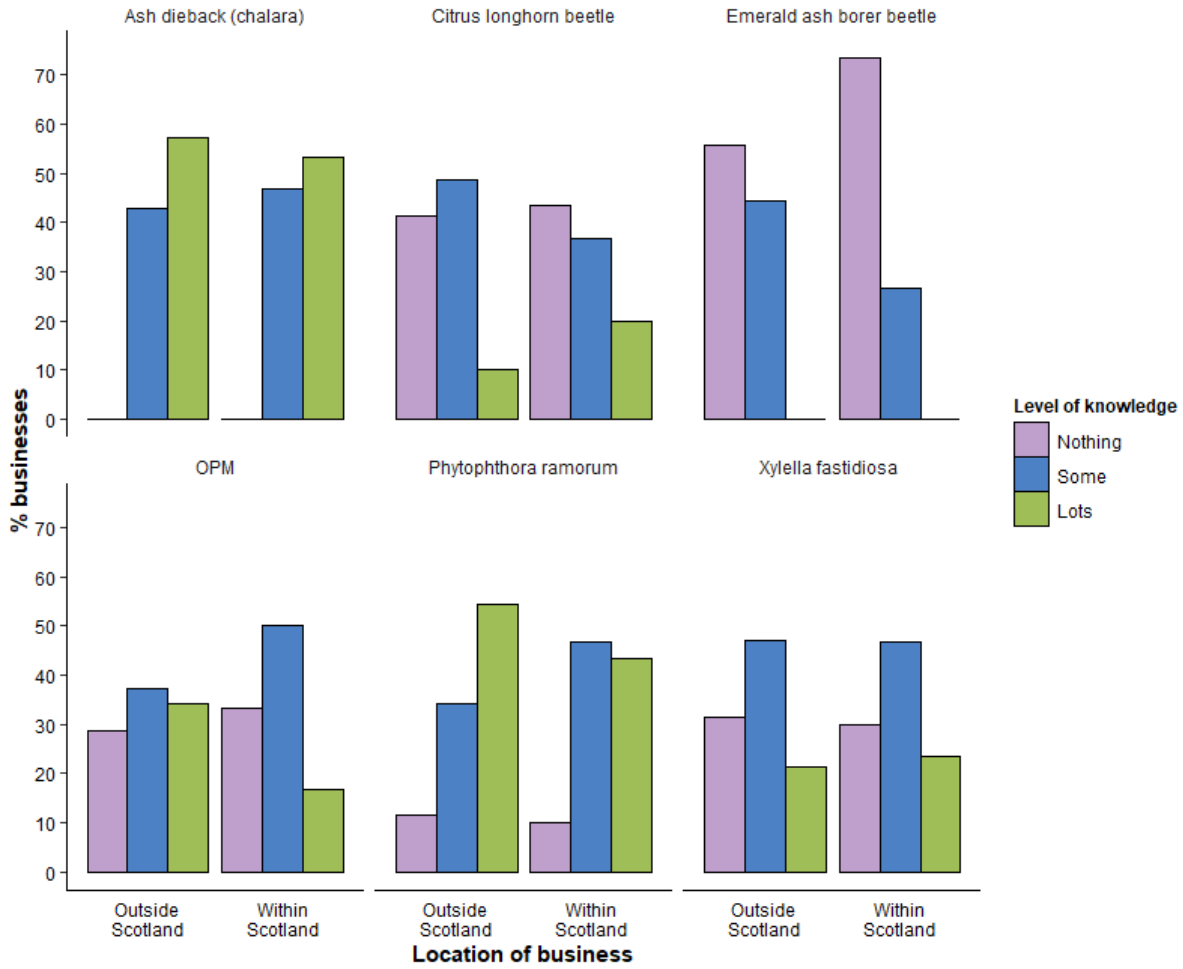

Figure 14 - Knowledge of pests and diseases. Outside Scotland (n=70), Within Scotland (n=30). OPM = Oak Processionary Moth

Table 5 - Concern about specific pests and diseases by locations. Mitigated risk rating from UK Plant Health Risk Register (accessed March 2021)

Pest / disease	UK relative risk rating; score 1 (no risk) - 125 (high risk)	Survey response	% Outside of Scotland (n=70)	% Scotland based businesses (n=30)
Ash dieback (chalara)	80	Concerned	67.1	63.3
		Unconcerned	32.9	36.7
Citrus longhorn beetle	30	Concerned	22.8	16.7
		Unconcerned	77.2	83.3
Emerald ash borer beetle	75	Concerned	14.3	13.3
		Unconcerned	85.7	86.7
Oak processionary moth	45	Concerned	41.4	33.3
		Unconcerned	58.6	66.7
Phytophthora ramorum	80	Concerned	65.7	63.3
		Unconcerned	34.3	36.7
Xylella fastidiosa	60	Concerned	40.0	16.7
		Unconcerned	60.0	83.3

The most frequent (>60% of participants) sources of pest and disease information were government departments (e.g. APHA, SASA) and the Royal Horticultural Society. All other sources were each accessed by less than 25% or retailers surveyed (Figure 15).

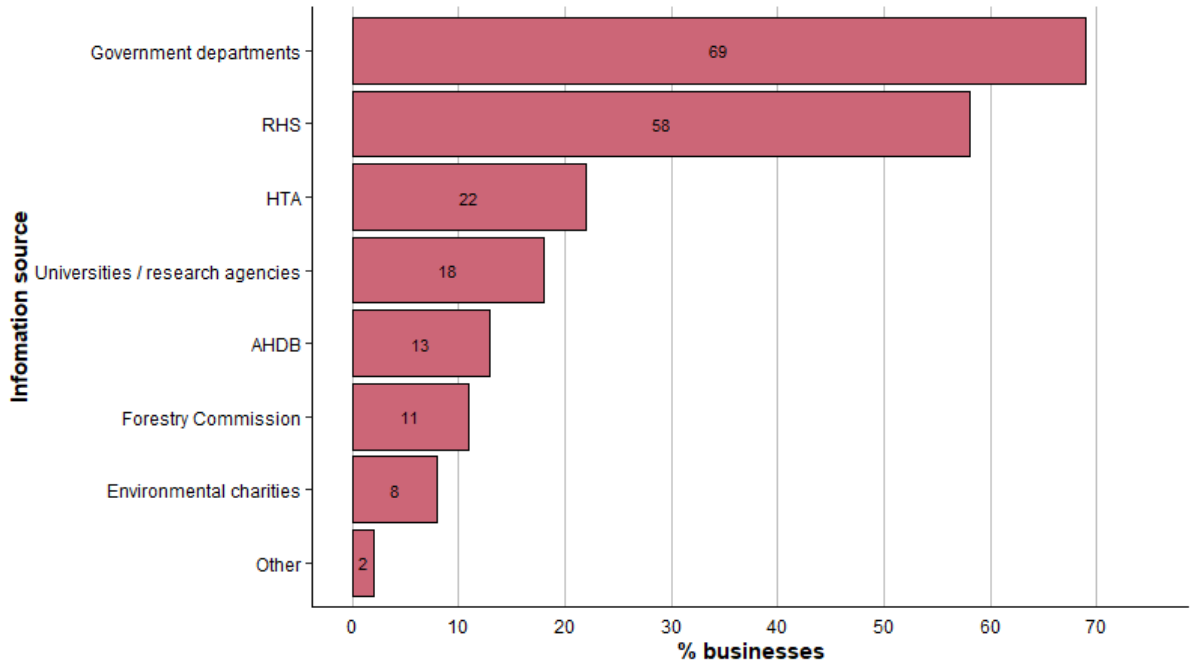

Figure 15 - Preferred sources of pest and disease information. RHS, Royal Horticultural Society; HTA, Horticultural Trade Association; AHDB Agriculture and Horticulture Development Board. n=100

5.1.5 Biosecurity actions and risks

Summary

- The average number of biosecurity actions currently taken (from list of 12 actions) by business in Scotland was 4; average outside of Scotland was 5
- >60% sought info on pests and diseases; checked plants upon arrival
- >20% did not check plants upon arrival
- >40% have removed risky species from range; have a formal biosecurity policy
- Barriers to greater biosecurity action: ≥50% unsure what they could do; waiting for others to adopt; not confident actions available would work
- Biggest risks to business: economic downturn / Brexit consequences; issues in sourcing from both the UK and the EU

Businesses were asked which biosecurity actions they currently take, are planning on taking in the next two years, or are not planning to take at all (Figure 16).

