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Future of Horticulture

Overview

- The horticulture sector cultivates various edible and ornamental plants, contributing to the provision of healthy diets. The UK is mostly reliant on imported horticultural produce.
- The sector faces multiple challenges arising from high energy costs, low profit margins, trade barriers and a dependency on migrant labour, while also mitigating the implications of climate change.
- Technological innovation could help to tackle some of these interconnected challenges. Innovations include automation, greenhouse optimisation, alternative growing media, genome editing, pest management using sensor data and AI-mediated crop monitoring.
- Several barriers may prevent growers from adopting innovations. These include capital investment costs, technology readiness, skills and knowledge communication and ethical concerns relating to labour displacement.
- However, innovation alone may not be sufficient to address all challenges in the sector. A systems approach that considers horticultural policies alongside wider economic, health and environmental policies may be required.

Background

Horticulture is a branch of agriculture that relates to the production, cultivation and management of edible fruits and vegetables, and ornamental plants.[1]

The value of home-produced vegetables and fruit amounts to just under £1.8 billon and just under £1 billion, respectively, with the ornamental sector surpassing fruit production at £1.580 billion.[a,3] Ornamental horticulture (the growth and marketing of plants for decorative and recreational purposes) is not covered in this POSTnote.

Fresh fruit and vegetables are fundamental to a healthy diet (PN 686). The independent food system review, the 2021 National Food Strategy,[4] stated that healthy diets have declined in recent decades. The 2022 Government Food Strategy has committed to deliver "healthier, more sustainable and affordable diets for all".[5]

The horticultural sector has several interconnected challenges. The UK depends on imports from areas affected by climate change, with implications for reduced supply and increasing production costs. It also has historically relied on seasonal migrant worker labour, the supply of which is affected by external political factors.

Some commentators suggest investment in technological innovation may mitigate some of these challenges (**Box 1**). Others contest this and suggest that reform of the supply chain infrastructure is required instead (PN 702).

[a] The Royal Horticultural Society estimates that the UK horticulture and landscaping industries contributed £28.8 billion to UK GDP in 2019.[2]

Box 1: Defining innovation

- In this POSTnote, innovations are defined as encompassing any new practice or tool that adds value to a process, some of which *may* be technological. Innovative solutions may involve new technology, but many incorrectly equate innovations solely to technology.
- Some stakeholders used the phrases "low-tech" and "high-tech". However, horticultural innovations may not be easily defined by these two categories. For example, Integrated Pest Management (IPM)[b] is inherently "low-tech" but is perceived as an innovative, novel alternative to synthetic pesticides.
- "Low-tech" may include innovations such as polythene tunnels, alternative irrigation methods, insect netting or misters and suction fans for evaporative cooling within glasshouses.[6] Notably, indigenous peoples created some horticultural practices still used today, such as multi-cropping, seed breeding and other land management strategies.[7]
- "High-tech" solutions are likely to refer to innovations such as picking or packing robots, controlled environment agriculture (such as vertical farming), or using Artificial Intelligence (AI) for automated plant monitoring.
- The biggest barrier to implementing technological innovation is the capital investment required to push them through various stages of development before they are commercially viable. Many innovations do not make it through this challenging process (the "valley of death").

Current state of the sector

Several economic, environmental and political factors drive sector trends.

Levels of production

The horticultural sector is diverse; from market garden smaller-scale production sold directly to the customer or restaurant, to large-scale agriculture that intensely produce mono-cultured crops for large retailers.

Horticulture used less than 1% of UK agricultural land in 2018.[8] In the context of UK agriculture, the horticulture sector is comparably high value, constituting 20% of production value.[c,9]

From 2021–2022:[10]

- The UK's production of vegetables decreased by 5.8% to 2.4 million tonnes

[b] IPM is a coordinated strategy to prevent, detect and control pests and diseases in a more sustainable way by minimising health and environmental risks.

[c] Farmgate value is the market value of a product minus the selling, marketing or transport costs. It is often described as the value of the crop before it leaves the farm.

