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KNOWING TO GROW: INCREASING THE RESILIENCE OF PLANT-CENTRED FOOD PRODUCTION SKILLS

Horticulture in the UK – Characterising Knowledge Ecosystems

Research Report 2022

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1. Introduction

Knowledge and skills are essential for producing food; ensuring their future availability is therefore vital for resilient agri-food systems. The *Knowing to Grow* project (2018-2022) focuses on this challenge in the specific context of UK horticulture - the most labour intensive part of food production. The research sought to characterise the skills essential to horticulture, and identify vulnerabilities in current knowledge systems. It considered growers operating at different scales, operating conventional and organic production.

Methods included semi-structured interviews, participatory workshops, and observation or go-along interviews at growing sites. The project received ethical approval from Cardiff University School of Geography and Planning Research Ethics Committee. Data collection was interrupted by the coronavirus (Covid-19) pandemic, which reduced the potential for on-site fieldwork. This was counter-balanced by use of remote methods (online interviews and workshops) involving a wider range of growers. In total at least 50 Individuals were interviewed, representing 15 growers and 17 associated organisations; additional participants joined workshop discussions across the project. All data was stored and processed in NVivo to enable thematic analysis.

This report presents the characterisation of growers' knowledge ecosystems – the key actors and processes which ensure the know-how required to grow food is available and applicable. Analysis suggested that it was most insightful to distinguish between larger and smaller growers as operational scale was a key determinant of the form of knowledge flows, and the issues faced. There is variation within these categories - not least between organic and conventional growers - but there are sufficiently common issues associated with scale. Smaller growers include those which are owned and run by one or two individuals a family or community organisation, with less than 10 workers, tending to supply local supply chains and operate to agro-ecological or organic principles. Larger growers include businesses with multiple production sites, 100+ workers, likely to supply large national retailers and operate in-house packing.

2. Horticultural skills

There is a widespread and long-standing narrative that work in horticulture is largely unskilled (Pitt 2019, Pitt 2021). Those who work in the sector or are familiar with the work are clear this is not the case, and that even the most manual tasks entail skill which employees become adept at, gaining expertise as they work. The tension between the narrative about the work, and the reality of what it entails has been highlighted by the industry's plea to be allowed to recruit beyond the UK within a skills-based immigration system (EFRA Committee 2022). This recruiter for a large grower therefore commented of their seasonal workers:

> As much as the government says it's not a skilled job, it is a skilled job, it's a very hard day's work (L2[1]).

Studying the tasks and processes involved from seed to saleable produce reveals the vast array of expertise required. Growers emphasise the breadth of knowledge their operations entail, including not just the obvious crop husbandry but crucial dimensions such as business planning:

[1] Growers are categorised as larger (L) or smaller (S) and referred to be a number to maintain anonymity. Other stakeholders are referred to as (SH).

> I think the actual farm management's the hardest thing and the actual idea that we have to be able to do this in a manner which is timely enough that we can actually make money (S1).

For businesses run by one or two individuals this means each require a huge range of abilities and insights. In larger operations with greater division of labour the skills involved range from those of a technical specialist with post-graduate training, to the many fieldworkers who mostly learn on the job:

> I hate it when people dumb it down. You can make a leek look like a dog's dinner, or you can make it look like an absolutely lovely vegetable that's delicious to eat, and it's just the skill of how you pick it, and how you strip it and that's the skill of it really (L1).

This manual dexterity and hand-eye coordination represents a crucial form of skill within horticulture which is often over-looked or deliberately under-valued (Klocker et al 2019).

The definition of skills developed for this research seeks to embrace this diversity, and acknowledge the considerable amount of experiential learning crucial to horticulture (Pitt 2021). It understands horticultural skills as the abilities required to grow food, know-how which extends throughout human bodies and between them through social interactions and use of materials (Figure 1). These have three key areas of accomplishment: know-how to grow food plants, managing/maintaining a viable enterprise, and developing insights to enhance production and mitigate risks. Knowledge flows between those involved through formal and informal education, with a high degree of 'learning by doing'. However, these flows are disrupted or prevented by external pressures and inadequate resources or people flowing into the system. Over time this has created a situation of shortage with horticulture lacking skilled workers and its educational infrastructure depleted (Pitt 2019).

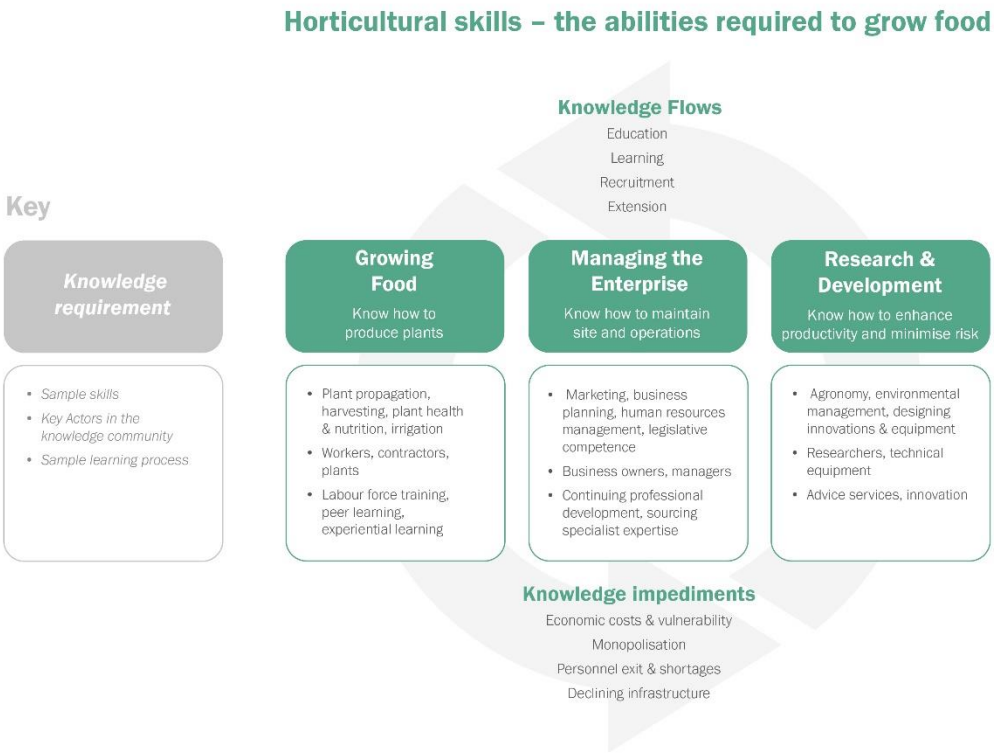


Figure 1 The food growing knowledge system and its challenges (Pitt 2021)

3. Growers' skills ecosystems

To better understand the nature of the sector's skills and the challenges faced, data from a number of growers was analysed to characterise their knowledge systems. Based on this analysis, an archetypal knowledge ecosystem of growers at larger and smaller scale was devised, identifying key actors, resources and flows associated with essential know-how. These are organised around the three key knowledge categories noted above. The research also sought to identify what makes it difficult for growers to access or apply knowledge (impediments) and conversely, how this is aided (enablers).