The most widely taken biosecurity actions were seeking information on plant pests and diseases, inspecting plants on arrival, removing risky plants from range, and having formal organisational biosecurity guidelines or policy. The biosecurity actions which the highest number of businesses were planning on taking in the next two years were undertaking the Plant Healthy self-assessment, inspecting suppliers, removing risky species from their range, and training or employing specialist staff. The biosecurity action which the highest number of businesses were not planning on implementing was further domestic sourcing (domestic suppliers already account for nearly 90% of plants bought by those surveyed (Figure 12) and the survey asked about domestic supply, rather than domestic origin), contacting customers upon potential plant infection, changing to a more biosecure supplier, and undertaking the Plant Healthy self-assessment.

Recruitment for the Plant Healthy Certification Scheme has concentrated on nurseries since its launch in February 2020. The relatively short time between launch and this survey, and nursery focus may explain the number and type of businesses having taken, or planning to take the self-assessment, as over half of nurseries surveyed are planning on taking the self-assessment in the next two years (Table 6).

Over 20% of retailers do not yet routinely inspect plants on arrival/departure (Figure 16). Of these 21 businesses, 10 were nurseries and seven were garden centres, and all do plan to take this action within the next two years. The survey question did not specify methodology for inspecting of plants; in very large batches not every plant may be routinely checked.

The mean number of actions currently taken by businesses based in Scotland (4.1 actions), was significantly lower than those outside of Scotland (5.0 actions) (Figure 17).

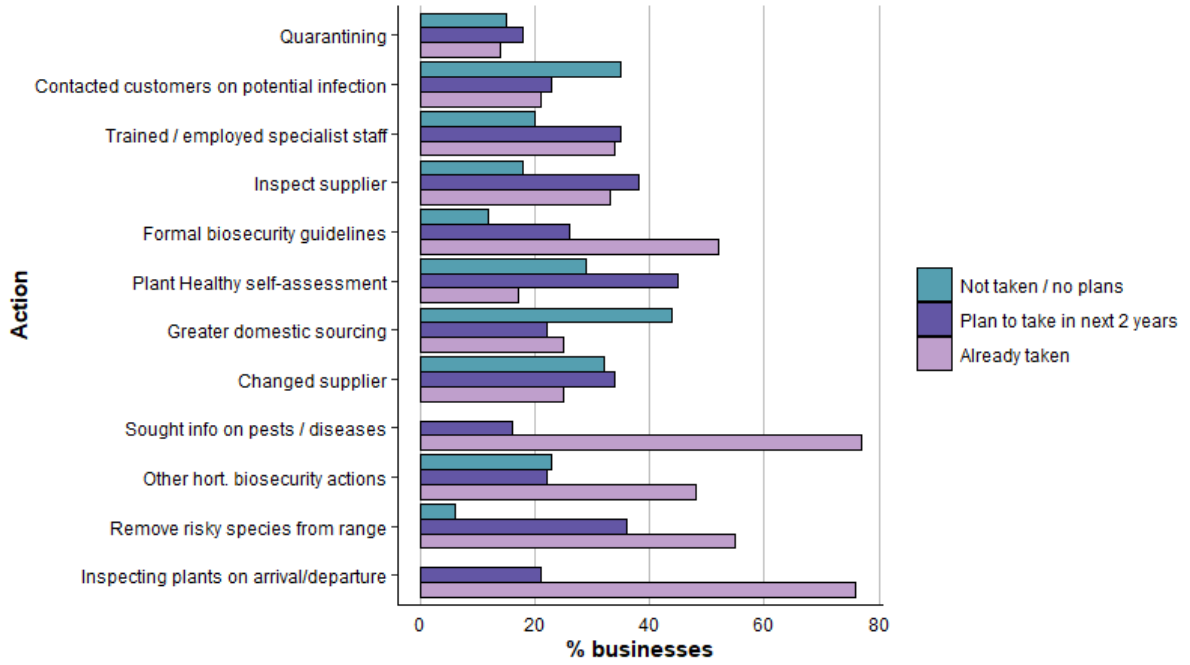

Figure 16 - Biosecurity actions, either already taken, planning to take, or not planning to take at all. n= 100. 'Not applicable' as a choice has been omitted, hence the sum of each Action does not equal 100.

Table 6 - Businesses taking the Plant Healthy self-assessment. n=100

Business type	**Taking the Plant Healthy Certification Scheme self-assessment**				
	Not taken / no plans	Plan to take in next 2 years	Already taken	Not applicable	Total (n=100)
Nursery	8 (17.0%)	27 (57.4%)	11 (23.4%)	1 (2.1%)	47 (100%)
Garden centre	13 (54.2%)	8 (33.3%)	2 (8.3%)	1 (4.2%)	24 (100%)
Grower	4 (28.6%)	8 (57.1%)	2 (14.3%)	0 (0.0%)	14 (100%)
Others	4 (26.7%)	2 (13.3%)	2 (13.3%)	7 (46.7%)	15 (100%)

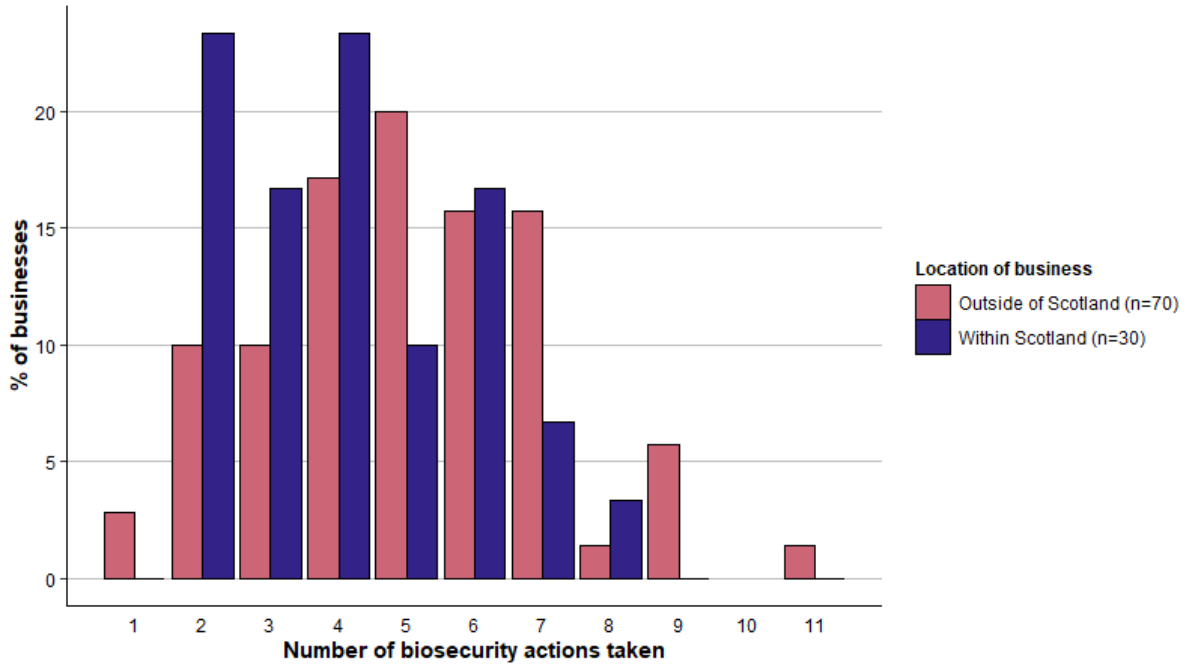

Figure 17 - Proportion of businesses undertaking biosecurity actions, by location of business. Respondents selected yes/no from a list of 12 potential actions. Mean number of actions taken significantly lower Within Scotland than Outside of Scotland (P=0.04)

The most frequent barrier selected for not being able to undertake more or greater biosecurity actions, was a lack of awareness of what to do (Figure 18). This was followed by a wish to see other businesses adopt similar measure first, followed by a belief that changing their practices actions would not reduce the risk, and a lack of skills and training available.

