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**What knowledge is required to grow food? A framework for understanding
horticulture's skills 'crisis'**

Abstract

For more than a decade actors in Europe, North America and Australasia have been warning of crises with horticultural skills, highlighting shortages of specialists, educational programmes and traineeships. Related warnings predict worsening shortages of skilled workers essential for production of horticultural crops. Analysis of recent strategies from the UK finds these problems poorly defined and characterised, without articulating what horticultural skills comprise, tending to misconstrue problems and causes. This paper aims to characterise food growing knowledge systems and challenges they face. The result is a new definition of and conceptual framework for horticultural skills to enhance understanding of the sector's problems and formulation of solutions. The framework valorises knowledge of workers often portrayed as unskilled, and demonstrates how skills and labour challenges are wholly inter-linked. Knowledge flows are found to be affected by multiple impediments which contribute to a sense of crisis. Unresolved questions regarding this skills system present avenues for research to better understand the future prospects of food production skills, and demonstrate the value critical social science can bring to this topic.

Key words: horticulture, knowledge, skills, agri-food system, labour

1. Introduction: Horticultural skills in crisis

Knowing how to produce food is fundamental to human health. Food security requires producers have knowledge and skills¹ to meet current and future challenges (FAO 2018; Government Office for Science, 2011: 34). For UK agriculture and horticulture, under-

¹ Terminology around agri-food skills is under-defined, but skills typically implies practical forms of knowledge, distinct from information or other intellectual modes of knowing such as research. As we will demonstrate, these distinctions are not always valid or productive; when discussing the literature review we reflect how these terms have been employed by others.

investment in skills is identified as a factor in relatively poor productivity (AHDB, 2018). Supporting skills and education is a common strategy for supporting the food industry (DEFRA, 2018; Government Office for Science, 2013; Welsh Government, 2014). The latest reforms of EU agricultural support recognise knowledge as essential for sustainable agriculture (EU Commission, 2019), with transitions to more resilient or innovative production requiring new knowledge and skills supported by extension services (Godfray et al., 2010; SCAR, 2016; Willet et al., 2019: 37). Research generates knowledge feeding innovation and addressing emerging challenges so production can endure systems change (Dicks et al., 2013). A resilient food system which can adapt to change therefore requires open knowledge flows (Anderson, 2015). Meanwhile, local re-skilling has been a goal of community-led food transitions (Sage, 2014). Some suggest ecologically sustainable production is knowledge rather than resource intensive, making education a key scaling strategy (Anderson et al., 2019; FAO, 2018), and knowledge diversity a prerequisite for a diverse production landscape (Carolan, 2011). It is of concern then, that much of the minority world² has long reported agri-food skills gaps, shortages of personnel including research specialists (Government Office for Science, 2010; Llewellyn 2011; Rotz et al 2019), and depletion of knowledge extension services (Fuglie and Toole, 2014).

One food production sector has been vocal in highlighting what it calls its skills crisis: horticulture, growing fruit and vegetables for human consumption³. For more than a decade actors in Europe, North America and Australasia have warned of crises with

² Like others in this journal (Klocker et al 2019), we follow Punch (2002) to use minority-majority world terminology in preference to older terms such as developed world to draw attention to the inequality that the smaller proportion of the world's land mass and population consume more global resources.

³ Production horticulture (also known as edible horticulture) is only one form. Growing ornamental plants, and management of plant landscapes are economically significant sectors with parallel challenges.

horticultural skills, highlighting shortages of specialists, educational programmes and traineeships, plus a diminishing research capacity (Aldous et al., 2014; Aldous and Pratley, 2016; ABARES, 2019; Bumgarner et al., 2019; Curtain et al., 2018; Devlin, 2016; Hertz and Zahniser, 2013; Horticulture New Zealand, 2018; Meydering, 2016; Preibisch, 2007; Richards, 2018; Strawbridge et al. 2011). Since the 1990s UK horticultural research and development (R&D) has suffered declining investment, privatisation and closure of specialist facilities, inhibiting innovation (Menary et al., 2019; NHF, 2008). The sector has expressed concern that research capacity is insufficient to meet current demand, and is not aligned with growers' needs (NHF, 2008). To become more resilient, food growing requires a broader range of knowledge (Aldous et al., 2014; Curry et al., 2012; ISHS 2012), enabling new practices, crops, products and technologies (Dicks et al., 2013). Horticulture also tends to be the most labour intensive form of agriculture (ONS, 2018), making the prospect of worsening labour shortages a long-standing concern globally (Meyerding, 2016; ISHS, 2012). The UK leaving the EU and associated access to a migratory labour force has exacerbated this (Hendry et al., 2019). Similar issues were highlighted as COVID-19 affected worker availability across Europe (Garnett et al., 2020).

Problems facing production horticulture encapsulate skills issues facing agri-food systems, with horticulture's labour intensity making it an acute example. Stakeholders have advocated for urgent action (Horticulture Matters, 2016; ISHS 2012). However, this is not underpinned by robust evidence; published material is dominated by practitioner/industry reports or commentaries. Social scientists have highlighted vulnerabilities around agricultural research, innovation and extension, but knowledge processes centred on mass labour have been over-looked or treated separately with horticultural workers not typically regarded as knowledgeable actors (Hernandez, 2012;

Klocker et al., 2019). Knowledge flows within agricultural systems are heavily associated with innovation, hence AKIS (Agricultural knowledge and innovation systems) which have received considerable social scientific attention. But knowledge is employed to grow food even when innovation is not occurring- what we might call the ‘maintenance’ dimensions of food production. Maintaining the status quo of food production also entails knowledge application. This paper begins to redress these oversights by providing a conceptual framework for food production skills, attending to multiple forms of knowledge including those enabling innovation and transformation, and essential to *maintaining* production. It considers dimensions such as labour relations and economic imbalances which curtail knowledge circulation, to characterise the sector’s ‘crisis’. By drawing on related research and thinking about agri-food knowledge it reveals issues requiring further data to fully comprehend the nature and causes of the horticulture’s skills challenges. The questions shown to require attention are ones to which critical social science can contribute valuable insights. If food production depends on knowledge, there is a role for social scientists to understand agri-food skills and analyse how their supply can be guaranteed.