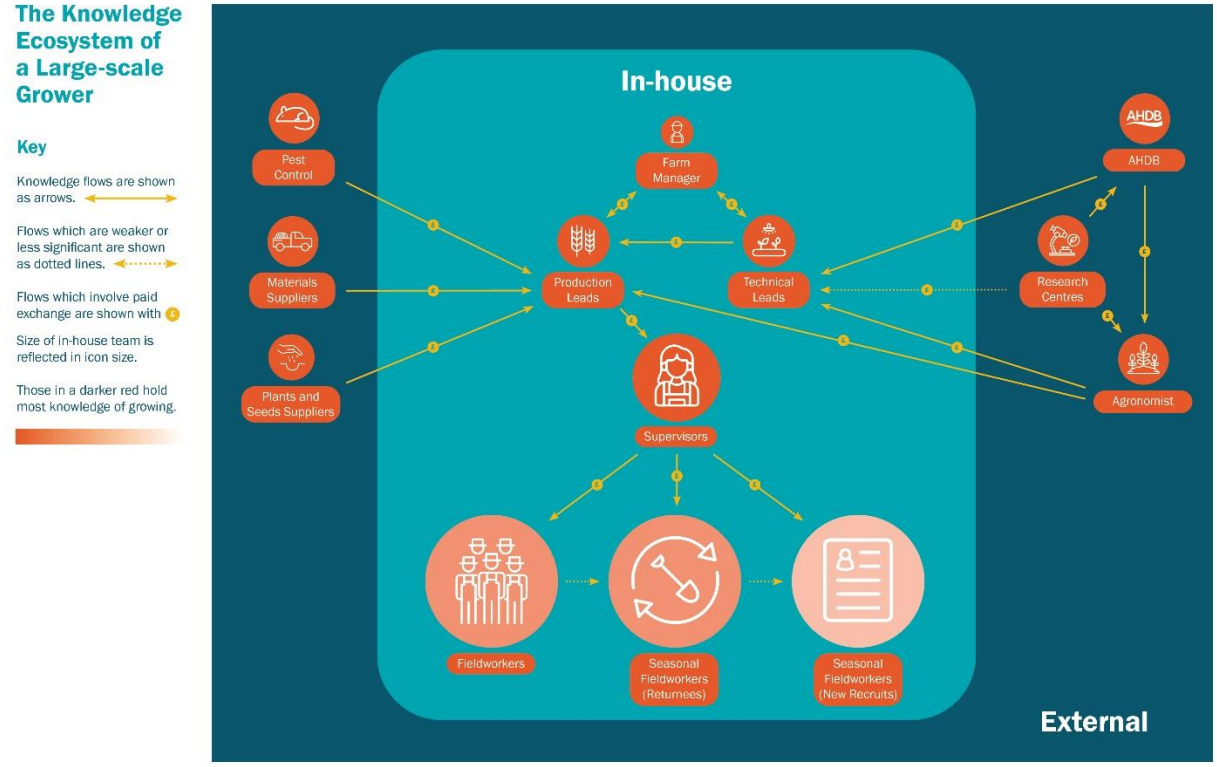


Figure 2

a. Larger Growers

Knowledge and skills used by larger growers are held by workers across the organisational hierarchy, and are distributed between teams which specialise in certain functions. Communication and coordination between these are vital to ensuring the complex logistics required to get quality produce to retailers at the right time. Knowledge exchanges are largely associated with paid transactions: being paid to do a job, or deliver a service. There are few exchanges between growers, due to specialisation as much as commercial confidentiality: there are few businesses engaged in the same kind of production. The levy on horticulture had required larger growers to contribute to a centralised knowledge and research hub – AHDB – but their recent vote to end this suggests that the service received was not perceived as good value (DEFRA 2021).

Table 1 Skills Ecosystem of Larger Growers

Larger Growers Skills Ecosystem

	Growing Food Know how to produce plants	Managing the Enterprise Know how to maintain site and operations	Research & Development Know how to enhance productivity and minimise risk
Description	Combination of in-house and contracted expertise / inputs (e.g. plants, pest control). Very specialised crop-specific knowledge built up over years of experience. A large proportion of work relates to harvesting/ picking.	Complex logistics and coordination of crop, employees and market. 'People skills' to keep employees motivated and efficient. Planning and monitoring to maximise efficiency.	R&D / trials in partnership with researchers. Knowledge exchange with crop specialists.
Key Actors	Machinery / technology. Large number of seasonal field workers and supervisors. Smaller number of permanent field workers and supervisors. Small number of managerial / specialist roles (e.g. Head Grower, agronomist). Suppliers of key inputs.	In house back-office teams (e.g. finance, HR, marketing, IT). Links between back office and field (e.g. farm managers, drivers, accommodation managers).	In-house specialist: agronomist, crop lead, trials team etc. Researchers at UK institutions. International specialist experts.
Knowledge Flows	Learning 'on the job' - by doing. Learning from colleagues - showing and shadowing. Higher level roles have generic / technical education but learn specifics in-house. Records of cropping plans and outcomes.	Internal communications (e.g. meetings, email). Administrative processes and records.	Recruit experts from other growers, often overseas. Pay for expert advice. In-house crop trials.
Knowledge Impediments	Poor retention or return rates reduce efficiency and learning on the job. Large number of seasonal roles. Inadequate supervisory skills. Can never 100% know what crops will do.	Lack of time and skills for thorough communication. Uncontrollable variables (e.g. weather, customer preferences).	Time to engage in knowledge exchange. High degree of crop specialism. Unpredictability of future conditions (e.g. climate).
	• Importance of timeliness and pace. • Communicating across languages and cultural groups. • Need for efficiency increases workload pressure. • Physically demanding work. • Numerous uncontrollable variables. • Specialisation limits relevance of external expertise.		
Knowledge Enablers	• Motivated workers with the 'right attitude'. • Good work-place conditions and culture. • High employee return and retention rate. • Public bodies provide appropriate and flexixble knowledge exchange options. • Resources to buy in people and expertise. • Business scale and diversity provides adaptability. • Internal career progression opportunities.		

Growers at this scale experience a range of skills-related challenges, the most prominent being labour shortages. Their operations require large numbers of field workers, particularly for the harvest season but all reported ongoing struggles to recruit and retain sufficient people. These shortages create uncertainty, and are hampering potential for expansion: "I could quadruple the veg business tomorrow

if I knew we had labour" (L4). Although recruitment at all levels across the sector is a known challenge (Pitt 2019), the scale of recruitment for fieldworkers makes it more acute, and is complicated by the dominance of seasonal roles. The volume of seasonal work gives the industry particular challenges:

> it's reliant on bringing in a lot of labour during that period. So there's a big emphasis on how do you recruit skills, how do you get those skills up to speed as quick as possible and then how can you then retain the skills? (SH2).

Whilst this challenge has been apparent for many years, growers suggest that it has changed in recent years as the quality of workers has declined:

> so not only have we had migrant labour slowing down, that migrant labour coming is not the same quality as it always used to be (SH1).