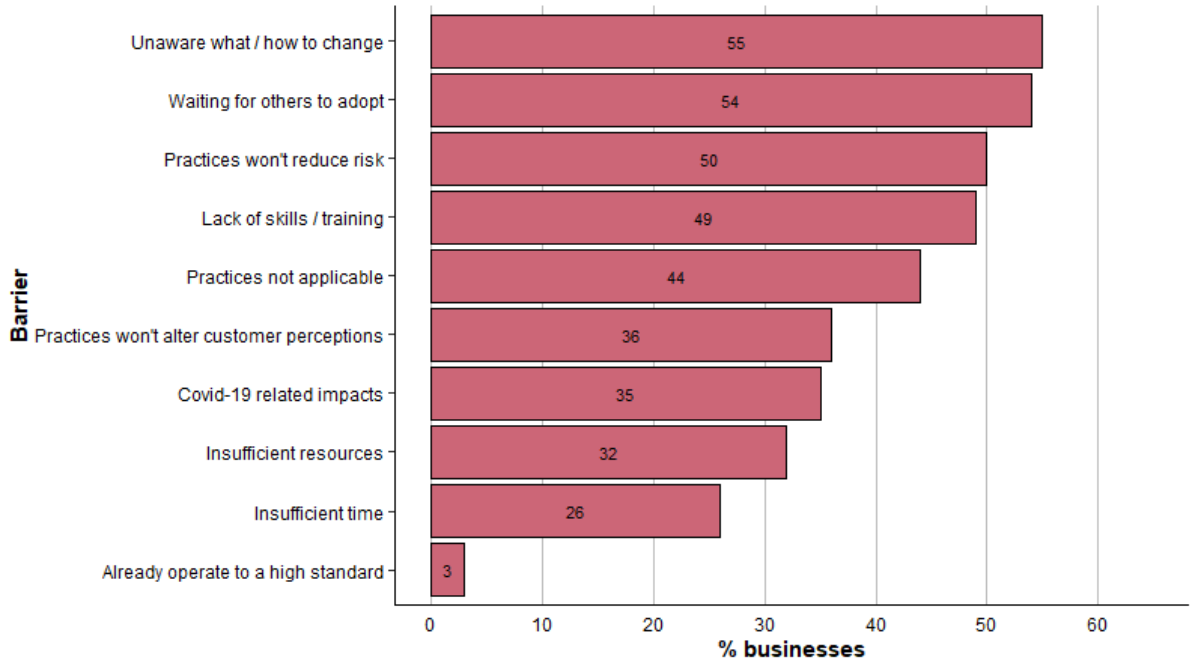

Figure 18 - Barriers to adopting more biosecurity actions. n=100

Participating retailers were asked to pick up to five from a selection of 14 risks which impact their business (including 'other'). The two risks most frequently selected (>60% of businesses) were changes due to Brexit and economic downturn (Figure 19). Other macro-economic and sourcing related risks made up four of the next six most frequent risks selected, with loss of stock to pest and disease and increase in environmental legislation accounting for the other two. There was little difference in the range of risks selected between different business types or their location.

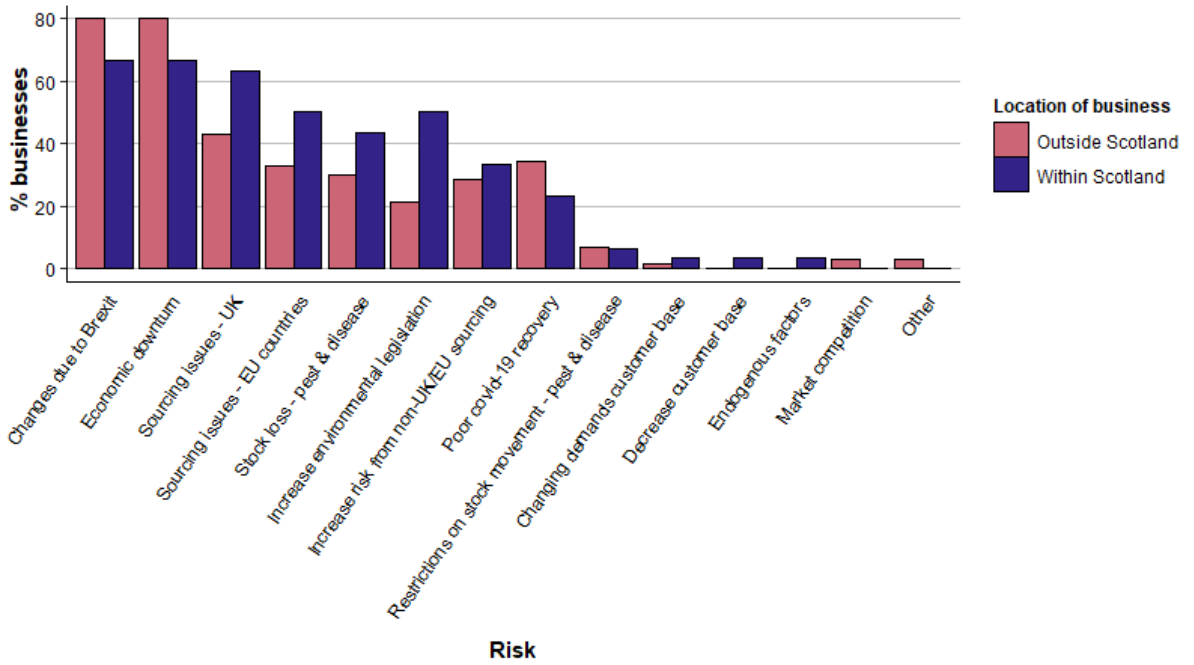

Figure 19 - Biggest risks to their business, by location (respondents could select up to five risks). n=100

5.1.6 Plant health accreditation and assurance

Summary

- 18% already participate in Plant Healthy in some way
- Lower proportion of online sales is associated with greater participation in Plant Healthy
- Top benefits of accreditation schemes in general: increased confidence for all buyers (including public); having a minimum industry standard; increased biosecurity
- Top constraints of accreditation schemes in general: low uptake across the sector; time and finance costs

The Plant Healthy Certification Scheme has concentrated on recruitment of nurseries since its launch in February 2020. Almost one fifth (18%) of those surveyed indicated they were already participating in Plant Healthy in some way, whereas 28% said they did not see themselves joining (Table 7). Seventeen businesses indicated they had already taken the Plant Healthy Self-Assessment (see previous section 5.1.5, Figure 16, Table 6). Of these 17, 16 said they would not consider participating in the scheme, and one said they would consider participating.

Those who already participate sold a significantly lower proportion of their sales online than those who do not. There was no correlation between responses to Plant Healthy and turnover of business (Figure 20, Figure 21).

One fifth (20%) of those surveyed perceived an increase in confidence for buyers (including the general public) to be a benefit of accreditation schemes in general. Other benefits named were having an industry minimum standard (17% of respondents) and increasing biosecurity (16%) (Figure 22). Almost a quarter of those surveyed perceived lack of sector uptake of accreditation schemes and costs involved with becoming accredited (24% and 23% of respondents, respectively), as the major constraints to accreditation schemes in general (Figure 23).