Next we report analysis of recent UK strategies addressing the horticultural skills challenge, highlighting gaps and flaws in their framing of skills. We then show how continuity between knowledge and skills suggests a system including both, leading to a definition of food growing skills which embraces all workers as knowledgeable actors. This valorises the work of ‘manual’ workers, and embeds labour practices within the knowledge system. The review points to unresolved questions regarding horticultural skills and causes of the sector’s knowledge challenges. These present avenues for future research applying our conceptual framework to interrogate how knowledge and skills are accessed, circulated and applied, with the hope of informing better solutions.

2. Review of UK Skills Strategies

2.1. Research Design

To assess how the crisis in horticultural skills is characterised and framed we scoped recent academic literature to identify primary research addressing the question: What is the crisis facing skills for production horticulture in the UK? (Appendix 1) This identified no published academic research focused on the skills crisis or providing comprehensive treatment of UK horticultural skills. Attention therefore turned to grey literature. Internet searches identified documents authored by stakeholder organisations discussing horticultural skills challenges in the UK. Relevant Government policy and strategy was identified by searching websites of UK and devolved administrations with key terms (horticulture, agri-food skills, agri-food research) to identify the most recent relevant documents. Criteria for inclusion in documentary analysis were: a national (UK or devolved nation) remit, provides assessment of/reporting on the state of skills for production horticulture (specifically or as a sub-sector of agriculture, land-based industries or food production), or recommends actions to enhance the sector's skills. A 10 year timeframe was applied (2010-present) to ensure a contemporary focus. To confirm search results were comprehensive, stakeholders were asked to identify key horticultural skills strategies and policies; any recommendations meeting the criteria were analysed. These stakeholder interviews (n=15) were a parallel stream of scoping research reported elsewhere (Author reference excluded for peer review). As suggested by Arksey and O'Malley (2007), combining literature searches with stakeholder consultation and prior knowledge enhances the results. In total 13 strategic documents met the inclusion criteria (Table 1). These were analysed by applying three questions:

How are skills defined?

How are skills problems and their causes characterised?

Is the characterisation supported by data?

The results of this analysis are the focus of the next section (see Table 1 for abbreviations used to refer to each strategy).

Given the limited results generated by the scoping review, exploration of the academic literature was broadened beyond horticultural skills to investigate related topics, including those raised by the documentary analysis and stakeholder discussions. Research on these topics (agri-food skills; agricultural knowledge systems; agricultural careers, training, education, R&D) informed the documentary analysis and is referred to in the Discussion.

2.2. Review Results: What is known about horticulture's skills crisis?

In this section we summarise the results of documentary analysis of the 13 skills strategies. All identify skills problems within horticulture and broader agri-food sectors, and propose remedial actions. However, a clear majority do not define skills or the knowledge required to grow food. It is therefore unclear what are regarded as essential skills, making it difficult to thoroughly analyse shortages. The most recent survey of UK growers begins to address this by offering the following characterisation:

“As a sector the edible horticulture industry is highly skilled. The demands of plant propagation, plant health, food assurance, spraying, plant nutrition and much more – require high levels of knowledge and competence” (AHDB2: 78).

This suggests skills comprise ‘knowledge and competence’, and that a broad range of abilities beyond those focused on plants are essential to horticultural enterprises. The

report specifies a range of essential skilled activities including plant focused tasks (propagation, agronomy, plant nutrition, crop management) and those less directly associated with growing (social media, supervision, order fulfilment). This suggests that growing food entails skills of working with plants, and those of managing an enterprise (see also ISHS 2012: 36). A similarly broad specification encompassing practical and manual tasks as skilled (SDS), arises from the UK's standard classification of Skilled Trades which recognises skills acquired through work-based training (ONS 2010). In contrast, strategies which define agri-food skills take a narrower focus on formal education, equating skills with accomplishments gained through professional development (ASF). Narrower still is a focus on skills as "research-informed technical expertise" acquired through education at graduate level or above which enables individuals "to understand and make use of specialist knowledge and new findings" (FRP: 5). These narrow perspectives exclude experiential knowledge and learning which seem important to food production (Hernandez 2012; Krzywoszynska 2016; Šūmane et al. 2018). A narrow definition of skills seems inappropriate to the wide-ranging expertise required to maintain horticultural operations (AHDB2). In the absence of a consistently applied definition of skills, or clarity regarding what is essential food production knowledge, it is difficult to accurately characterise shortages, or assess their impacts.

Horticulture's skills problem is also weakly articulated and evidenced. The latest report clarifies distinct components:

"Skills gaps are skills and competences that are not present in the existing workforce (as opposed to skills shortages which are skills not present in the wider population for recruitment purposes)" (AHDB2 p39).

Although not always expressed in these terms, other strategies address gaps and shortages, referring to challenges around training, education, recruitment and research. Gaps mean employees' skills levels fall below what businesses need or expect to require in future (FRP; AHDB2; SDS). As with other agri-food industries, the sector has low uptake of formal training and professional development, relying on informal education (ASF p7; WFDB p15). Skills shortages are associated with inadequacies in the training system, but it is not clear whether the problem is a shrinking knowledge base or poor uptake of it. Growers report constraints on their ability to enhance employee skills, such as difficulty freeing staff to attend courses, and lack of suitable provision (HFNI; AHDB2 p40). Others suggest skills are lacking because not enough people are becoming horticulturalists, shrinking the knowledge base (HM).