There are three important repercussions of this which ripple across the knowledge ecosystem: firstly, the supply of labour is less certain making it harder to plan or coordinate logistics across the business in response to short-term changes such as weather. Secondly, fewer workers are in-post long enough to gain good proficiency in tasks, or bring back skills acquired in previous seasons. If a high proportion of seasonal workers are returnees it is easier to up-skill new recruits:

> the retention thing it's just so important because you retain that kind of skills base that you can then use to help, because that's essentially how - through our totally informal training structure - that's how we get the message across about how to do all these quite technically skilled jobs (L1).

Thirdly, retention is financially advantageous as it avoids the cost of finding and establishing new starters, but also experienced workers are more efficient so more productive, meaning better profit margins. This means more resources available to invest across the business' needs, including knowledge exchange.

Large growers have established their preferred routes for filling seasonal vacancies, with first preference being for good workers from previous years returning, bringing back skills they acquired. Various incentives are used to encourage returnees, as their efficiency and reliability is worth investing in. Where recruiters have to take new starters, they seek indications that someone will commit to the work meaning signs of endurance to physical, outdoor work. They described trying to convey the reality of the role, to avoid starting people not suited to it or who are unlikely to stay the season. As it is unlikely that many people have done fieldwork before, the priority is recruiting people with the 'right attitude':

> It's about attitude, it's about wanting to be here and wanting to do it (L3).
>
> People with the right attitude, a good working attitude, reliable, industrious, you know (L1).
>
> You don't really need any skills, but yeah, just willing to work really (L5).

As suggested by the last quote, growers know they can upskill people on the job, providing they show up willing to work. One grower's recruitment process includes time in the field so they can observe knife handling skills and check for manual dexterity. But even for more specialist roles such as tractor driving, there are few qualified applicants so in-house training is common.

The challenge of securing sufficient workers relates to the nature of the work:

> they are doing cultivation by hand because all of our crops are quite labour intensive. So we have tried to mechanise where we can, but we can't for a lot of it (L2).

Tasks such as picking are difficult to complete with technology, whilst reducing the appeal of fieldwork jobs. The work is commonly described as 'back breaking' due to the physical demands of bending, moving quickly or standing and kneeling for long periods plus being outdoors in any weather, or under hot humid polytunnels, then lifting and carrying heavy crates. As well as deterring potential recruits this fuels staff turnover: "it's just very physical, you can't do it for very long" (L1). These workers typically have long days, perhaps doing a very repetitive task which presents another challenge: "Keeping them motivated and happy which is pretty difficult cos it's an awful job" (L3). It is the supervisors' job to maintain productivity, but they do not always have the abilities for this:

> The supervisory skills is a gap we've seen as well, so those people that have been promoted from doing, into management, but not given the skillset (SH1).

Some growers target training and support at this issue, as do programmes such as AHDB's Champion Picker (AHDB n.d.). In most cases, they also have to consider how to communicate effectively with teams that have mixed levels of English language ability, with messages ideally conveyed in two or more additional languages.

A strong theme was the importance of supervisors and managers having 'people skills' to communicate effectively, and get the best out of a team. However:

> You've got this big uplift in numbers of people in the business for a period of four to five months and then most people leave the business again. So it's how do you upskill those individuals as quick as possible? So freeing up some capacity for team leaders to allow them to pass on their knowledge to those individuals that have come into the business so they can be upskilled in shorter lead times and therefore contribute quicker (SH2).

At managerial level workload means there is not always time to communicate thoroughly. Some managers described a culture of farm work which includes long hours, unpredictable demands and being 'on call' every day. Whilst other industries have this, the difference is unpredictability of conditions and the need for rapid responses:

> it goes wrong a lot no matter how brilliant you are and it's coping with those stresses cos it is pretty stressful. And so much of what happens is actually out of your control (L4).

Farm managers described many elements to their role, little of which is directly involved in growing crops, rather they oversee and coordinate aspects of the system, and trouble shoot.

Across this activity, a consistent challenge is uncertainty and the number of unpredictable elements affecting production. As one farm manager described it: "you're in control of very few aspects of your role" (L4). Unpredictable variables such as weather and plant health are not new, but these growers now experience significant uncertainty about staffing which adds stress: "this period of uncertainty is making us all feel a bit icky" (L2). This began to intensify in 2016 with the UK referendum on EU membership, and resultant uncertainty regarding migration rules. Then came lack of clarity about the Seasonal Workers Pilot, followed by complications of new visa administration processes. Worker availability can no longer be predicted with certainty:

> when we sat down yesterday, I had to remind [management] when they're doing the labour forecast, that lead-in time is now not days, it's a minimum of six weeks (L3).

This is a significant increase which reduces growers' flexibility to respond to changing conditions:

> there is so much possibility for, for variability, and you have to be able to have a robust plan that's got enough, sort of, tweak room in it if needs be" (L2).

Linked to the uncertainty of growing crops, is the time pressure:

> people are busy and in fresh produce, time doesn't stop, like you have to just keep going and you have things that are now suddenly urgent (L2).

Growers have to coordinate the crop's response to growing conditions, with the orders and retailer timescales:

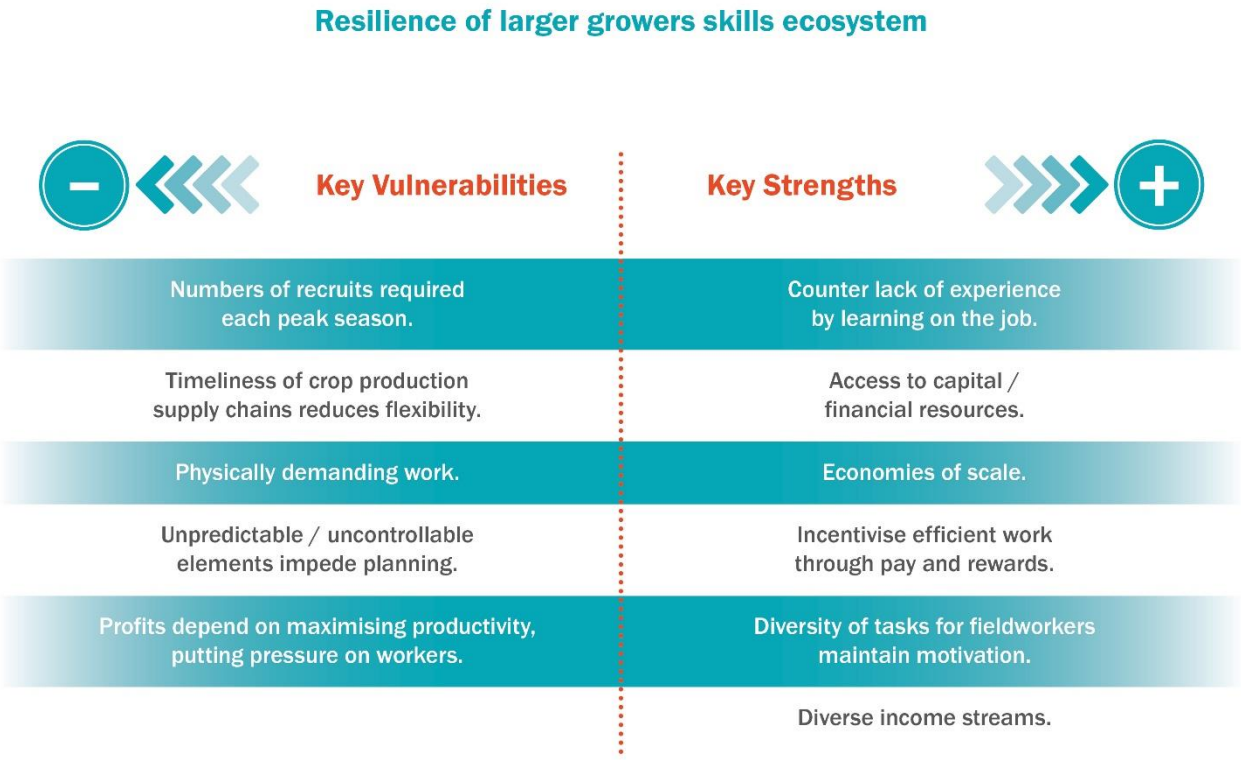
> it has to be, very much just in time, harvested, and honestly, in a customer depot, overnight, and then on a shelf the next day really. And then it has a shelf life of probably, three to five to maybe seven days. It's timing it, so you can have a brilliant crop but if it comes too early or too late, then it might not be particularly useful to us (L2).