Table 7 - Participation Plant Healthy Certification Scheme

	Already do participate	**Would consider**	**No**
Location of business			
Outside of Scotland	14 (20.0%)	39 (55.7%)	17 (24.3%)
Scotland	4 (13.3%)	15 (50.0%)	11 (36.7%)
Business type			
Nursery	2 (4.3%)	29 (61.7%)	16 (34.0%)
Garden centre	7 (29.2%)	10 (41.7%)	7 (29.2%)
Grower	1 (7.1%)	10 (71.4%)	3 (21.4%)
Seed supplier/ supermarket/ DIY/ Lifestyle store/ Other	8 (53.3%)	5 (33.3%)	2 (13.3%)
Total (n=100)	18	54	28

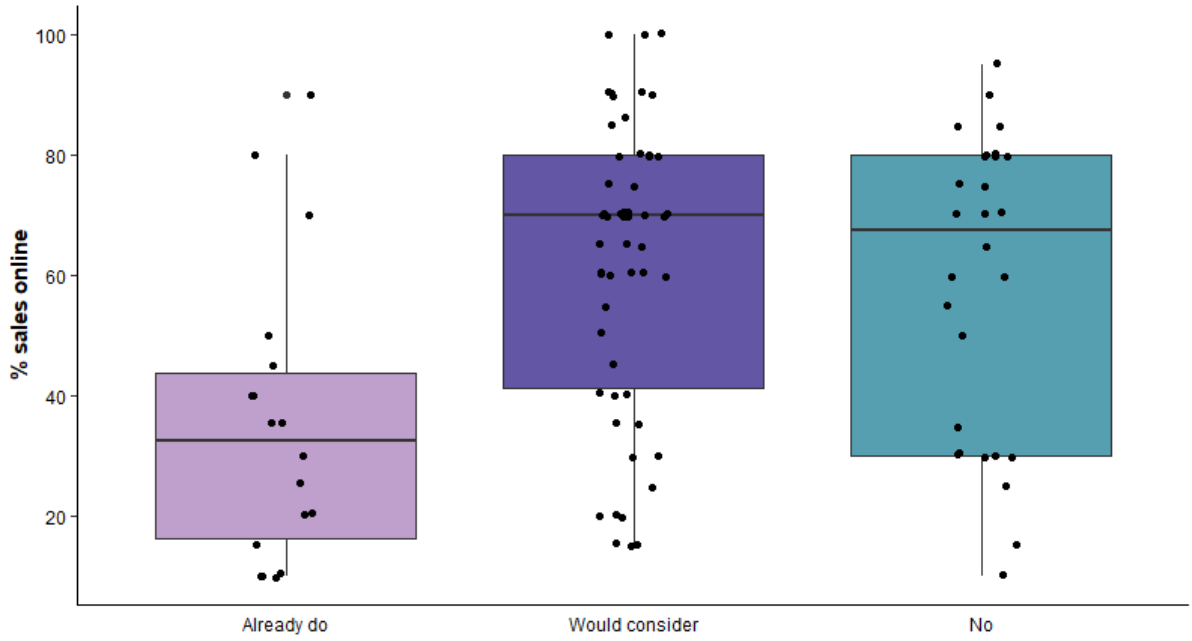

Figure 20 - Plant Healthy scheme participation, by online sales. n=100. Retailers who have already participated with Plant Healthy have a significantly lower proportion of online sales than those which have not (combined 'Would consider' + 'No' into one group for comparison) (p<0.001)

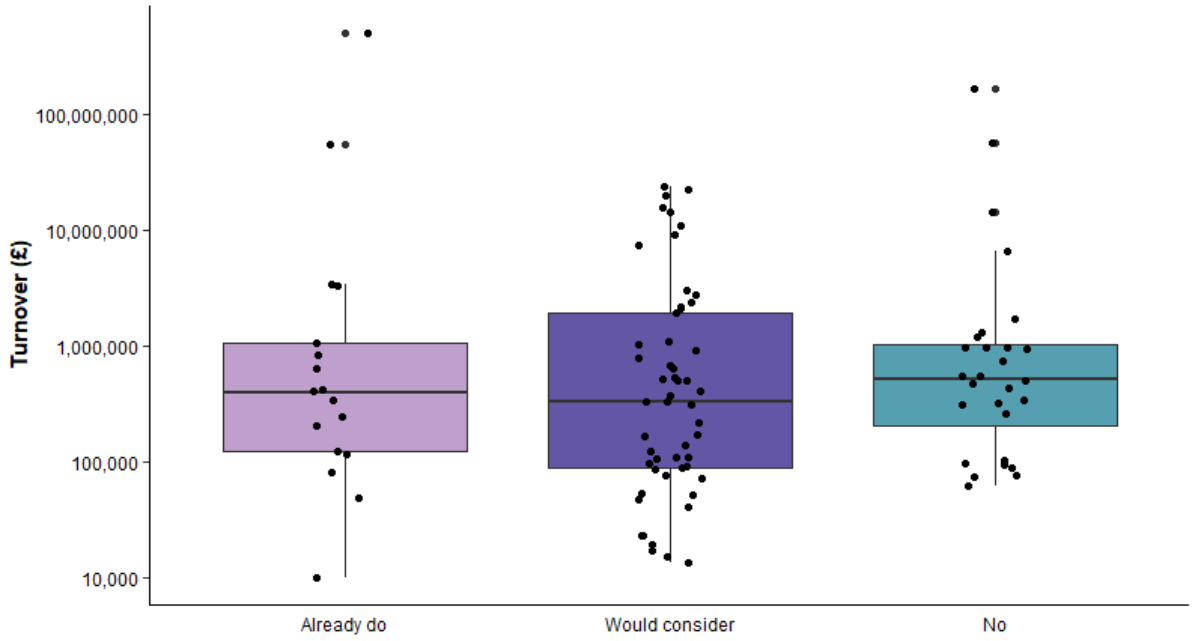

Figure 21 - Plant Healthy scheme participation by turnover. Y-axis on log_{10} scale n=100. No significant difference between those businesses which have already participated and those which have not (combined 'Would consider' + 'No' into one group for comparison) (p=0.82)

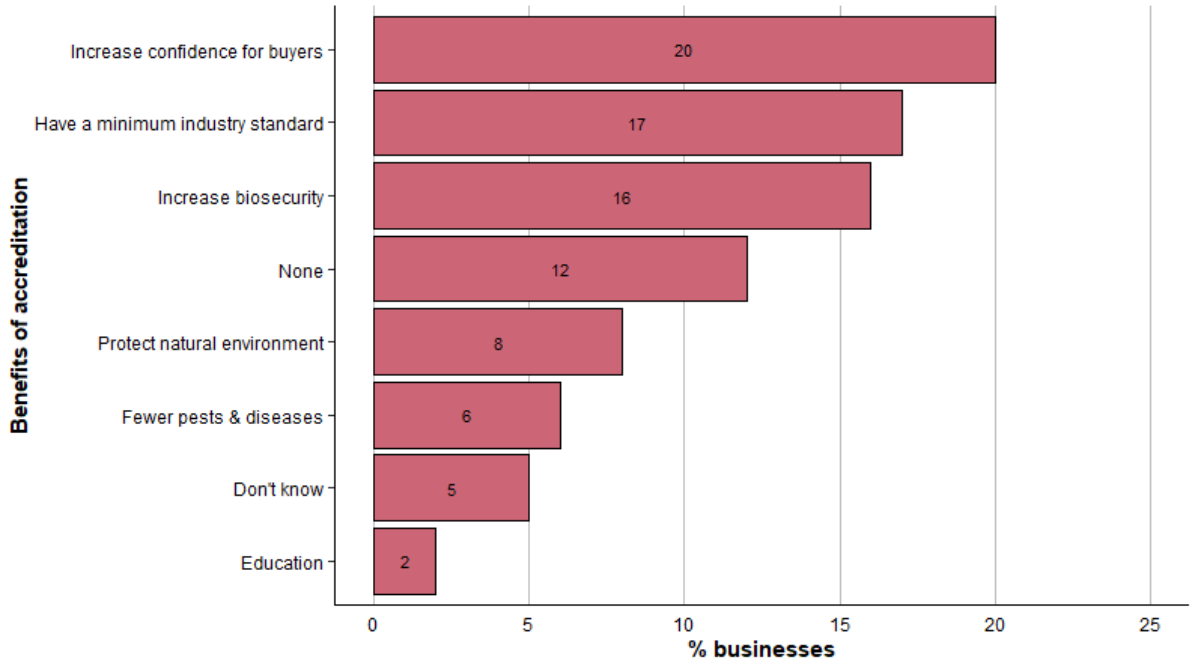

Figure 22 - Benefits of a biosecurity accreditation scheme. Data collected were open question, coded into categories. n=100