Recruitment is the problem most prominent in the strategies: inadequate numbers coming to work and train in the sector (ASB, ASF p9; AHDB1, WFDB p13, HM, WG p21). Shortages of highly trained specialists may be less acute (FRP), whilst growers identify access to sufficient labour as one of the top two challenges they face (AHDB2). They perceive recruitment shortfalls to have quantitative and qualitative dimensions, noting an overall lack of applicants, and that applicants lack specialist skills or qualifications (AHDB2 p35). Applicants are found lacking due to having the wrong attitude, particularly lack of motivation for the work (AHDB2). This suggests that reported shortages of skilled workers may not indicate levels of knowledge (i.e. horticultural skills) in the labour pool, but aspirations for workers with particular personal qualities. Employers' desire for good workers is not wholly about ability to complete tasks as they also seek agreeable employees (Freidberg, 2010; Rogaly, 2008), making apparent shortages complex issues requiring critical reflection.

Analysis found broad consensus on causes of horticulture's skills problems, with the unappealing nature of work in agri-food production often blamed (AHDB1, FVT, HM). Growers perceive young people to be unmotivated for demanding work, hence not applying for or staying in these jobs (AHDB2). Graduates and more qualified recruits are thought to find horticulture less appealing than other sectors, hence poor levels of recruitment and retention (AT p34). The nature of and attitudes to available work is said to explain skills gaps, whilst skills shortages are seen to result from steady decline in provision of specialist horticultural courses (AHDB1; FVT p16; FRP p37). Under-investment in the infrastructure for applied research and knowledge exchange means specialist knowledge is under-developed and/or does not reach industry (AHDB1 p58; FVT p13; WG p6). Available training may not meet business needs (AT p34; ASF p5; FVT), leaving growers under-provided with knowledge to support them through change (AHDB1 p11; AT p34). This suggests infrastructure supporting the development and circulation of horticultural knowledge is inadequate.

Whilst causes noted in the strategies may be influential, it is difficult to evaluate their impact due to a weak evidence base. Stakeholder interviews highlighted the lack of robust data on horticultural work, training and skills needs (reference removed for review). Interviews reinforced the findings of the documentary analysis, emphasising recruitment challenges and declining investment in education, training and research for horticulture. Data on basic trends such as numbers of horticulture courses and students is not collated nationally, nor is information on who is employed in the sector, their education and career trajectory. Reports of the sector's 'image problem' undermining recruitment are anecdotal, rather than based on analysis of attitudes or comparison with other career pathways. This is also a potential red herring, obscuring deeper problems which make food production jobs unappealing (Devlin 2016; RSA 2018). Some

growers acknowledge that the rewards and conditions for horticultural roles are relatively poor given the skills involved (AHDB2 p40-41). But businesses struggle to redress this because of their financial vulnerability (EFFP 2010). This point was echoed by stakeholders who saw the marginal position of horticultural businesses as the fundamental driver of skills challenges (Reference removed for review).

2.3. Discussion: What is (mis)understood about horticulture's skills challenges?

Documentary analysis found gaps in understanding and evidence regarding the horticultural skills problem. There is a fundamental lack of data on skills needs and gaps, and the sector's workforce, with particular difficulties tracking seasonal employees (NHF, 2006; Pitt, 2019). This lack of evidence is confounded by lack of attention to defining skill or characterising essential skills. Three recurrent tendencies in how the problem is interpreted seem to hamper remedial activity. In discussing these we draw on wider literature on agrifood knowledge for insights and context.

First, recruitment difficulties are elided with skills shortages, blurring distinct issues and causal pathways. For example, not being able to recruit enough employees for low paid jobs at a time of almost full employment may have causes distinct from employers' failure to recruit people meeting their quality expectations. This elision also implies a particular perspective on skills: equating shortages with the inability to recruit sufficient employees implies skills are wholly situated with workers, making their bodies repositories of horticultural knowledge. This is only possible if horticultural knowledge is tacit: "that which defies codification or articulation" (Gertler 2003: 78). Explicit knowledge can be verbalised so is more easily circulated and stored as

information (Gertler, 2003). Codified or explicit knowledge is more standardised so regarded as shareable across global scales (Allen, 2002; Morgan and Murdoch, 2000), whilst tacit knowledge is embodied so acquired through direct personal experience (Carolan 2011). But it is not definite that horticultural knowledge is predominantly tacit, embodied, and shared through personal interactions (Gertler, 2003). Farmers share knowledge without being co-located (Oreszczyn et al., 2010), and seem to mingle use of formalised *and* tacit knowledge (Brice 2014; Curry and Kirwan, 2014; Krzywoszynska, 2016; Morris, 2006; Oreszczyn et al., 2010). Such categorisations may anyway be misleading as very little knowledge is impossible to codify, suggesting the two cannot be wholly separated (Allen, 2002). More important is understanding how all knowledges interact (Krzywoszynska's 2016), and their distribution (Wilbur, 2014). Horticulture's knowledge transfer techniques, including the role of codified information, require further investigation, within a framework recognising that skills are not wholly embodied, as skilled work enrolls materials and is learnt in contexts extending beyond the individual.

If horticultural knowledge can circulate then we need to understand how, and where there are deficiencies or blocks preventing its exchange. Research into agricultural systems identifies how knowledge fails to reach or inform producers' practices (Oreszczyn et al., 2010; Sewell et al., 2017). Inadequate, inappropriate and mistrusted extension services are often blamed (Curry et al., 2012; Knierim et al., 2017; Pollock, 2012; SCAR, 2016; Sewell et al., 2017), as is privatisation (Menary et al., 2019; Sewell et al., 2017). Horticultural enterprises complain that not only has public investment in R&D shrunk, it has also been redirected away from their prime concerns (Menary et al., 2019; NHF 2008). One suggested solution is an integrated, better funded R&D pipeline with more actively engaged producers (Pollock, 2012). But producer-scientist