And all this in return for a low price, driven by retailer's wish to charge customers as little as possible. Timeliness makes the logistics of coordinating people and produce highly complex, and place workers under strain (Medland 2021).

Another crucial dimension of these growers knowledge systems is that many skills are acquired on the job rather than through prior training or qualifications. As noted above, there are insufficient experienced seasonal recruits so supervisors have to induct and upskill new starters annually. This is largely achieved through showing a task, then doing it and being observed so improvements can be suggested, then the worker keeps repeating the task and develops their own techniques. Over time workers gain pace meaning those on piece rates can earn more, and are incentivised to work rapidly. At more senior levels and for more specialist roles, learning on the job is also prevalent as there are too few people graduating with specialist qualifications in horticulture. Even those coming with experience from other growers, are unlikely to be familiar with specific crops or production systems. As these businesses have a hierarchical structure there are career progression opportunities, which can help retain 'good workers', and means knowledge built through experience stays within the company.

Whilst not encountered during this research, there are known cases of exploitation of horticultural workers including those on the Seasonal Workers scheme (FLEX 2021; Mellino et al 2022). The regulatory controls which should protect those coming to work on UK farms is under resourced and inadequately enforced to prevent this. Poor treatment of workers and the risk of modern slavery is the nadir of the race to the bottom driven by pressure to keep prices low. The impacts on those treated badly is clearly the prime concern; there are also knock-on effects for the industry as a reputation for exploitative practices makes it harder to recruit, or argue for public support.

Figure 3



In face of these challenges, growers at this scale have some features which help them ensure access to the knowledge and skilled workers they need. Firstly, are resources to invest in conditions which enhance retention rates such as quality accommodation, and payment incentives as detailed in a project case study[2]. Secondly, effort is going into improving efficiency to maximise productivity from the minimum number of workers. This was the aim of AHDB's SmartHort programme, which advised on how to coach teams to enhance their performance, and use of approaches like LEAN to reduce inefficiencies. Some growers are also evolving their production to adapt to the types of workers available, for example providing part time family friendly roles. Where businesses produce multiple crop types, or combine horticulture with other production, there is capacity to offer year-round posts which may be more appealing to local recruits:

> So you're trying to set these bits of the business up to have permanent staff year round. [...] So you work from the labour backwards (L4).

Larger growers can address such enhancements because they have specialist staff focused on human resources, and resources to invest in them. They are also able to ride out short-term challenges due to having financial reserves, or a diverse business model which means losses in one income stream are

[2] https://www.cardiff.ac.uk/__data/assets/pdf_file/0011/2592335/GEOPL-Keeping-and-improving-seasonal-workers-November-2021-final.pdf

made up elsewhere. Whilst scale and diversity can reduce risks, growers also pointed to the need for similar resilience at the individual level given the likelihood of things not going to plan.

These growers are large enough to have most of the expertise they need within their own staff. Experienced specialists might have been recruited internationally, or from other UK growers but the level of specialisation and consolidation in the industry means that there are few high-level experts with experience of each crop type. It is not unusual for a generalist with useful technical skills or scientific education to gain higher level expertise via the company as they work. Large growers effectively become the authority on the crops they specialise in, with more knowledge than more generalist advisory bodies or consultants in the UK. For innovation they therefore look to research institutions and countries with larger horticultural industries. At the levels of both specialist technical expertise and field worker skills, learning on the job and from others within the business are crucial, with knowledge circulating within the organisation rather than flowing in from outside.

b. Smaller Growers

Smaller growers are required to deliver many of the same functions as their larger counterparts but with fewer workers, meaning less division of labour. These growers are more likely to produce a range of crops rather than specialising in a small selection, meaning that workers need wide-ranging horticultural knowledge. Knowledge flowing into the organisation often comes via voluntary processes such as peer exchanges, for which no payment changes hands. Growers are likely to have learnt to grow through training placements or internships with more experienced growers, or in the course of doing the job. This learning is supplemented by self-teaching and experimentation, plus use of resources such as books and instructional videos. Organic and agro-ecological approaches common at this scale entail work to adapt general principles and practices to specific sites and contexts, meaning that learning by doing or trial and error is almost inevitable. Many participate in the community of practice represented by networks of growers working in similar ways, and associated organisations such as the Organic Growers Alliance. This often includes passing learning on to volunteers, trainees or employees, and advising new entrants through formal and informal mentorship. The values and benefits associated with this approach to food production means growers attract volunteers, including international visitors who live on-site.