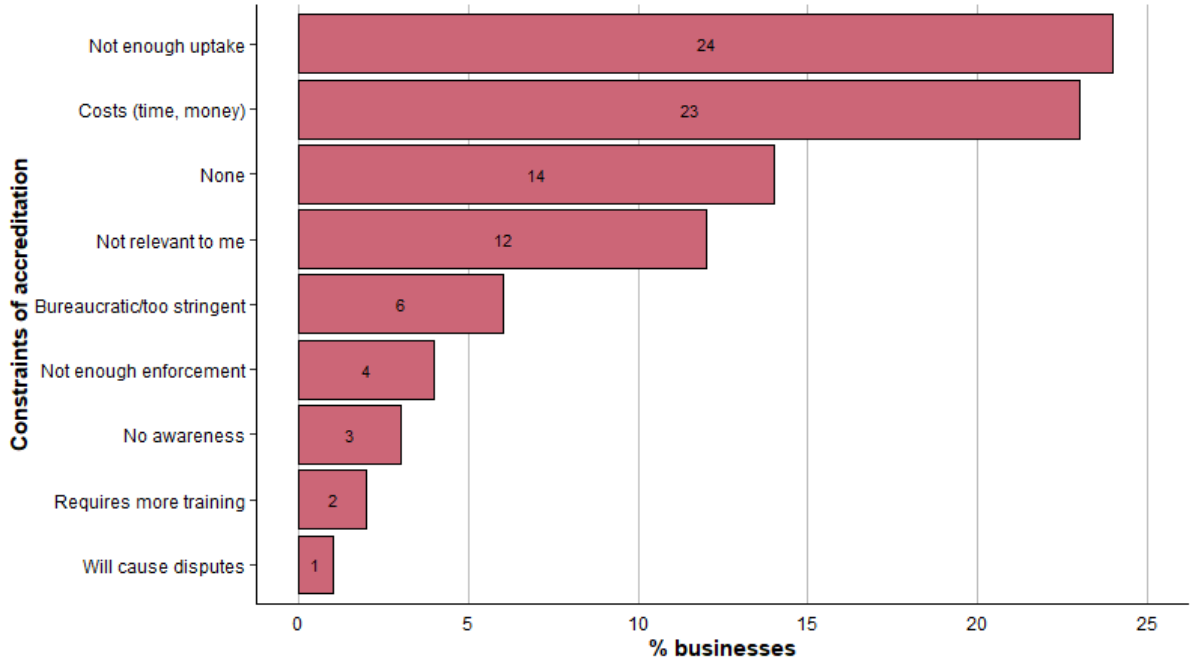

Figure 23 - Constraints of a biosecurity accreditation scheme. Data collected were open question, coded into categories. n=100

5.2 Interviews with non-specialist multiple retailers

This section describes the results of four semi-structured interviews with non-specialist multiple retailers that sold plants in Scotland. Non-specialist multiple retailers of plants typically have physical stores in many locations, selling a wide range of non-gardening products in addition to plants. Some multiples will sell live plants online as well as in store, but recruitment focussed on those multiples for which the majority of plant sales were made in-store. The small sample size means data are unlikely to be representative of the entire multiples sector, however themes are highlighted below for insight into the stakeholder type.

It should be noted that interviews took place during the Christmas season of 2020, and so poinsettias feature heavily in the examples given by interviewees.

5.2.1 Product types and flows

Summary

- Poinsettia, lavender, roses, geraniums, chrysanthemums, and bamboo were top selling plants
- Large retailers listen to customer demand on range of species offered, but can also influence the market
- Plant flow from suppliers to stores:
    - Supplier -> retailer regional hub -> store (pathway of majority of plant stock; proportion stock on this pathway is decreasing)
    - Supplier -> store (pathway of minority of plant stock; proportion stock on this pathway is increasing)

The most popular plants (by volume) mentioned by interviewees included poinsettia, lavender, roses, geranium, chrysanthemums, and bamboo. The range of plants sold in Scottish stores was essentially the same as in stores elsewhere in the UK and would not change greatly year-on-year. A core range of plants would have been refined with businesses making strategic decisions on what species to offer customers. Development of new product lines (e.g. disease resistant varieties) involved influencing research companies and growers now for products 5 or 10 years into the future. One interviewee described having enough influence on the market, that they felt able to reassure a research company that specific disease resistant products would be profitable in the future.

The businesses interviewed moved large volumes of plants into Scotland. Based on our small sample, supermarkets tended to have more stores with fewer plants (range and volume) sold, and DIY fewer stores with greater volume and range of plants sold. In both business types plants mostly flowed from suppliers through one or two central hubs in England, or Scotland prior to reaching Scottish stores. One interviewee described how their own fleet of trucks would pick up from UK suppliers and deliver to hubs. International deliveries (from the Netherlands only) would arrive at hubs on suppliers' trucks. All plants would then be logged into the system and distributed to stores via the retailer's fleet of trucks. The movement of plants through hubs is quick – one interviewee said it was less than 48 hours.

For all of the businesses interviewed, a small proportion of plants moved from UK or international suppliers directly into their stores. Where delivery from suppliers did bypass one or more hubs, this was volume driven, where full truck loads did not need to be split and could go directly to a point further down the logistics chain. This would particularly happen at busy

times of the year or with very popular plant species (e.g. poinsettias in the run up to Christmas). One interviewee described a likely increase in the proportion of plants from the EU bypassing UK based hubs and going direct to stores because of increased paperwork requirements, resulting in up to 30% of all their plants moving in this way. Interviewees could not predict how trade flows from the EU would change due to Brexit.

One interviewee described how prior to plant passporting legislation, some plants which had arrived not fit for sale (e.g. fallen over during transit not because of pest or disease), would be sold to staff. This was not possible after 1st January 2021 due to new legislation, and so from this date forward plants would now be destroyed.

5.2.2 Suppliers and supply decisions

Summary

- Only a small number of suppliers can meet high specification and volume requirements
- Long-lasting, close relationships are often formed between retailers and suppliers; they will discuss pests and disease issues and exchange information formally and informally
- Individuals may bring their suppliers with them if they move from one retailer to another
- UK suppliers are preferred: fewer biosecurity concerns; lower logistical costs
- International suppliers now need to have good knowledge of UK biosecurity rules and regulations
- Suppliers go through internal biosecurity audits and this is seen as more stringent than independent accreditation / assurance schemes

All of the interviewees described their stock coming from a small number of suppliers, each providing a large number of plants. They highlighted that there are a limited number of suppliers able to produce a large volume of plants to the required specifications. One interviewee indicated that 85% of their live plant volume came from three suppliers.

Relationships between these retailers and suppliers were long lasting, with many being decades long. One interviewee described a "mutual dependence" between retailer and supplier, where virtually all of the specific supplier's stock would go to the retailer. Amongst those interviewed there was often a constant communication between supplier and retailer, one example given was of a supplier sending photos of a plant with marked leaves to the interviewee, seeking advice on the cause. This was described as an informal discussion rather than a formal reporting. The retailer then got advice from industry experts including APHA and fed back to the supplier with a response before the plants were sent.

The lack of alternatives and the mutual dependency meant it was rare for a retailer to walk away from a long-standing supplier. It was more likely for the retailer to work with a supplier to manage or solve any problems than to change to a new supplier. One interviewee did describe having to stop sourcing from one EU-based supplier because of a pest and disease issue, but that was over 10 years ago. The same interviewee indicated that they would not hesitate to stop buying from a business which supplied risky plants and because of this, they had a strong reputation in the industry for their high standards.