interactions are not straightforward transfers, rather are entangled with social processes and affected by personal factors (Krzywoszynska, 2019; Sewell, 2017). For example, growers' demographic profiles affect their learning with those close to retirement disinclined to take up innovations (Stimpson and Lloyd, 2018). Such insights point to a knowledge system less a pipeline from researcher to producer, more a web of multidirectional flows in which all actors generate and exchange knowledge. Power dynamics are likely to affect these flows, influencing the ease of accessing and sharing knowledge (Gertler, 2003; Oreszczyn et al., 2010; Wilbur, 2014). Industrialisation of the food system has concentrated knowledge control with corporations, reducing producer autonomy (Carolan, 2011; Morgan and Murdoch, 2000; Rossi et al., 2019; Rotz et al., 2019). Questions which become important in light of this are: What prevents producers accessing knowledge they need? Who is monopolising or controlling sources of knowledge? To answer these in relation to production horticulture requires investigation of knowledge flows and what impedes them, hence an emphasise on these in the new conceptual framework; better understanding them is essential to fully understand horticulture's skills crisis.

The second problematic tendency highlighted by documentary analysis is equating skill with formal training and education, designating skilled workers as those with qualifications. Lack of systems for recognising on-farm training mean much skills development within agriculture goes unrecorded and unrecognised (DEFRA, 2011). This is not universal, as some actors highlight skill levels gained on-the-job, including by seasonal workers (AHDB2). Recognising informal learning and experientially developed skills forces reassessment of horticulture's skills shortages: is there a lack of necessary knowledge and abilities, or rather of qualifications? Distinguishing these two is an important part of better characterising the problem.

If horticulture is heavily reliant on informal skills development it is not clear whether this is because these knowledge flows are preferable, or are the only accessible learning modes. Organic growers suggest the latter, with lack of specialist training driving reliance on learning through volunteering and internships (Pitt, 2019). Economic constraints prevent other growers accessing formal training, as narrow margins drive down spend on human resources (Devlin, 2016; Ekers, 2019; Findlay and McCollum, 2013; Friedberg, 2010). This is further constrained by high levels of seasonal work, meaning recruitment and training must recur constantly (Klocker et al., 2019; Reilly et al., 2018). Various impediments might prevent horticultural businesses accessing and sharing knowledge, particularly the economic costs associated. Understanding these complexities requires attention to knowledge flows, including informal exchanges, and analysis of what impedes them.

The third area of misunderstanding identified in the strategies is that although discussed as skills shortages, difficulties recruiting workers may not centre on knowledge, being more significantly matters of economic relations and workforce conditions. Whilst these issues are connected, framing the challenge as one of skills might misdirect remedial action. Recruitment problems are symptomatic of deeper issues within UK horticulture, a vicious circle of decline as poor profitability undermines confidence to invest, reducing productivity and increasing costs, perpetuating poor profitability (EFFP 2010: 21). If businesses cannot afford to improve workers' rewards and conditions, jobs remain unappealing and attract insufficient applicants. Investing in the horticultural knowledge base through education or research cannot solve this problem, so is it a skills issue? Some analysts suggest remedies focused on skills allow Governments to appear to act without having to intervene in trickier areas such as

employee relations (Keep and Mayhew 2010). This suggests a need to interrogate whether mobilisation around horticulture's skills crisis is actually about skills, and why other drivers of under-recruitment might be kept in the shadows. This can only be achieved by recognising labourers as significant actors within the knowledge system, and acknowledging the influence of business pressures which determine work conditions.

That recruitment challenges are not simply a result of poor perceptions of food production work is suggested by a counter-trend. Agro-ecological horticulture *is* attracting future growers not impeded by lack of motivation (Soil Association, 2018; Taherzadeh, 2019), suggesting the work holds some appeal. But this sub-sector still faces skills challenges: internships and volunteering are common ways to learn agro-ecological production, but are low- or unpaid opportunities as growers often cannot afford to invest in worker development (Ekers et al., 2016; Levkoe, 2018; Weiler et al., 2016). These businesses' precarity threatens the knowledge system because if they cannot survive economically the experts running them are not available to educate future growers. Economic costs and business viability impede flows of horticultural knowledge.

There is reason to believe the three misunderstandings highlighted are significant. Numerous strategies tackling skills challenges have made little progress (AHDB1), suggesting the problem has been misdiagnosed or remedies mis-prescribed (Pitt 2019). In particular, action has failed to connect skills shortages with the challenge of securing labour by improving work and living conditions for food producers (RSA 2018). The three misunderstandings point to a need to characterise horticultural skills more accurately, attending to knowledge flows and impediments which contribute to a sense

of crisis. In particular, workers and workforce issues need to be considered within the knowledge system, along with systemic economic pressures which affect growers' ability to access learning. This requires full attention to workers' informal learning and skills beyond those acquired through formal horticultural training. Workers and employees do not always feature in analysis of agricultural knowledge systems typically centred on 'the farmer' (SCAR 2019), or flows between farmers and expert advisors (Klerkx and Proctor 2013). But there are multiple knowledgeable actors involved in production, as demonstrated by studies of horticultural businesses. Studying horticultural workers, often seasonal migrants, reveals additional dimensions to the skills challenge to be encompassed within the conceptual framework and future research, namely connections between workers, knowledge, and economic dynamics affecting these relationships. Next we summarise what such studies reveal about horticultural skills and the sector's challenges.