Figure 4

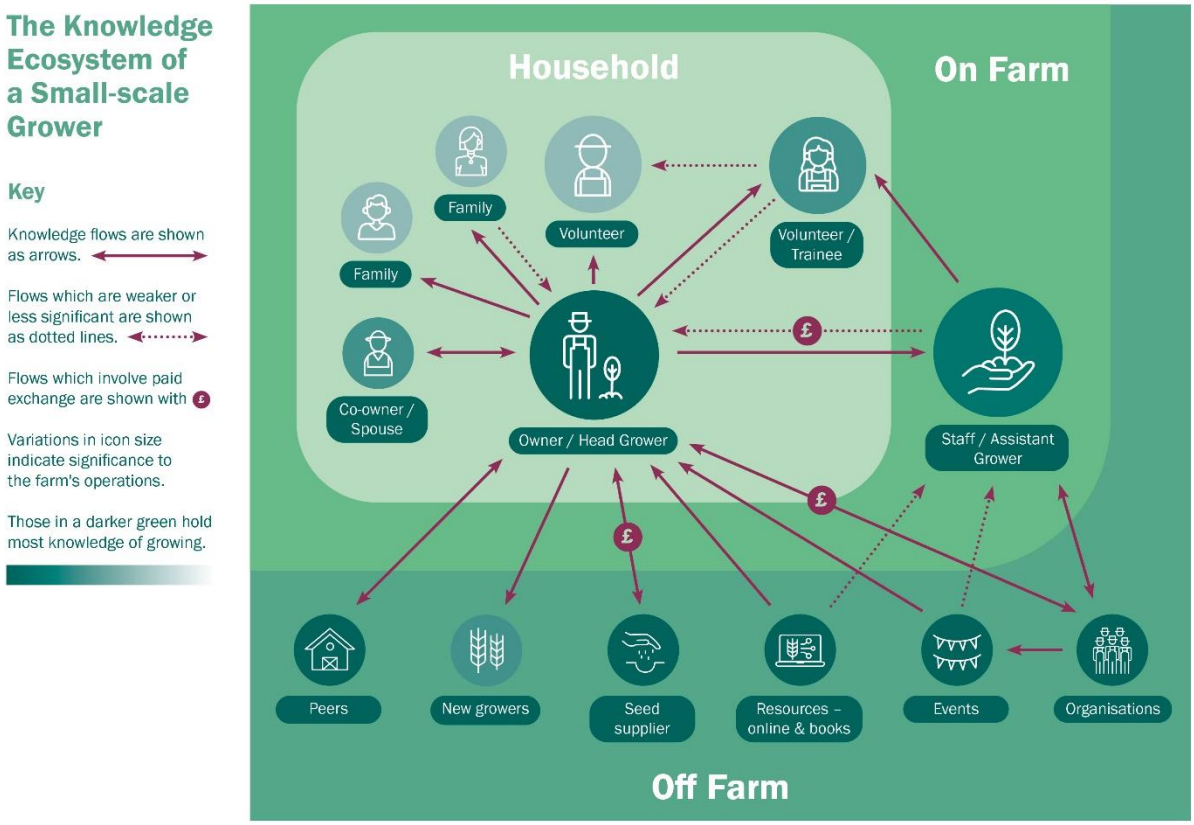


Table 4

Smaller Growers Skills Ecosystem

	Growing Food Know how to produce plants	Managing the Enterprise Know how to maintain site and operations	Research & Development Know how to enhance productivity and minimise risk
Description	Small team responsible for all stages of producing diverse crops. Knowledge specific to location and production system. Emphasis on fertility and soil management. Chemical-free pest and weed control.	Whole supply chain management including sales, marketing and customer service. Financial management e.g. book keeping, grant applications. Hosting residential volunteers and running the household.	On-farm trial and error. Trials run by specialist organisations and research institutions.
Key Actors	Owner / head-grower. Employed or volunteer assistant growers. Apprentices / trainees.	Partner / family members. Book keeper/ accountant.	Sector organisations e.g. OGA, Soil Association. More experienced growers.
Knowledge Flows	Self-learning by doing. Showing by more experienced growers. Advice from peer networks through informal exchanges or mentoring. Online and printed resources.	Self-learning by doing. Advice from peers through informal exchanges.	Advice and training sessions e.g. Farming Connect. Publications e.g. OGA magazine. Online forums.

Smaller Growers Skills Ecosystem

	Growing Food Know how to produce plants	Managing the Enterprise Know how to maintain site and operations	Research & Development Know how to enhance productivity and minimise risk
Knowledge Impediments	Uncertainty and uncontrollable variables e.g weather. Need to adapt generic knowledge to specific site/ system. Difficulty recruiting experienced growers / assistants. Short term volunteering placements mean regular turnover.	Lack of personal aptitude.	Time to engage in knowledge exchange. Lack of resources to invest in innovation. Unpredictability of future conditions e.g. climate. Limited formal provision of specialist knowledge exchange e.g. organic horticulture.
	• Workload exceeds regular or reasonable workforce. • Lack of resources (time, capital) to invest in learning. • Lack of time for communication and knowledge exchange. • Large amount of crucial knowledge held by individuals. • Limited record keeping. • Auto-didacts lack efficiency / reinvent the wheel. • Working under physical and mental strain.		
Knowledge Enablers	• Personal qualities and motivations e.g. determination, resilience, interest in food. • Willingness to share knowledge and grow the sector. • Informal learning processes operate with minimal resources.		

The scale of these operations means that recruitment and workforce challenges are less acute than those common to larger growers. But operating at this scale brings other challenges, most notably workload and associated stress: “you know what makes it stressful is that there’s never enough time, you know?” (S1). Growers described working long hours with little time off, and rare holidays, resulting in physical and emotional strain, which makes it harder to carry on working or think through solutions. At key times in the growing cycle the pressure is particularly intense, but there is no option to rest:

> Spring is the worst if we miss things because catching up in the spring is really difficult. If things are difficult in the spring, so then generally difficult throughout the year. If you miss the opportunity of sowing seeds or you miss the opportunity of getting those sown seeds, those modules to plant into the ground, it’s quite hard to come back from that (S1).

Having a small, or no team, places many responsibilities on few shoulders:

> I feel an emotional strain, it’s like I’m so busy already and suddenly the only person that’s gonna fix this is me. And then I have to go and learn how to weld and there’s that horrible realisation that ends up, I’m just gonna have to go and learn how to do this (S1).

In family farms, the business owner may also bear the burden of financial pressures such as ensuring repayment of loans used to buy the property. Here the pressures of farm work includes work of keeping the household going, as this spouse of a grower explains:

> so that’s the other struggle, and X totally does not get it. I manage way too much. I largely manage the kids, I do a lot in the household as well as working two days a week and then trying

> to stay on top of our books and our [accommodation] bookings. It's too much to manage. Even with a book keeper, and we do have accountants but we kind of keep them to a minimum because it's expensive (S1).

For farms which use residential volunteers, this also includes hosting duties – keeping everyone fed, and providing a rewarding experience.

Closely related to these workload pressures are the challenge of making a profit and securing sufficient income. This is particularly acute for those who took out significant loans to buy land, but is more widespread:

> How do we make sustainable farming pay? Because, it's evidenced widely in the States - there was a huge number of young farmers who've gone into farming who can't make a living off it. And we have to fix that. But again, I think that means also changing our economic system so the likelihood of that happening… (S1).

Scaling-up production might seem an obvious route to increase profitability, but this is complex:

> The issue that we always face is economy of scale. The problem is scaling up and the finances of scaling up. It's labour really over everything. It's just having the money to invest in that initial scaling up and then getting it delivered (S1)

Business growth requires more work, which means generating sufficient to pay more workers – a tricky balance between workload outstripping capacity or costs exceeding income. When smaller growers do seek to recruit for paid roles, they are not always able to: "I've been desperately looking for an assistant grower, and the difficulty of finding that person, that has surprised me actually." (S1). There are a steady stream of people wanting entry level roles, or training to set up their own enterprise, but few applicants for more skilled roles.

Whilst smaller scale growers do not require significant numbers of workers their production is relatively labour intensive due to tasks like weeding which are particularly important in organic systems. The challenge of delivering these in a low-income operation is often met through voluntary work. However, this is not an uncontroversial issue and is often debated amongst growers:

> over the years we've just had lots of discussions about the ethics of that, and for a lot of businesses it is essential, because they can't run - or they feel they're not financially viable - without using volunteers, or they want the community engagement. But it's just a really thorny issue. Should the organic vegetable market be propped up by volunteer labour? (S4).