One interviewee expressed confidence in the robustness of their systems, particularly in comparison with smaller organisations which they believed didn't have the ability to do the due diligence on suppliers and build in routine checks at many points across the plant journey.

In this way they felt that buying a single plant or ten thousand plants is no different, as long as good plant health systems are in place.

Interviewees described trying to work with UK suppliers as much as possible and that they are mostly successful. The main reasons given were increased biosecurity of UK supplied plants, that international delivery costs more, and a long transit time can result in a drop in product shelf-life. Other than live Christmas trees, very little volume originated from Scottish growers as they did not currently produce to the scale required for our interviewees.

The most important characteristics in a supplier were described by one interviewee as capacity and technical competency: capacity to grow to the timing and volume required, and technical competency to produce the required quality. Price and personal relationships with suppliers used to dealing with multiples were also mentioned. When dealing with suppliers outside of the UK, supplier knowledge of international rules and regulations was important. An example of the value of knowing the rules was given by one interviewee: a supplier whose product was completely pest free might see no reason not to send their plants to the UK, but if they hadn't got protected zone status then they couldn't ship to the UK. One interviewee who had worked elsewhere in the industry believed it was likely these would be the key factors for any multiple trading in large volumes – either a garden centre chain, supermarket or DIY retailer.

Suppliers go through a high number of checks (supplier approval process) in order to win and maintain contracts to supply plants to the retailers we interviewed. For example, these include sustainability, and anti-slavery checks as well as for plant health. One interviewee described how good supplier practice evaluations were built in line with a set of corporate values and principles, such as being customer and community focussed. Additionally, an interviewee described how a new individual in a technical manager or buyer role might switch to a supplier with whom they had previous experience of working, valuing their previous relationship over the status quo. This would not happen immediately after the individual had started their new role but up to a year later.

5.2.3 Roles and responsibilities

Summary

- Technical managers visit supplier sites to check on processes; update technical specifications of plants; check suppliers and products against requirements; deal with quality issues reported throughout the supply chain
- Recent increases in requirements for tracking of plant movements have led to fewer returns of substandard plants to suppliers

For those businesses interviewed, technical managers write the requirements or specifications for products which suppliers must meet, including those associated with plant health. An interviewee indicated that technical specifications should be updated annually, and it was their responsibility to keep up to date on current issues and guidance in industry and government. The technical manager will also check suppliers and products against the requirements. Checking suppliers involves visiting sites. One interviewee described visits as using judgement to assess growing practices, rather than checking many plants themselves, as the scale is too large for the latter.

Overseeing a check of plants as they enter the business was a major responsibility of one technical manager interviewed. This technical manager assessed all aspects of plant quality upon arrival from suppliers, decided what left to go to deports or stores, and dealt with quality issues reported back from further down the chain. They shared information on pests and diseases throughout the business so quality control staff could perform further checks locally. Plants arriving from a supplier would land in a specific area for checking. Prior to 1st January 2021, if there was a pest and disease problem the plants would have been sent on the same truck back to the supplier. However, now sending back would be classed as a re-export and require more paperwork, so it's likely that the plants would be destroyed. The interviewee could not confirm this would be the case as no pest or disease had been identified between this date and the date of the interview.

5.2.4 Risks and responses

Summary

- Finding suppliers who take responsibility for high biosecurity standards is the predominant mechanism for maintaining plant health
- Responses upon detection of pest / disease varies by business:
    - An example: tracing back and forward to find source and destination; prevent any plant from affected batch being purchased
    - An example: affected plants were processed similarly to substandard non-plant products (e.g. foodstuffs); supplier informed and product either returned (if supplier UK based)/disposed of, then replaced
- Respondents self-reported a very low instance rate of pest or disease issues

Interviewees described how they rely on good plant health systems in their suppliers, check plants whilst in their possession for signs of pest or disease, and then have processes in place should a plant health issue arise.

Focussing on the quality and processes of suppliers was the foundation for the retailers. Many plants are grown by suppliers in areas or structures physically protected from the outside. There was confidence in the ability and processes of plant health inspectors, both in the UK and Europe, who check suppliers regularly and are welcome in depots and stores throughout their systems. One interviewee explained how cuttings arriving to a supplier from East Africa would be inspected on arrival at the supplier and then every two weeks thereafter for six months as the plant grows in a closed system. This gives a long period of monitoring before the plant even reaches the retailer. Finding the cleanest source for a product, then working with the supplier to keep them up to date with any extra measures was seen as the most important part of being pest and disease free.

Upon delivery of plants from suppliers, interviewees described plants being checked by quality control (QC) staff against all specifications including pests and diseases, being logged into logistics systems, (re)labelled, split and sent out to the next depot or to stores. Several interviewees emphasised that QC staff were trained horticulturalists, and that higher risk plants would receive more attention.

All interviewees said there were rarely any pests and diseases detected on their plants. Tobacco whitefly (*Bemisia tabaci*) was mentioned as an issue, but one of quality assurance rather than a biosecurity danger. One could not recall any instance of plants arriving with a pest and

disease problem for at least a year. Another was not aware of any customer complaints about plants with a pest or disease issue. One interviewee explained that there had been fewer than only two or three instances of notifiable pest or disease per year, on millions of plants moving through their system and that these were dealt with to the satisfaction of the APHA.

Should a plant health issue be detected on a plant, there was variation in response between interviewees. If detection happens within a hub or depot, one interviewee sourcing plants from a UK-based supplier said that the plants would be moved to a rejections area, along with other (non-plant) products which were being rejected. An email would be sent to the supplier with details for rejection, and the plants sent back at the next opportunity where possible. The returning of plants was the same process as for non-plant products. Should there only be a small number of plants affected, the supplier may ask that the retailer disposes of the plants, rather than return them, as the supplier is responsible for the cost of the return. Another interviewee described separating out problem consignments from healthy ones taking into account the transport they had arrived in. This was to minimise the amount which would have to be incinerated. Traceability was very important to several interviewees. They had systems in place which would allow a plant to be tracked back and forward through the system and therefore, should a plant health issue be detected at any point from grower to customer or if a notification came from inspectors, the problem could be isolated, and no more plants from that batch be allowed through store checkouts. Plants would then be destroyed as necessary, either by incineration or double-bagged and sent to landfill. One interviewee described how a notifiable disease detected in a batch of plants grown from abroad would mean destruction of the entire batch – potentially tens of thousands of plants. Whereas UK grown plants would be investigated in more detail to determine localisation of any problem and minimise required losses. Interviewees described losses of plants due to pest and disease as very low, with one saying nothing coming from suppliers in the Netherlands (which may just be a hub for growers elsewhere) had been sent back for at least the previous year.

5.2.5 Plant pests and diseases

Summary

- Those surveyed had high concern regarding *Xylella fastidiosa*, but mostly had to deal with tobacco white fly on a regular basis
- Interviewees obtained pest and disease information from government sources and Horticultural Trade Association. Close relationships with government inspectors were seen as useful for dialogue

Three of four interviewees mentioned *Xylella fastidiosa*, when asked which pests and disease were of particular concern. The uncertainty connected to a potential discovery of *Xylella* was a concern for the retailers, regarding both the impact of the disease itself and the impacts of the government mediated response to detection. One interviewee highlighted the potential impact on multiples should *Xylella* be detected, as plants are moved in such large and complicated networks across the country. The interviewee described how high-risk species and high-risk areas were avoided to protect from potential *Xylella* incursion.

All four interviewees mentioned tobacco whitefly (*Bemisia tabaci*) as a concern from a quality aspect, rather than the biosecurity danger associated with diseases such as *Xylella*. Efforts to curb levels of tobacco whitefly led to removal of some species from their range (e.g. *diplandenia*) or identifying 'clean' supply lines from the UK or elsewhere.