- Protected vegetable production (grown in a protected environment, such as a glasshouse or polythene tunnel) fell by 5.7% to 247 thousand tonnes — the seventh consecutive year of falling production since the 2015 peak production of 310 thousand tonnes
- Land area used for protected vegetable production fell by 11%
- Vegetable imports increased by 3.3% to over 2 million tonnes

Trading

The UK imported £2.7 billion worth of vegetables in 2022, a 15% increase from 2021.[10] Fruit imports were worth £3.9 billion in 2022, a 4.5% increase since 2021.[10] As a percentage of total value, Spain produces the highest amount of fruit and vegetable imports; 25% and 7.7%, respectively.[10] This is followed by 6.8% of vegetables from the Netherlands, and 15% of fruit from South Africa.[d,10]

Legislation for a new UK Border Strategy & Target Operating Model following a departure from the EU was completed in 2020 but is yet to be implemented.[12] A new grading system for biosecurity risk[e] of foods (PB51) is being implemented, but several reports suggest this could be further delayed due to high UK inflation.[13,14]

Commentators highlight that these border vehicle inspections may cause severe delivery schedule delays, increased consignment costs and compromise fresh produce quality.[15]

Supply chain relationships

The horticultural sector supply chain is complex. Navigating product shortages, delivery delays and overall higher prices raises challenges for growers.[16,]

Grocery and supermarket retailers' share of the food and drink market was 64.9% in September 2022.[16] Many stakeholders have voiced concerns about supermarket dominance in the supply chain.[17,18,19] Requesting a higher amount of produce than needed or "supermarket specifications" (for example, that products must be a specific diameter to be deemed marketable) is commonplace, which diminish returns and create food waste.[19]

Chatham House posited there is a 'cheaper food' paradigm of self-reinforcing food overproduction in a globally competitive market. [f,20,21] Consumer demand for cheaper

[d] The UK currently has free trade agreements (FTAs) with some EU and African countries. Upon leaving the EU, the UK has signed FTAs with Australia and New Zealand which came into effect at the end of May 2023.[11]

[e] These threats include diseases, such as Xylella and African Swine Fever.

[f] Economic gain incentivises the conversion of land and increasing crop yields for food production, with demand for food also shaped by supply and price. Income tends to positively correlate with consumption of foods with resource-intensive production methods.

food drives growers to produce more at even lower prices. This has environmental impacts,[22] and the economic consequence of reducing profit margins for growers. [g,23]

Energy

The 2022 Russian invasion of Ukraine increased global energy costs.[24] A large proportion of the UK horticultural sector requires energy to heat glasshouses through winter.

Glasshouse growers have operated in the Lea Valley, a 450-acre area north of London, for over 100 years. This land accounts for around 65% of the UK's cucumber and pepper production, as well as tomato and aubergine production.[25] Approximately 50% of growers in the Lea Valley Growers Association could not plant crops in 2022 due to high energy costs.[26,27]

Migrant labour

The government commissioned an Independent Review into Labour Shortages in the Food Supply Chain[h] in 2022 to address workforce difficulties in recruiting and retaining staff.[28] The National Farmers Union (NFU) reported £60 million of losses in 2022 due to visa processing delays that caused a shortage of workers for crop harvesting.[29] There are currently around 40,000 permanent workers in the UK horticulture sector, 46% of which are employed on a casual basis.[8]

The sector has relied upon seasonal migrant workers to supplement its workforce, where an estimated 99% of these workers come from the EU.[30] Following the UK's EU departure, a new points-based immigration system requires that "anyone coming to the UK for work must meet a specific set of requirements for which they will score points."[31]

Seasonal workers are not categorised as "high-skilled" under this points-based system,[31] but are still permitted immigration under the Seasonal Workers Pilot of 2019.[32] This categorisation has been contested by the sector, who argue that many tasks performed by migrant workers require considerable skill.[33]

The scheme launched with a cap of 2,500 non-EU workers. In response to concerns, the quota has expanded from 10,000 workers in 2020 to 45,000 in 2023.[34] However, reports vary regarding the number of visas required to cover seasonal work, with the NFU reporting this as nearer to 80,000.[35]

[g] Sustain's 2022 report into the food supply chain highlighted that for 1kg of apples purchased in a supermarket, the grower has costs of 76p, and gets back 1% (3p) from the selling price of £2.20.

[h] Defra and the then Secretary of State, George Eustice, commissioned John Shropshire OBE to lead this review.