Minimum wage legislation means: "[if] all you're after is free labour, that's not only not particularly moral, it's also actually illegal" (S3). Within community supported agriculture (CSA) volunteer participation is part of their engagement and education remit. Long-term volunteering is seen as a sustained form of this exchange:

> we are aware that we definitely run on that volunteer help to make it viable. I think that is true. I used to feel really concerned about that and I feel less concerned because I feel that we are able to pay back in a different sort of way. And that's not hollow words. We really put a lot of effort into doing that and I think people appreciate that (S1).

This family feel their volunteers are rewarded through learning about food production and associated issues, and an enjoyable experience, alongside the more material provision of food and accommodation. Those who choose to work in this way clearly think it worthwhile, whilst organisations such as WWOOF seek to foster a safe, fair and rewarding experience.

What makes the ethics of volunteering more complex is that it is a key pathway into agro-ecological growing, with most experienced growers having taken voluntary roles or placements:

> I got my training by being a WWOOFer, and I directly committed to work and then I was learning what I wanted to learn from being there (S2).

But this means that the opportunity to train in growing is limited to those able to work for no income: "if you can't pay people there's only very few people who can do the training" (S2). This limitation may be mitigated by providing accommodation and/or board, however:

> that's obviously only going to be people who are in a position where they can just take six months out, live on a farm and they don't have any other responsibilities that are going to need an income beyond the stipend for that time (S6).

Growers who want to provide more inclusive training opportunities look for funding to enable them to pay trainees: "Every year we're scrabbling for bits of money to support trainees, we haven't got the money within our business to employ trainees" (S2). Some have used schemes such as Kickstart to support this, but such funding is not flexible or long-term.

The challenges around offering internships or similar training placements are significant as it is the most common way for people to develop knowledge in agro-ecological and organic growing. This situation has arisen because of a long-standing lack of suitable education provision:

> I applied to Harper Adams and to Aberystwyth as a mature student on their organic farming courses. But there were two frustrating things. One of them was the realisation immediately was that actually it was an organic module which was tied onto a conventional agriculture course and b), I was going to spend the next two years in a classroom. And I'd come out probably trained as a agronomist having a real understanding but actually no soil time. Or the alternative was to go, if I could have found one - because there are still a few around - to go to a straightforward horticultural college. Again, you'd either be in horticulture but really utility horticulture, looking after grounds in a very conventional way, or driving a sprayer safely. None of these things ticked any of the boxes so I really didn't know how to learn and there really weren't any alternatives that I could access. So I just had to go and do it (S1).

This grower described a typical pathway of volunteering on a farm, then taking an entry-level job as a grower, and learning by doing. They have no formal training or qualifications in agriculture, and now offer similar learning opportunities to new entrants.

How people learn the skills of food growing suggests that this reliance on learning by doing is not just a result of lack of courses:

I think that will always be amongst the growing community the most valuable source of growing is that, of learning, is actually doing it and actually just doing it with someone else who knows about it (S2).

The most prevalent way knowledge is exchanged within growing operations, and between growers, is: "just sort of learning as you go along" (S1). Even those with some prior experience, need to adapt knowledge to their site, in particular weather and soil:

> having an understanding of how plants grow and of soil - all of those things can be learnt and then you adapt because you can only learn on somebody else's ground. I can take my skills and what I know - I came here from Hampshire having grown on a yard of topsoil with everything being fantastic and very, very different and [here is] very difficult soil in comparison. You just have to be adaptable and I think adaptability is an important thing, being able to understand that and go with it (S1).

There is little alternative to learning by doing, because each farm, each crop and each year is different. For the less experienced worker, doing this alongside others is a key knowledge flow, a form of apprenticeship in which instruction combines with practice and improvisation (Lave and Wenger 1991). This volunteer explained how they knew how to do a task:

> In that case X guided me, so, I'm guessing, Y had taught her, but she would very specifically, literally, with hand in the soil direct me what to - or just say what to look for, what to worry about and what not to worry about. And, actually, just, sort of, show me two or three examples and then let me go for a while. So, very hands on. She just has to show me first. We're doing things together most of the time (S1).

This mode of learning can be delivered by anyone with adequate experience, happens informally, and is context-specific. It has characteristics of a community of practice in which novices are inducted by the more experienced (Wenger 1998). These exchanges also occur throughout the network of smaller growers, through farm visits, events, or discussions. Increasingly they are mediated by technology as peers exchange images and advice via WhatsApp, or look to YouTube tutorials to be guided in new tasks.

Several of the challenges experienced by smaller growers are parallel to those noted by larger ones, and arise from the nature of horticultural work. Firstly, at any scale, the work is 'back breaking'. This in combination with outdoor conditions which take a toll, particularly on those who are older or have worked many seasons. But persisting when work needs doing is difficult for anyone:

> The most challenging? Maybe the winters. The wet days, the shit days. I would say yeah, just like keeping motivated, I guess (S1).

Weather is also part of what makes the work unpredictable, with successful growers seeing themselves as adaptable:

> I think naturally people in this sector can respond really well to vulnerability because it comes second nature, whether you're responding to pests and disease, or too much rain. Everything is problem solving from start to finish (S5).

Being able to observe what is happening with crops, assess conditions and respond are key skills, which develop over time. Whilst there are advantages to learning by doing as many growers do, there are potential limits: "one of the real concerns about learning here is that you sometimes feel like you're re-inventing the wheel and that's rubbish" (S1). Those who have relied on self-learning recognise that they may not be doing things the most efficient way, or might have developed expertise more rapidly through teaching.

Growers noted that they might usefully introduce innovations or new enterprises but struggle to take time to develop these: "I don't even have the time to think it through properly, let alone make it happen" (S1). This arises from the volume of work and need for timeliness:

> during the growing season there's very little time to do anything meaningful outside production (S3).

This means accessing learning events is difficult, as is participating in mentoring or other knowledge exchange – as recipient or provider. The significance of peer networks as support to growers, and the centrality of informal knowledge exchange to their learning makes this problematic as these flows depend on people volunteering their time. The strength of this system is the extensive willingness to do this: "So pretty much everybody is desperate to share in their own way" (S4). Those who benefited from others' expertise want to offer the same for others, but this can be limited by capacity and is an additional source of pressure: "I don't know how sustainable it is in terms of burnout" (S4).

Even within their operation, growers noted that it can be difficult to keep information moving due to workload pressures. Things like regular meetings and recording data or plans slip down their priorities, plus those attracted to growing do not always have an affinity with such tasks.[3] This can exacerbate the risks from limited division of labour and reliance on key individuals:

> I think probably the majority of small farms run like that, that there's one or two people who hold all that information, and it can very quickly all fall apart (S2).

Relying on one or two people, and limited record keeping is vulnerable to individuals being incapacitated or moving on:

> I guess the main vulnerability is just how it's proportionally much more dependent on individuals than in a larger business (S4).

It also exacerbates the strain those key people work under: "it's a lot of work and a lot to keep in your head and a lot to keep on top of" (S2). The breadth of responsibilities each worker has makes it difficult to replace them with someone who can immediately step in. A grower who had struggled to recruit an assistant noted that applicants lacked experience at a commercial scale, or had only entry-level skills.

This relates to another key vulnerability across this sector:

> I think there's actually quite a good network for the informal exchange of information and tips between experienced growers. I don't think that there's a clear route for somebody who wants to come into the industry, organic horticulture from scratch, I think that's got weaknesses (S3).