Interviewees all used government agencies and inspectors as their main source of pest and disease information. The APHA newsletter and website were used and questions asked of inspectors, particularly local inspectors with whom relationships had been established. The HTA were also a source of information. All interviewees described obtaining information from their suppliers about pests and diseases. One interviewee also mentioned checking foreign press for news, such as the Olive Times for *Xylella fastidiosa* updates.

5.2.6 Challenges and barriers

Summary

- Challenges faced: finding adequate information; sourcing plants from the UK; dealing with international rules and regulations
- Most (not all) interviewees were extremely confident in their internal biosecurity systems

Retailers had mixed views about the challenges they faced. Those who were confident in their own systems suggested getting up to date information on pests and disease, dealing with variation in rules and regulations between countries, and finding UK based suppliers for some high-volume plants such as lavender, were the main issues. One interviewee thought APHA should increase their inspections of very small plants brought into the UK from equatorial countries for growing on. They felt such small plants are not as visible as the large plants toward the retailer end of the supply chain and thus are under-inspected.

Three of the four interviewees were confident in their internal biosecurity systems. One interviewee felt the internal system of the business could be improved, questioning if the systems which treated plant and non-plant products similarly in terms of returns to suppliers, were as good as they could be.

5.2.7 Accreditation schemes

Summary

- Independent accreditation not seen as useful currently, as internal audits are more stringent

None of the interviewees currently used the Plant Healthy Certification Scheme and two had not heard of it. The Plant Healthy Certification Scheme with independent auditing were thought to have potential value, particularly for smaller companies who could not put their own audits in place, or to ensure technical developments were highlighted and best practice maintained. The retailers interviewed felt that their audits were high enough quality that external certification for their suppliers was not required.

6 Discussion

6.1 Sample considerations

The survey sample included businesses with a wide range of both turnover and proportion of trade made online, so given the size of the overall sample, we were confident in being able to detect any broad-scale patterns in data correlated with these two variables. Across the sample, Scotland-based businesses were rarely different from the rest of the UK. UK wide research (e.g. Phytothreats project) is therefore likely to be applicable to Scotland also.

A wide range of retailers sell online and through physical sites. We found that garden centres made a lower proportion of their sales though online channels than did nurseries or growers. There are online-only plant sellers, but this study suggests that those selling more online (both as a proportion of plants sales, and in total) are no more likely to engage in risky behaviour than those who sell less. Finer categorisations of online plant retailers are required to identify potential patterns of behaviour. It is likely methods of sale have changed during 2020 due to Covid-19 restrictions, but this requires monitoring going forward as the retail environment begins to (hopefully) stabilise.

The low number of interviews with non-specialist retailers means caution is needed in generalising from these data. However, there are not many businesses operating in the UK of comparable type and size, and they are known to be hard-to-reach, so all data from this sector is valuable.

6.2 Plant product flows and types

Surveyed retailers based in Scotland sourced the majority of plants from other businesses based in Scotland than elsewhere but sold more to customers based in England than to customers based in Scotland. Focussed policy interventions could be developed (for example education and awareness), which impact multiple points within one supply chain in Scotland (supplier-retailer-consumer).

The majority of plants sold by nurseries and growers, and almost half of those sold by garden centres were grown from seed. Where plants were bought in, more than 80% were sourced from UK suppliers. Replacing plant imports with homegrown plants is seen as one way of reducing the risk of pests and diseases entering the UK, however our survey data did not determine the origin of the plants bought by those surveyed. Plants with international origin which had been grown on for a substantial period in the UK were seen by interviewees as being biosecure. Buying from UK suppliers was also preferred due to lower logistical costs, however many of those surveyed were not planning on sourcing more domestically grown plants. This was due to the difficulty in being able to get such plants, especially at the required specification, time and volume required by large businesses.

Plants are the responsibility of the supplier up until delivery to the hub or store. The majority of stock sold by non-specialist multiples would be delivered to their hub where there would be a quality control check, before splitting of each batch to delivery by their own logistics fleet to stores. Suppliers could deliver directly to stores if it was logistically efficient (e.g. a supermarket store receiving a large number of poinsettias before Christmas) or increasingly, if it meant a reduction in paperwork by bypassing the hub. This could be a risk if important pest and disease checks at a retailer hub are bypassed without replacement elsewhere, potentially putting greater responsibility on suppler and in-store biosecurity.

There is a large range of top selling species. The species most frequently named as top sellers by online retailers were roses, geraniums and bamboo. These plants were also named as top sellers in interviews with non-specialist retailers. Commonly traded plants and trees which are also a plant health risk include Rhododendron, Camellia, Azalea because of *P. ramorum*, and lavender because of *X. fastidiosa*.

Product range is determined by a broadly equal balance of business and customer drivers, although larger businesses can influence the market. It was encouraging that many surveyed retailers have already removed problem species from their ranges, although which species had been removed, and under what circumstances is not know from this data.

6.3 Pest and disease knowledge and awareness

Knowledge of pests and diseases was generally good but was variable and country specific. Both knowledge and concern of the pests and diseases were associated with their current level of impact. Over half of Scottish businesses were concerned about ash dieback and *Phytophthora ramorum*, likely because the diseases are a long-term problem and there has been much mainstream publicity and education. Fewer than half of Scottish businesses were concerned about the remaining four pests and pathogens: emerald ash borer beetle, citrus longhorn beetle, and *Xylella fastidiosa* which are not currently present anywhere in the UK; and oak processionary moth which is primarily confined to the south east of England.

In a previous study of UK nurseries and garden centres (Dunn and Marzano 2019), 31% and 38% of respondents (n=100) indicated that they were concerned about *Phytophthora ramorum* and *Xylella fastidiosa*, respectively. The present study indicates greater concern regarding *Phytophthora ramorum* but not *Xylella fastidiosa*.

Xylella fastidiosa is a high-risk pathogen, and even though natural spread may be restricted in Scotland due to climate, the greatest chance of introduction is via movement of an infected plant. The government response to an outbreak of *Xylella fastidiosa* is the same across the UK and can have severe consequences to businesses. As such the low level of concern of *Xylella fastidiosa* held by Scotland-based online businesses is a potential worry. Recent efforts to increase awareness of *Xylella fastidiosa*, and its potential impacts have reached a number of businesses (Pérez-sierra et al. 2019) but increased information on pest and disease threats which are not yet in the UK could be beneficial.

Government departments and RHS were the most frequent choices for obtaining information by online retailers, but a wide range were used. Non-specialist retailers used similar sources as well as the HTA, but also described the value of a developed relationship and dialogue with a local plant health inspector. Seeking information on pests and diseases, was the most commonly taken biosecurity action by surveyed retailers. However, a lack of awareness of what or how to change to achieve greater biosecurity was the most frequent barrier cited by online retailers and non-specialist retailers indicating they found it difficult to find the right information. It is clear that there is an ongoing information and or communication gap for retailers operating in Scotland. Reaching the maximum number of businesses with good biosecurity information relies on using multiple channels to disseminate, directly through government websites, through membership organisations and through interactions with inspectors.

6.4 Plant procurement and selecting suppliers

For online retailers, the most important characteristic sought in a supplier is a high-quality product. However, perceived quality of a plant will often rely on certain aspects of plant health. Biosecurity was the characteristic most frequently ranked lowest. Disentangling the two perceptions of quality and health in plants, may be key in understanding behaviours. For example, quality assurance processes will often include considerations of biosecurity alongside other aspects of quality. In practice the advantage of such a tangled relationship could be to use the concept of quality (rather than biosecurity or plant health) to communicate and drive biosecure behaviour change.

The characteristic of good faith of a supplier ranked relatively low. Good faith is connected to holding trust that a supplier will act well, and yet 7% of respondents commented that Trust was a worthy characteristic not given in the list. Almost a third of respondents said they had not changed to a new supplier for better biosecurity, nor were they planning to.