2.4. (Migrant) horticultural workers and what they know

Migrant workers are central to the fresh produce industry in north America (Bonanno and Cavalcanti, 2014; Friedberg, 2010; Hernandez, 2012; Holmes, 2013; Preibisch, 2007), and Europe (Findlay and McCollum, 2012; Rye and Scott, 2018). UK horticulture's survival and growth is seen as threatened by controls on international mobility (Lang et al., 2017), as growers rely on migrant workers for seasonal roles (Curtain et al., 2018; Hill et al., 2007; Scott, 2015). Following the UK vote to leave the EU, a hostile environment to non-UK nationals reportedly deterred seasonal migration, leaving crops unharvested (Maye et al., 2018). Importing labour is said to be essential to fill jobs indigenous citizens will not do (Campbell Gibbons, 2011; Findlay and McCollum, 2013; Meyerding, 2016; NHF, 2006; Rogaly, 2008; Scott, 2015; Weiler et al., 2017). A

typical narrative - one mirrored in the stakeholder interviews - is that horticultural supply chains concentrate power with large retailers, pushing growers to casualise employment, sometimes to point of exploitation (Forsyth, 2017; Scott, 2013; Schenner, 2018). Low profit margins create a need for the cheapest, most flexible labour which is often migrants (Rye and Scott 2018; RSA 2018; Scott 2015). But such 'needs' are socially constructed (Rogaly 2008), with knowledge and skills strongly implicated in the construction. We have already seen that to horticultural employers 'skilled workers' can mean people with the right temperament. Good workers are "reliable, flexible and compliant" (Rogaly, 2008: 500), a construction the fresh produce industry has long aligned with gender and race, arguing certain bodies suit the work (Friedberg, 2010). In the UK 'hard-working' Eastern Europeans are favoured (Scott, 2015). But migrant workers might also appeal because their weakened status pushes them to accept worse conditions (Friedberg 2010; Rogaly, 2008; Rye and Andrzejewska, 2010; Scott, 2015). Seasonal worker schemes appeal to employers because they increase their control over employees (Curtain et al., 2018; Findlay and McCollum, 2013; Rye and Scott, 2018; Scott, 2015). The 'need' for migrant workers cannot be taken at face value and requires critical attention.

To unpick this dynamic it helps to consider four ways migrant-labour and skills connect. First, the knowledge resource within horticulture is highly dependent on migration, because the workforce is a core component of growers' skills base and as immigration hugely determines who grows food in minority-world businesses. Secondly, attributes of good horticultural workers go beyond technical abilities, to attitudes and demeanor (Rogaly 2008). What is considered 'essential food growing skills' is socially constructed, representing much more than horticultural knowledge, including attributes such as diligence and reliability. Thirdly, much horticultural work entails low paid, 'bad jobs'

dominated by migrants (Rye and Scott, 2018), making businesses unlikely to invest in workforce skills development. Yet, the recruitment challenge has been addressed as a problem of image and misperceptions, without questioning how these jobs could become more rewarding or attract UK citizens (Devlin, 2016; RSA, 2018).

A final connection between labour and knowledge is the portrayal of horticultural work as unskilled to justify poor pay and casualisation: if anyone can do it then untrained people only available for a season are suitable, require minimal training and deserve the lowest possible rewards (Hernandez, 2012; Klocker et al., 2019). But what appear to be routine tasks, are complex and skilled (Aldous et al., 2014). Experienced workers are faster and more accurate at tasks such as fruit harvesting because with time and practice they develop their abilities, becoming sources of knowledge valuable to production (Curtain et al., 2018; Dun and Klocker, 2017; Klocker et al., 2019). Growers want experienced employees to return to the UK each season because they are more productive (Evans, 2020), proof that seasonal workers learn on-the-job and become skilled.

Viewing food production labour as unskilled has "diminished attention to the skills and abilities needed to do these tasks, to the processes of acquiring them, and to their impact in the life trajectories of those working in the fields" (Hernandez 2012: 73). Attending to what horticultural labourers do and how reveals their work to employ complex knowledge, refined through practice and peer learning (Hernandez, 2012). A job involving repetition is not mindless, as the worker continuously perceives varying conditions and plants to respond appropriately (Klocker et al., 2019). Even in mechanised production, 'manual' workers think, drawing on diverse knowledges (Carr and Gibson, 2016). To keep doing repetitive, physical tasks workers learn and teach

each other efficient bodily techniques (Hernandez, 2012). Regarding this ‘manual’ work as skilled requires a definition which does not foreground intellect, hence a new conceptual framework which includes bodily knowledge or ‘knowledge in action’. This section demonstrated how workforce dynamics including migration entwine with knowledge processes. It explained that anyone working to grow food undertakes skilled work and holds valuable knowledge, meaning shortages of personnel impede knowledge flows. A pressing question for rural studies is how changing migration patterns will affect food production in countries reliant on imported labour.

3. A conceptual framework for understanding horticulture’s skills challenges

The Discussion demonstrated the need for a new understanding of horticultural skills, resolving the three flaws identified in previous accounts. It leaves questions unanswered, particularly regarding impediments to knowledge flows within UK horticulture. These can be better answered using a conceptual approach embracing varied knowledge practices and processes, including those centring on actors previously characterised as unskilled. Before elaborating the framework it is necessary to clarify what skills are through a definition appropriate to horticultural work.

3.1. Defining food production skills

Building on recent research to characterise horticultural work (Klocker et al. 2019) which draws on studies of artisanal skills and manual labourers’ expertise (Carr and Gibson 2016), we consider skills as socially embedded knowledge practices. This moves beyond binaries between manual and intellectual work by recognising thinking and learning as situated throughout bodies, not wholly in the mind (Ingold 1997, 2000). Skills are a form of knowledge typically associated with technical ability or craft, which

Ingold terms knowledge-how, not manual deployment of a pre-conceived cognitive plan, but ‘thought in action’, including a degree of improvisation. Learning happens by novices working alongside more experienced practitioners, repeating movements until they become habits (Ingold 1997). No work is unskilled, as even apparently repetitive manual tasks require deliberate adjustments to bodily motion (Carr and Gibson 2016; Klocker et al., 2019). The overlap between knowledge and skill becomes so significant as to make distinguishing between them unnecessary; both are know-how developed as perceiving bodies engage with environment and expert guides (Ingold 2018). To know is to have the capacity to perform an activity, inseparable from practice (Gherardi, 2006). Know-how is not developed just through formal education, but includes abilities gained through practice and peer learning, as happens amongst horticultural workers learning from each other on-the job (Klocker et al. 2019; Hernandez 2012). Ingold’s ecological approach, and Gherardi’s treatment of knowledge as situated practice emphasise how practitioners learn together through doing and talking about doing (Lave and Wenger 1991). A final component are materials and nonhumans, because growing food involves plants, soil, water and more, and materials always make a difference to learning (Aberton 2012; Gieser 2014; Sørensen 2009). It is also important to counter Ingold’s silence on macro forces, not least power (Hornborg 2018). Power shapes contexts in which skilled practitioners act, for example, holding together a business as a relatively stable collection of elements and shaping employee relations (Gertler 2003; (Gherardi 2006). In our framework macro forces circulating beyond horticulture are therefore encompassed within knowledge flows and impediments.