Environmental trends

The term food system encompasses the production, transportation, manufacturing, retailing, consumption, and waste of food (PN702). [i,20] The GHG emissions produced by UK agriculture are 11%,[37] and a responsibility remains for the horticultural sector to reach Net Zero targets by 2050.[j,k,42] Lowland drained and cultivated peat soils are the largest source of land use GHG emissions in the UK (PN 668, PN 662), and major centres of field vegetable production.[43]

Climate change-related extreme weather events have affected UK imports of fruit and vegetables. Cold weather and heavy rain in Spain and Morocco resulted in high prices that caused supply shortages in UK supermarkets in early 2023.[44]

A climate-related challenge particularly affecting UK production is water availability (PB 40).[45,46] Projected changes in weather patterns and climate (increased temperatures and greater variability in rainfall) will reduce water availability further.[l] This is exacerbated regionally, such as in South East England, which has an increasing population and water demand.[48]

The government's 'Plan for Water' has predicted that the UK will need a supply of 4 billion more litres of water per day by 2050,[49] with Defra setting out aims to increase water storage usage in the horticultural and agriculture sectors by 66% by 2050.[m,51]

[i] The food system is the main driver of global biodiversity loss is through conversion of natural habitats to agricultural land,[20] but the majority of this conversion relates to meat and dairy production (78%).[36]

[j] The Climate Change Act 2008 was amended in 2019 to set the target of Net Zero by 2050.[38] This is in line with the 2015 Paris Agreement, an international agreement to keep global warming under 2°C and ideally at 1.5°C.[39]

[k] In September 2022, Defra commissioned former energy minister, Chris Skidmore MP, to lead an independent review of the UK's net zero targets.[40] The UK is currently not on track to deliver all of its commitments according to the latest progress report by the Climate Change Committee.[41]

[l] Most UK crops rely on rainfall. A drought and heatwave in 2018 affected fruit and vegetable production that season. But even during periods where the weather is wetter, some crops still rely on irrigation. Irrigation often requires abstraction, a method where water is extracted from a natural source. During periods of low water availability, there may be restrictions placed on abstractions.[47] Altogether, this highlights the importance of longer-term water storage and availability.

[m] Defra will provide grant funding and review planning barriers until 2024 to support investment into reservoirs and irrigation infrastructure.[50,49]

To automate or not to automate

Defra commissioned a 'Review of Automation in Horticulture'[n] (**Box 2**) to prepare and support the sector in a shift away from migrant labour toward automation.[52] This section describes some changes that could be implemented to achieve various aims.

Box 2: Review of Automation in Horticulture

The review considered the available technologies, what would be required to accelerate their development and how feasible their adoption is.

Depending on whether stakeholders are small- or large-scale producers, their opinions on the value of technology and robotics in the sector vary. However, most stakeholders agree on common challenges and similar goals. Usefulness of innovations is assessed using several factors:

- Ability to reduce critical system inputs (water, nutrients, seeds, growing media, energy)
- Ability to reduce or supplement workforce
- Ability to reduce greenhouse gas emissions
- Ability to increase sustainability

Stakeholders agreed robotics has the greatest potential to supplement harvesting and packing workforce roles. The review concluded that the most likely robotics to be mass adopted first are in-field rigs[o], packhouse automation and optimised production systems, followed by a second wave of autonomous crop protection monitoring and forecasting, and then selective harvesting.[52]

The Transforming Food Production Challenge (£90M), the Farming Investment Fund (£27 million) and the Farming Innovation Programme in partnership with UKRI (£270M) are some of the government-backed funding opportunities available to the sector. The Farming Innovation programme has provided £12.5M towards automation and robotics innovations.

[n] The independent review was co-chaired by the Secretary of State for Defra, George Eustice MP, and Professor Simon Pearson of Agri-Food Technology at the University of Lincoln.

[o] An in-field rig is a mechanical mobile platform that moves across the field and can automate a range of tasks, such as planting, harvesting or weeding. Field rigs are not one-size-fits-all, and different crops require different rigs.