Suppliers need to meet the high specification and volume requirements to be adequate for multiples, and as such there are not many choices of supplier for large businesses. Contracts reward suppliers with certainty, and reward retailers with quality (including plant health). These high specifications include biosecurity. This results in short supply chains and long-lasting, mutual relationships between suppliers and retailers who discuss and share information on pests and diseases, both formally and informally. Personal relationships are strong enough that an individual moving between businesses may seek to change the supplier of their new employer to one they already know.

Close relationships with suppliers and with plant breeders suggest multiples have the potential to be 'plant health influencers' both within the industry and in wider society in Scotland. It is therefore key to engage these businesses and encourage them to play a part in consistent biosecurity messaging resulting in, for example behaviour change of retail customers or overcoming the barrier of certification uptake as identified by retailers.

The increased complexity of trading rules and regulations (for example due to the UK leaving the EU) has resulted in greater value being placed on a supplier's ability to navigate such procedures.

6.5 Tackling plant health issues in the supply chain

Online businesses based in Scotland reported that they conducted fewer biosecurity actions than those based outside of Scotland. The mean number of actions selected from a list of 12 was four in Scotland and five outside of Scotland. This is a simple measure of biosecurity actions and does not measure how well these actions are completed but could indicate biosecurity in this business type in Scotland could be improved.

Over 20% of surveyed retailers do not inspect their plants on arrival, which is a key onsite biosecurity behaviour. Approximately half had formal biosecurity guidelines.

Non-specialist multiple retailers rely on upstream process management to prevent pest and disease issues, viewing that the best way to have healthy plants is to tightly regulate their suppliers. Close relationships with suppliers to share information minimises disruption to supply chain which rely on speed and efficiency. This includes pest and disease information, which is based strongly around regulations. Retailers and suppliers work together to find the most efficient way to meet all the regulations and deliver the best product.

However, there was variation in descriptions of how a pest and disease issue might be tackled; a highly centralised system to freeze movement / sale and compartmentalise risky plants versus placing plants in an area with other goods requiring return to suppliers. The interview sample size was small and due to the complexity of large multiples and the range of potential risks faced, it is not clear how response processes are designed or operate, or how responsibilities are shared across individuals or roles. This highlights the lack of current industry standard allowing for independent comparison and understanding of strengths and risks. This does not mean that retailers are not working to a very high biosecurity standard, but a better knowledge of these workings is required to assess plant health risk and determine: if these behaviours are generalisable within the sector; how decisions are distributed between individuals and designed processes; and what authority or responsibility an individual may have to update or change the system for better or worse.

Waiting for others to adopt biosecurity actions was a frequent barrier for online retailers surveyed to taking actions themselves, only behind knowing what to do, and having the correct skills and training. These barriers require a coordinated approach, potentially best suited to industry campaigns (for example Plant Healthy) publicising the businesses which are making changes, alongside government initiatives of information and training and other support to help business make the required changes.

6.6 The role of industry assurance or certification schemes

The Plant Healthy Certification Scheme was launched in February 2020, just a few weeks before the first Covid-19 lockdown. This resulted in challenges for the scheme, for example difficulties in auditors being able to visit sites for inspection. There are currently seven Plant Healthy certified nurseries, with a further seven that have the status of applicants (planthealthy.org.uk; List published 19th March 2021).

Over 70% of retailers surveyed either participated or were interested in Plant Healthy, although the survey did not ask respondents to specify how they participated. Encouragingly, of the biosecurity actions which online retailers are planning to take in the next two years, conducting the Plant Healthy self-assessment was the most frequent response, including 27 of 47 nurseries (57.4%); nurseries are currently the target business type of the scheme, which will expand into other horticultural business types.

None of the businesses who said they had taken the self-assessment continued on to participate in the scheme, whereas eight businesses who felt the self-assessment was not applicable to them did say they were already participating in some way. Assuming internal consistency of respondents' answers to questions of self-assessment and 'participation', 'participation' could perhaps be perceived as attendance at a workshop or webinar run by the scheme.

Having 'participated' with Plant Healthy was significantly associated with a lower proportion of sales made online - a lower proportion of online sales meant businesses were more likely to have already done the self-assessment. Garden centres surveyed had lower online sales and were more likely to have participated with Plant Healthy than either nurseries or growers. This study has not identified further subtypes of online retailer (see Section 6.1 Sample considerations), and so it is not clear what is driving this relationship. Most widely perceived

constraints of accreditation schemes in general were a lack of uptake and associated costs. Willingness to participate in a voluntary scheme may involve a complex relationship between perceived benefits and barriers along with knowledge of plant pests and diseases and concern for their impacts (environmental, commercial, reputational etc.). Over 80% of our sample of online retailers were specialists (garden centres, nurseries, and growers) and these business types may be thought to have a higher level of engagement with biosecurity issues than non-specialist types. This could be reflected in our results, and again would warrant further examination of sub-types of retailer. For example, a business which treats live plants foremost as a tradeable commodity, potentially with minimal contact with the plant or customer, may have a distinct set of knowledge, concerns, and perceptions, and thus distinct biosecurity behaviours.

Interviews suggested the value of accreditation schemes is seen as low with those non-specialist multiples interviewed, as they perceive their suppliers are already meeting or exceeding independent accreditation standards. Should government, industry or the consumer wish to compare a standards scheme such as Plant Healthy like-for-like with internal auditing of non-specialist retailers, efforts to encourage and facilitation their participation should be pursued.

7 Conclusions

The following conclusions relate to the study research objectives.

7.1 Identify decision-makers, their knowledge, attitudes, and behaviours relating to plant health

- Both knowledge of and concern for specific pests and diseases appears to be related to the presence of the pest or disease in the region, rather than the potential threat posed. *Further engagement with retailers is necessary as well as providing focussed plant health information through trusted sources and through multiple channels, particularly focussing on those pests and diseases which are of a high risk to the plant trade such as* Xylella fastidiosa.

- Online retailers have the potential to maintain minimal contact with both plant and customer, which could influence their biosecurity behaviours. However, biosecurity behaviours are not consistently predictable through the proportion of sales made online alone. The progress made by this study has further highlighted the knowledge gap in this area and a subsequent need *for research into understanding which characteristics of online plant retailers predict good or poor biosecurity behaviours.*

- The concepts of pest- or disease-free and high quality, are distinct but entangled. Whilst further research would help understand the differences, *using the concept of quality (rather than biosecurity or plant health) could help drive better biosecure buy-in and behaviour change amongst retailers and customers.*

7.2 Assess opportunities for and barriers to better plant biosecurity

- Within a number of large businesses, knowledge and responsibility for biosecurity is potentially distributed between several roles and plant health processes may well be unique to each business. It can therefore be difficult to pin down where risk dialogue should be targeted. We have found that non-specialist retailers can be disengaged from research and discussions on biosecurity. However, non-specialist multiples retailers could become biosecurity influencers both with their suppliers and customers. *Scottish government should work with Scottish Plant Health Centre and trade bodies to lead a series of focussed events and campaigns on plant health, including the potential for multiples to become plant health influencers.*

- Biosecurity is often a low priority for many businesses, both as a preferred characteristic in a supplier and when assessing risks to their business. The uncertainty of Covid-19 and EU exit impacts are of greater concern to retailers. There is potential to *consider further research into the impact on biosecurity behaviours of economic, legislation, or societal shocks, with the aim of increasing resilience of biosecurity behaviours in Scotland.*

7.3 Assess the potential role of assurance schemes for plant health

- Over 50% of retailers were planning on taking the Plant Healthy self-assessment in the next two years, and over 70% were either participating or willing to participate in the scheme. The major barrier was perceived as low uptake by other businesses. Non-specialist multiples rely on their suppliers to maintain high standards and work closely with them to achieve it but without independent auditing. *Further promotion to increase uptake of businesses joining the Plant Healthy Certification Scheme (including large retailers), would raise awareness of biosecurity issues and lead to an industry-led biosecurity standard. More work is needed however to address perceived challenges and concerns amongst all business types and sizes.*

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