As discussed, gaining skills and experience usually comes through a job or volunteering, which is not inclusive and lacks assurance that learning is quality and comprehensive. More standardised programmes have been run by Soil Association and others in the past, and are being developed by organisations such as Land Workers Alliance, but are dependent on project funding. This is problematic for being short-term and uncertain; some argue reliance on voluntary sector provision is also wrong:

[3] Research associated with this project identified numerous challenges around data collection and recording amongst organic market gardeners https://www.cardiff.ac.uk/news/view/1718735-data-collection-tool-can-help-organic-market-gardeners-maximise-profitability

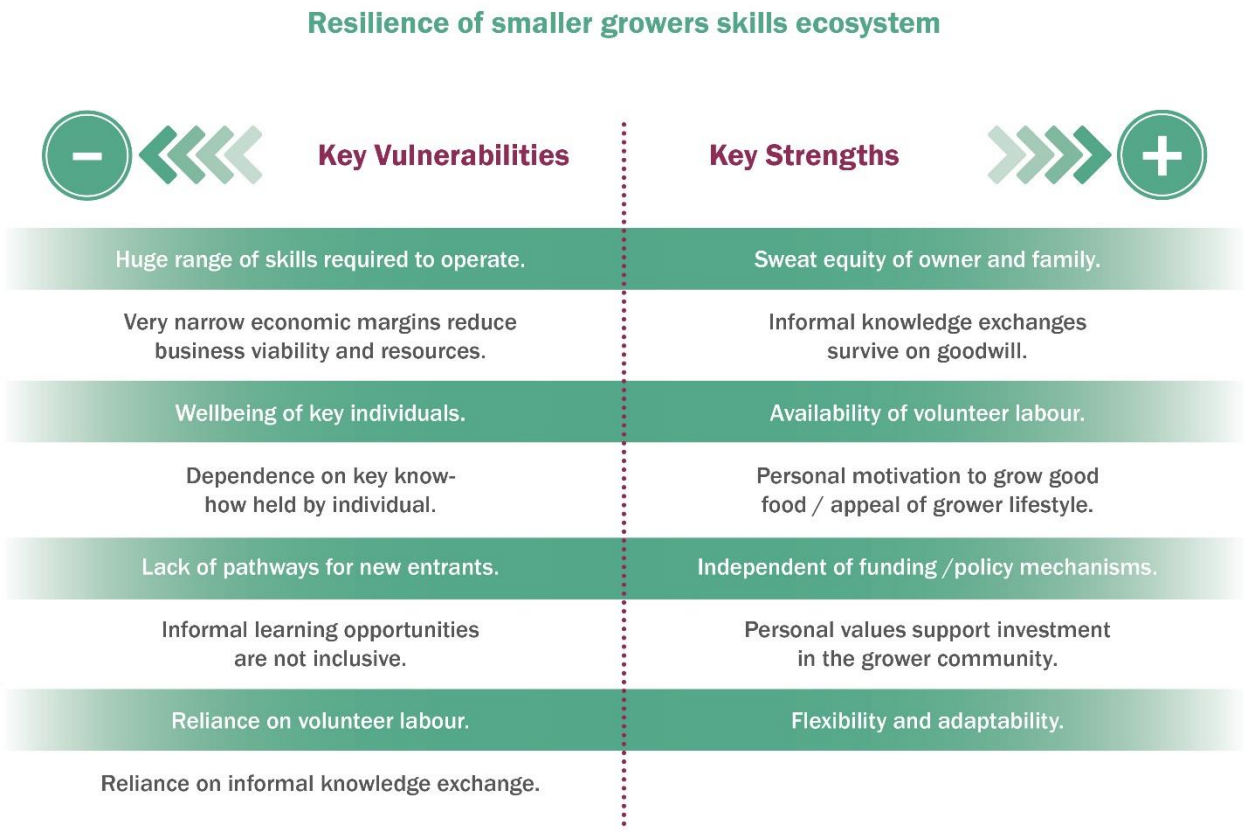
> Actually, I don't think it's a charity's job. I think it should be a government thing and it should be linked very closely to a comprehensive strategy to get a resilient, sustainable food and farming system (S3).

Growers who have accessed government support to host paid apprentices suggested this model should be guaranteed:

> a properly funded functional apprenticeship scheme that actually gives new entrants the knowledge and experience and equips them to go off and start the business on their own (S3).

Such support would allow growers to recruit trainees annually and pay them, whilst rewarding time they invest in sharing knowledge, thus addressing current limits experienced by those hoping to access or offer traineeships. There was no suggestion that growers want to stop contributing to voluntary knowledge exchange, or reduce their use of peer learning, rather they want to have capacity to invest in it properly. This either requires their businesses to be more profitable so they can pay for additional labour to reduce workload, or that external funding pays for time they contribute to educational activity.

Figure 5



Looking at smaller growers as a sector, what is striking about their resilience is that the potential areas of strength and vulnerability overlap. Use of volunteers allows growers to reduce labour costs, and

provides a system of training which can function with minimal external inputs. However, these same facets are points of weakness in terms of limiting entry to training routes to those who are mobile and able to work unwaged for some time. Similarly, a sharing culture of knowledge exchange fueled only by goodwill can function in the absence of external funding or intuitional support, making it resilient in face of changes in educational policy or investment cycles. But it is vulnerable at the level of the individual and their enterprise: the cycle can only continue if people have time and energy, which is always subject to their workload and economic viability. Some at this scale have developed structures to insulate against these risks, for example cooperative and community models which spread workload pressure, and build support from customers. Organisations like Land Workers Alliance are also building a collective voice on these issues, and have attracted funding to support knowledge exchange initiatives. Research participants suggested that such collaboration and cooperation is key to allowing their businesses to thrive and any ambitions to scale up production. They aspire to networks of connected growers sharing equipment and even staff for efficient production, whilst combining crops to supply diverse customer offers or large contracts. Such division of labour would gain some of the advantages of specialisation and scale which larger growers have, whilst retaining the preferred scale of individual operations and the benefits of their values driven systems.

c. Comparison across scales

What becomes clear from looking across growers at all scales is that resilience of the knowledge ecosystem depends on individual businesses' economic viability. If too few smaller growers remain active and able to participate in knowledge sharing then the pipeline which develops future growers becomes blocked. If larger growers lack resources to invest in R&D and developing their in-house expertise then there is no one with good reason or finance to step in. Ensuring availability of knowledge required to keep growing food in the UK in future therefore depends on a vibrant horticultural industry in which all types and scale of operation generate healthy incomes.

Comparison across scales also highlights contrasts which point to potential areas for enhancement. The strengths and weaknesses at each scale are essentially mirror images: smaller growers are relatively weak as individuals, but have strong networks and connections between them which bring collective strength. Conversely, there are few links between larger growers or collective actors, but each is relatively strong in its own right. For the former strength comes through connection, whilst for the latter strength comes through scale. Learning across the sector would suggest that smaller growers could gain resilience by scaling up, not through individual businesses growing but through cooperation and collaboration which brings the strengths of division of labour and specialisation. In the other direction, larger growers might recognise that people are attracted to work in food growing if it is values driven, and that connecting their investments in knowledge flows enhances overall capacity and advocacy for their needs. Both pathways suggest the need for collective work to foster horticultural knowledge.