Alternative definitions current in social and academic discourse associate skill with economically productive work and enhanceable personal qualities (Green 2013). This is enacted in economic and educational policy which assumes increasing numbers of

skilled people feeds innovation and economic growth (Keep and Mayhew 2010), a tendency noted in some of the agri-skills strategies discussed above. This does not undermine our definition of skills which considers knowledge as social practice functioning within socio-economic contexts, including policy discourses. More problematic is Green's definition of skills as practices with purpose confined to *paid* work, given feminist recognition of the economic value of alternative forms of work (Gibson-Graham, 2006). Voluntary labour has a significant role within horticulture (Ekers et al., 2016), pointing to a broader definition of productive work and its value.

To summarise, skills are a form of knowledge as socially embedded practices, enabling achievement of a goal. Knowledge and skill combine thought and practice, as bodily abilities of 'thinking through doing'. Knowledge and skills are not personal attributes, being embedded in environments which include institutional context, materials and technologies. They are exchanged through social interactions involving things and nonhumans. Never fully abstracted into codified forms, knowledge is however described and treated as such in formalised education and economic policy. Skill acquisition is subject to power dynamics, with the ability to learn or transfer knowledge unevenly distributed and shaped by organisational contexts.

From this perspective, horticultural skills are the abilities required to grow food - abilities with several dimensions. Horticultural knowledge centres on "understanding plant responses to the environment and modifying them" (Dixon 2016). The ability to propagate plants and manage their health and nutrition is important, but sector specialists emphasise that producing food successfully also relies on managerial abilities such as budgeting and the soft skills of running an enterprise (AHDB, 2019; ISHS, 2012). Crucial food production knowledge includes organisational work and people

management not always considered as components of knowledge systems (Klerkx, 2020). As discussed above, R&D indicated, growers also draw on knowledge generated through research and innovation activity. The skills required to grow food therefore comprise three strands: know-how to grow food plants, managing/maintaining a viable enterprise, and developing insights to enhance production and mitigate risks. The first two represent knowledge required to maintain production whilst the third includes innovation. Each relies on supplies of people and investment, including that necessary to maintain associated infrastructure such as educational institutions.

Practices across the three domains happen in fields, greenhouses, offices, boardrooms, and labs - a complex array of skills exchanged and deployed in multiple settings involving diverse actors. These include 'manual labourers' with no formal horticultural training who become highly skilled, developing complex knowledge of what plants and their fruits are doing and how to respond. Following the proposed definition all horticultural roles are skilled, just employing different forms of skill. Shortages of 'unskilled labour' are rather an under-supply of certain types of skilled workers, shortages which impede flows of horticultural knowledge. As highlighted above, what is not yet clear is the degree to which essential knowledge is held out-with the current workforce, in codified or abstracted forms which can be stored and transferred.

3.2. Food production knowledges: a new conceptual framing

This definition indicates that food growing relies on various knowledges, centred on diverse actors. To analyse all aspects of skills issues it is necessary to begin with a comprehensive picture connecting these dimensions, and including labour relations (*Figure 1*). The framework covers activity up to harvest, although post-harvest skills

such as packaging, transporting or storing produce are clearly important (ISHS 2012). This boundary was selected to focus on processes specific to producing plant foods and learning within the horticultural sector, but the knowledge system certainly extends further down the supply chain, so any boundary should be treated as fuzzy. Terminology is generalised to accommodate diverse modes of production but can adapt to specific systems. For example, an organic market garden's knowledge requirements might be 'producing food plants using organic methods, to supply local consumers', with a knowledge community including volunteers. The framework can be applied to individual enterprises or the whole sector; our research employs it as a heuristic device at both scales to explore with stakeholders the detail of knowledge systems and their vulnerabilities.

This framework centres on the three domains of knowledge outlined with the proposed definition of horticultural skills. Associated practices and processes involve diverse knowledgeable actors, including but not limited to the creation and spread of new knowledge. Actors include workers and business managers or owners;⁴ each may concentrate their activity within one knowledge requirement but this is not exclusive, nor is the list of actors associated with each. Following our ecological definition of skills, materials including plants are included within the knowledge community. The degree to which more-than-human actors affect knowledge flows is an area requiring further research which might consider the role of materials and plants as knowledge actors or holders. Locations are not indicated as knowledge is assumed to be dispersed and mobile, and it remains uncertain the degree to which distance affects knowledge exchange. Knowledge flows include exchanges beyond formal training or education,

⁴ We avoid the term farmers to better reflect the variety of horticultural production enterprises and that many in the sector identify as growers.

reflecting the dominance of informal learning and experimental knowledge within horticulture.