4. Pathways Forward

Those involved in this research are already working to address the challenges identified here. Good practice in some key areas is summarised in project case studies:

> Keeping and improving seasonal workers - Improving productivity through use of LEAN, whilst retaining staff through treating them as a valued resource.

Developing the next generation of experts - Supporting graduates from diverse degrees through dedicated training and development.

Building and owning as a team - Employee ownership and voice motivate, reward and attract workers.

Across these experiences a strong theme is that growers need to invest in their staff, recognising them as a highly valuable resource. Stakeholders suggested that those who do so are less likely to experience recruitment challenges as people want to work for them. A key message therefore is,

> "as an industry we need to look after our staff better" (SH1).

Recruitment challenges are not set to disappear as significant numbers of workers will be needed for some time. The potential for robots and AI reduce the need for seasonal workers is not imminent. One grower who had trialed automation of picking suggested: "after seeing the robot in the field at the farm, we're a long way away from losing our workforce at the moment, without a doubt" (L3). Predictions are that it will be up to a decade before the technology is good enough to replace humans in these roles. Certain tasks or crops may prove too difficult to automate, whilst equipment may remain too expensive to substitute all seasonal workers. Businesses struggling to recruit sufficient workers, and workers facing undesirable conditions now cannot wait for technical solutions.

The main barrier to offering better jobs is the cost of offering better rewards and enhancing conditions undermining profitability. For smaller growers this extends to the challenge of being able to afford to pay all workers and trainees rather than using voluntary contributions. Resolving this is complex as the causes extend deep into the agri-food system and beyond, and are rooted in the economics of food production (Pitt 2019). High costs of land, lack of subsidy and pressure to keep prices low for consumers mean horticultural production operates with very narrow profit margins. As production costs increase producers may opt to move more production overseas where labour costs are lower. This is a concern as it reduces control and transparency around worker conditions, with the risk that forms of exploitation known to exist in international supply chains which feed the UK become more prevalent (Gertel and Sippel 2014). It also reduces domestic food security and the diversity of a production landscape which is already highly specialised and consolidated (Lang 2020).

An alternative trajectory is for government to recognise domestic horticultural production as a vital dimension of sustainable and resilient agri-food systems. Welsh Government has begun to support it as such by introducing grants for new entrants and business development (Welsh Government 2022). Welsh growers and would-be growers have also benefited from six years of publicly funded support and training delivered by Lantra (Tyfu Cymru 2022). A current project is piloting a training scheme for agro-ecological horticulture which provides a structured curriculum, and supports host farms to deliver quality learning. However, this still relies on trainees being unpaid or access to funding to support them as apprentices. For England, government has invested in the creation of the Institute for Agriculture and Horticulture (TIAH) which is working to support skills development across the industry, whilst aiming to enhance recognition of work in the sector (TIAH 2022). It has already initiated much needed data collection to understand skills gaps and future needs across horticulture.

These areas of progress have all been advanced through collective action by growers and associated organisations. Historically, horticulture has been said to lack such collaboration, resulting in a relatively

weak collective voice and influence (Pitt 2019). The formation of networks like the Fruit and Vegetable Alliance, and the work of partnerships like the Sector Skills Group perhaps arose from a sense of crisis, and have helped draw attention to it. But the extent of collective action remains limited as one large grower described:

> Competitive tendering, the fragmented supply chain, we're not allowed to get together, we're not allowed to stand up for ourselves. Fresh produce is very dog eat dog (L4).

This sentiment suggests that growers remain subordinate actors in the supply chain as retailers hold greatest sway, and rarely face coordinated pressure from producers. The ending of levy supported activity by AHDB is further signal of the limits of shared responsibilities and action amongst larger growers. It is of particular concern in terms of skills for further individualising ownership of and investment in horticultural knowledge.

Given high degrees of specialisation in the industry, it is no surprise that growers wish to directly support research and innovation for their business. But if investment flows between company and researcher with no public or collective intermediary then the knowledge is privatised, limiting access to potential new businesses or for the public good. The result is a less resilient agri-food system focused on commercial interests (Anderson 2019). Contrast with the sharing community of smaller, agro-ecological growers who treat knowledge as a common good to be passed on and distributed. No individual owns or is responsible for essential expertise, and knowledge exchange is recognised as enhancing the sector and the agri-food system. As discussed, this approach is not currently problem free, but it demonstrates the value and potential of treating food growing knowledge as a commons – a shared good available to benefit all (Vivero-Pol et al 2019). The issues identified would be countered by recognising horticultural knowledge as an essential public good and investing in it as such so research, training and education feeding into the horticultural industry receiving public funding. A public body should have a duty to maintain a strategic overview of this knowledge ecosystem, and coordinate action to ensure it is resilient.

In terms of immediate support, some relatively straight forward steps are desirable. Firstly, the sector needs to know it can access sufficient seasonal workers, which likely means continued and guaranteed access through a Seasonal Workers Scheme. They need greater certainty about how many workers can come through this route for the next decade, and efficient administrative processes to ensure workers arrive as expected. Those workers should be confident that they will be treated well and have recourse to remedy through a robust, independent labour inspection regime and enforcement of regulations. Secondly, apprenticeships and training placements in edible horticulture should receive government funding, in return for quality control on traineeships conditions and curriculum coordinated by growers and their representatives. Thirdly, as UK governments are devising schemes to succeed CAP, they should include measures to support and invest in horticultural businesses, including the costs of establishing new businesses to foster a more diverse, resilient sector.

Taking a longer-term view on securing horticultural skills and knowledge, solutions centre on recognising that work in the sector is skilled and essential. This is the foundation of treating workers well, offering jobs which people want to do and rewarding them fairly for doing them. Rather than merely considering whether growers have enough workers to fill the jobs available, we need to consider the quality of the work offered. Similarly, grower-owners and the self-employed need economic conditions which allow them to avoid self-exploitation. Agricultural exceptionalism should not mean that businesses are

excused from regulatory standards, rather that its exceptional contribution to society is recognised and rewarded through state support. A strategic approach to food is needed to plan how the UK can feed itself without exploiting people or planet; considering who will do the work, and how they will access essential know-how should be a key element of this. For growers at smaller and larger scales, resilience will come from treating knowledge as a commons in which responsibility and ownership is shared.

The steps suggested here are even more pressing if the UK is to expand domestic horticultural production as is promoted by academics (Lang 2020), and others including industry representatives (FPAC 2021). Investing in expanding horticulture requires confidence that sufficient workers will be available. As seen during 2022 (Sijmonsa 2022), when labour is unavailable growers pause or reduce production, meaning greater reliance on imports. At the other scale, new growers will be deterred from starting if a secure income is unlikely or start-up costs are prohibitive. Disrupted supply chains for various foods this year demonstrate the reasons for producing more of what we eat within the UK. For horticulture to thrive and expand requires political support for this trajectory, including recognition that food growing know-how is a collective good to be invested in as such. Work in horticulture is highly skilled and should be valued as such.

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