The framework indicates potential causes of the sector's skills challenges. Firstly, lack of people and investment feeding any of the three domains or infrastructure supporting the knowledge flows will undermine their ability to function. Documentary analysis suggested this is the current situation in the UK. Secondly, the framework highlights impediments also suggested to be currently limiting knowledge flows within UK horticulture. These include long-term decline in R&D and knowledge infrastructure such as specialist education facilities. The risks of knowledge being monopolised by powerful actors and costs of accessing essential knowledge were both identified as socio-economic factors currently preventing growers developing a skilled workforce. There may be other significant power dynamics influencing knowledge flows, making the nature of power relations between actors within this system another area for future investigation. Reflecting what is known about challenges facing the sector, loss of knowledgeable personnel from the sector, and the difficulty of attracting sufficient personnel are noted as impediments. Recruitment processes and personnel shortages are thoroughly entangled with migration, making immigration policy a macro level influence on the horticultural knowledge system. The Discussion highlighted that reported personnel shortages have socially constructed dimensions related to employers' desire for good employees. Research to enhance Comprehensive data on vacancies within the sector, and the current skills profile of its workforce would enable a more objective picture of these impediments to be analysed in light of such discourse. The framework suggests that to fully understand challenges facing horticulture it is essential to investigate how knowledge flows operate, and what impedes them. What transfer techniques are most effective and the role of codified or stored information is

one area identified for further investigation. A related question requiring research is why the sector is reliant on informal learning, and whether more formalised knowledge exchange would be beneficial.

This framework includes multiple forms of knowledge and associated processes involving diverse knowledgeable actors, including but not limited to the creation and spread of new knowledge. Actors include workers *and* business managers or owners;⁵ each may concentrate their activity within one knowledge requirement but this is not exclusive, nor is the list of actors associated with each. Following our ecological definition of skills, materials including plants are included within the knowledge community. The degree to which more-than-human actors affect knowledge flows is an area requiring further research; this might consider the role of materials and plants as knowledge actors or holders. Locations are not indicated as knowledge is assumed to be dispersed and mobile, and it remains uncertain the degree to which distance affects knowledge exchange. Knowledge flows include exchanges beyond formal training or education, reflecting the dominance of informal learning and experimental knowledge within horticulture. The framework highlights impediments currently limiting knowledge flows within UK horticulture as identified in the review of recent strategies and literature. This includes long-term under-investment in R&D and knowledge infrastructure such as specialist education facilities. The risks of knowledge being monopolised by powerful actors and costs of accessing essential knowledge were both identified as socio-economic factors currently preventing growers developing a skilled workforce. There may be other significant power dynamics influencing knowledge flows, making the nature of power relations between actors within this system another area

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Figure 1: The food growing knowledge system and its challenges

4. Conclusion

Through a focus on horticulture, this paper highlighted the importance of knowledge and skills for food production, and that challenges facing these dimensions of agri-food systems are not well understood. Skills strategies were found to lack comprehensive treatment of all knowledges and how they connect to labour issues, increasing the likelihood of solutions being misdirected. This is in no small part due to horticulture being portrayed as un-skilled work, sometimes deliberately to maximise profit extracted from workers. A key aim of this paper was to counter this by articulating the nature of horticultural work and its skills. Analysis revealed characteristics of the horticultural

skills system and its crisis requiring further interrogation. This includes better understanding the degree to which distance influences knowledge flows: What might remote learning contribute to horticultural training? What horticultural knowledge is being codified, how and how is this exchanged?

Many challenges facing horticultural skills come back to lack of people and investment, and depleted knowledge infrastructure, but these ‘skills challenges’ cannot be divorced from broader food system problems. Weak training infrastructure and career paths within the sector, particularly for smaller agro-ecological businesses, indicate producers’ economic vulnerability. Profitability is essential to ensuring fair pay for all, including trainees, whilst underlying the appeal of becoming a food producer. A focus on skills can – intentionally or not – distract from these deeper challenges. Defining skills as social practices embedded within power dynamics emphasises that the ability to grow food includes the capacity to economically sustain an enterprise, generating income to invest in growing the sector’s knowledge base. Our conceptual framework should enable more nuanced analysis of skills challenges, providing a firmer foundation for building solutions, but better data on the sector and its workforce is also required.

The framework aims to valorise a range of knowledgeable food production actors, especially those too often treated as unskilled. It draws attention to impediments hindering knowledge flows, and macro factors influencing these. Critical social scientific attention can helpfully examine how these disrupt knowledge flows, through research addressing urgent questions including: How will changing migration patterns affect the ability to grow food in countries reliant on an imported workforce? How can the skilled work of growing food be justly rewarded? What prevents producers accessing essential knowledge? A fundamental question underpinning many aspects of the skills challenge

is: how can agri-food systems be transformed to make the business of growing healthy, ecologically sustainable produce profitable? Fostering viable businesses offering fulfilling, financially rewarding careers may be the best remedy to horticulture's skills challenge.

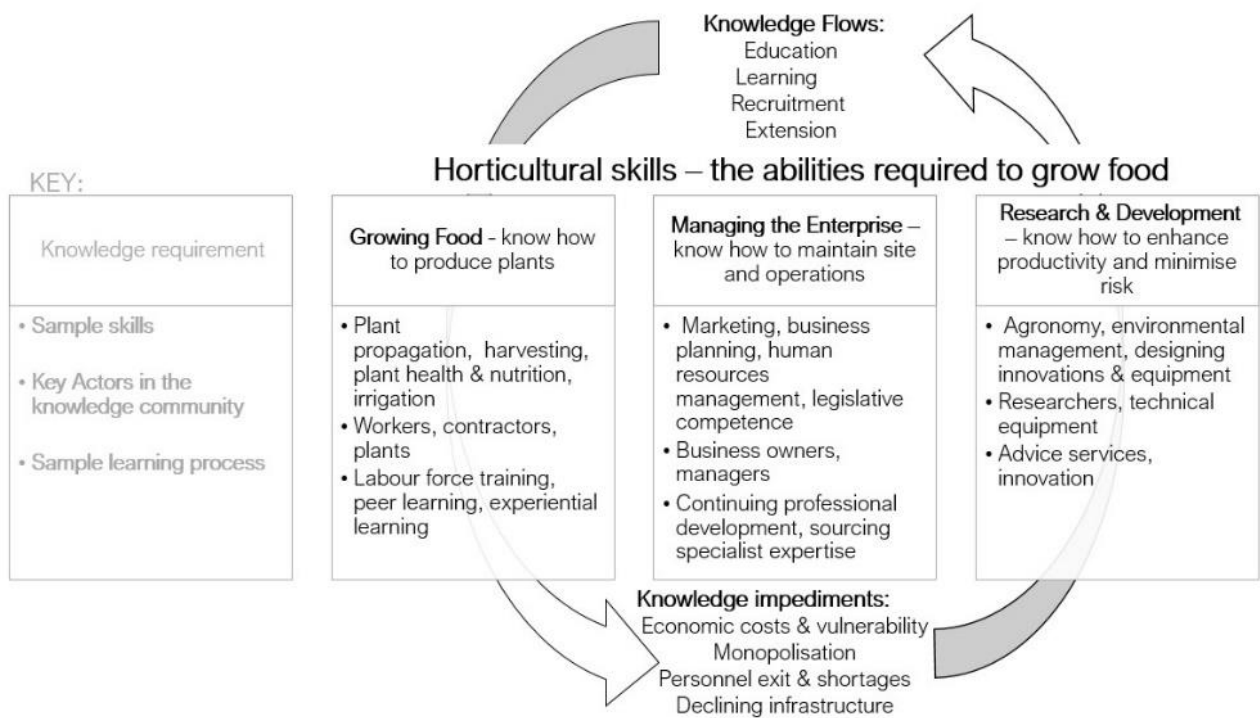


Figure 1

Table 1

Strategy	Led by	Country	Year	Focus	Define skills?	Skills data?	Source	Abbreviation
Agri-food Strategy Board ‘Going for Growth A strategic Action Plan in support of the Northern Ireland Agri-food Industry’	Industry - board in consultation with Government	Northern Ireland	2016	Agri-food industry	N	N	https://www.daera-ni.gov.uk/sites/default/files/publications/dard/goin-for-growth.pdf	ASB
AgriSkills Forum ‘Towards a New Professionalism The Skills Strategy for agriculture and horticulture’	Industry - consortium of agricultural and horticultural organisations in consultation with Government	UK	2010	Skills for agriculture and horticulture	Y	N	https://nlbc.uk/wp-content/uploads/2017/10/AgriSkills-Strategy.pdf	ASF
Agri-Tech Leadership Council ‘A UK Strategy for Agricultural Technology’	Government - in partnership with science base and food and farming industry	UK	2013	Agricultural technology supply chain, innovation and research	N	N	https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/227259/9643-BIS-UK_Agri_Tech_Strategy_Accessible.pdf	AT
AHDB ‘Edible Horticulture Skills 2020 Sector Report’	Levy body (AHDB)	England	2020	Edible horticulture industry	N	Y	https://ahdb.org.uk/news/edible-horticulture-it-s-a-skill	AHDB2
AHDB ‘Agri-Food Industry Workforce Skills and Development Strategy’	Levy body - (AHDB) in partnership with Food and Drink Sector Council	England	2018	Agricultural and horticultural Industry Skills	N	N	https://ahdb.org.uk/skills-strategy	AHDB1
Food Research Partnership Sub-group on Skills ‘High-level skills in the agriculture and food sectors’	Cross-sector group - research funders, researchers, NGOs and industry,	UK	2009	Post-graduate skills for agri food sectors	Y	Y	https://www.gov.uk/government/publications/high-level-skills-in-the-agriculture-and-food-sectors	FRP

Strategy	Led by	Country	Year	Focus	Define skills?	Skills data?	Source	Abbreviation
Fruit & Vegetables Taskforce ‘Report and Action Plan’	Industry - cross-sector group in consultation with Government	England	2011	Edible horticulture industry	N	N	http://webarchive.nationalarchives.gov.uk/20130402193337/http://archive.defra.gov.uk/foodfarm/food/policy/partnership/fvtf/index.htm	FVT
Horticulture Forum for Northern Ireland, ‘Review and Strategic Priorities for the Development of the Horticulture Industry’	Industry - partnership in consultation with Government	Northern Ireland	2012	Horticulture industry	N	N	https://www.horticultureforumni.co.uk/wp-content/uploads/2014/01/horticulture-forum-strategy-2012-Final-print-version.pdf	HFNI
Horticulture Matters ‘The growing crisis in UK Horticulture that is threatening our economy, environment and food security’	Charity - Royal Horticultural Society in partnership with other non-governmental organisations	UK	2014	Skills and careers in horticulture	N	N	https://www.rhs.org.uk/Education-Learning/PDF/Training/1016-RHS-Hort-Careers-Brochure-V8.pdf	HM
Scottish Horticulture Panel ‘Scottish Horticulture Action Plan’	Coalition of non-governmental organisations	Scotland	2018	Horticulture industry	N	N	https://hta.org.uk/uploads/assets/uploaded/640c0479-b58a-42e2-aa855e64d32e71a3.pdf	SHP
Skills Development Scotland Skills Investment Plan For Scotland’s food and drink sector 2nd Edition	Skills agency - on behalf of Government	Scotland	2017	Food and drink industry	N	Y	https://www.skillsdevelopmentscotland.co.uk/media/40095/3093-sds-food-and-drink-sip-digital-v3-11.pdf	SDS

Strategy	Led by	Country	Year	Focus	Define skills?	Skills data?	Source	Abbreviation
Wales Food & Drink Board ‘Transforming Skills in the Welsh Food and Drink Industry’	Industry - board in consultation with Government	Wales	2017	Skills for food and drink industry	N	N	https://businesswales.gov.wales/foodanddrink/sites/foodanddrink/files/180209%20F%26D%20Industry%20Skills%20A4%20ENG_1.pdf	WFDB
Welsh Government ‘Strategic Action Plan for the Welsh Horticulture Industry’	Government - in partnership with industry	Wales	2010	Horticulture industry	N	N	http://gov.wales/docs/drah/publications/100416-horticulture-action-plan-en.pdf	WG

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