Infrastructural: managing the cultivation system

Robotics

A range of robotics are being designed in the UK and globally for specific roles:

- The Lincoln Institute of Agrifood Technology (LIAT) is developing various soft fruit-picking robots[p]
- Muddy Machines has developed an asparagus-harvesting robot named "Sprout" [53]
- Garford Farm Machinery is marketing a weeding robotic system (RoboCrop InRow Weeder)[54]
- Saga Robotics has built a fleet of Thorvald UVC-light treatment-administering robots for powdery mildew prevention[55]
- Researchers at Japan's National Institute of Advanced Industrial Science and Technology have developed a pollinator drone that pollinates flowers but is not yet autonomous[56]

However, some horticultural tasks pose challenges for automation. For example, different crops each require a different robot, and robots are not yet available for all crops. Harvesting fragile soft fruit that are easily bruised is difficult to automate. Furthermore, robots do not eliminate the need for all workers as humans are still required to control and supervise the robots.

Protected/covered horticulture

Glasshouses or greenhouses have been used to improve UK crop production since the 17th century, and can increase yield by 15 times per acre compared to field conditions.[57,58,59] They can be equipped with other innovations, such as alternative growing media, and in combination with renewable energy generation to increase yield and reduce energy use.[60,61] The Netherlands is frequently described as having the most advanced greenhouses in the world.[62]

Similar glasshouses are already being used in the UK. APS Group produces 20% of the UK's tomatoes at the height of their production in July. Their growing sites use Combined Heat and Power Plants (CHP), where waste heat and CO_2 are recovered for use in glasshouses, and excess power is fed back to the National Grid. This increases yields by 10% and delivers an energy efficiency of 90% in CO_2 clean-up. Fertilisers and water are also re-used by circulation,[63] with one site benefitting from a one-season saving of £100,000.[64]

Glasshouses benefit from lower total purchased energy by harnessing natural solar light. However, many are supplemented with grow lights during winter months to ensure consistent crop production. The lights often remain on throughout the night, with unscreened light escaping from these glasshouses visible as a glow (magnified

[p] "GRASPberry", "SHAPE" (Strawberry Harvester for Polytunnels and Open Fields); "RoboFruit" (universal robotic fruit picking head); and "FASTPICK" (novel robotic picking head that aims to pick 95% of fruit at a speed of 2 seconds per berry, the same performance of human harvesters).

by mist conditions) from the outside.[65] Impacts of light pollution include disturbance to nearby residents and effects on wildlife.[66–72]

Other stakeholders would prefer a greater focus on investment into building or renewing[q] "lower technology" innovations to support market garden growers. Simple "polytunnels"[r] can also increase yield and create sufficient crop production for small-scale growers as a more affordable option, without the need for high energy input and running costs.[74] Used in combination with schemes such as Community Supported Agriculture,[s] low technology innovations have potential in locations where shorter supply chains or direct-to-consumer sale are possible.[76]

Abiotic environment: monitoring and management of the microclimate

Controlled environment agriculture and alternative growing media

UK arable land availability declined by around 26,000 hectares per year over the past 20 years,[77] but innovative measures could allow minimal land use farming in urbanised areas.[t] In vertical farming, plants are grown indoors and stacked vertically on 'shelves' to maximise the use of vertical space.[79–82]

Crops are grown under artificial lighting and often in conjunction with alternative growing media, such as hydroponic or aeroponic irrigation.[u,87–89] Vertical farms increase yield per unit of space, can produce crops year-round, and can reduce input of water, fertiliser and nutrients.

For some crops, aeroponics can be more efficient than hydroponics due to increased oxygen availability to the root. UK vertical farming company LettUs Grow has shown that aeroponics requires up to 30% less water than hydroponics and 95% less than outdoor farming.[90] Some evidence shows that crops grown through aeroponics

[q] Some growers in the Lea Valley were last able to afford renovation of their glasshouses using a 50% grant from the government in the 1980's.[73]

[r] Polyethylene polytunnels provide crop protection and create a more optimal microclimate to increase crop production, with the benefit of being moveable, non-permanent structures.

[s] Community Supported Agriculture is a product distribution service that often involves volunteering and connects farmers and consumers more closely, shortening the supply chain. Consumers subscribe to a farm/group and have access to the harvest. The risks, rewards and responsibilities are then shared between the farmers and consumers. UK CSAs have grown from grassroots initiatives and there are a diversity of CSA models that have now been developed.[75] CSAs are inherently low-tech because they do not rely on technological innovation to solve problems such as labour shortages, when implemented locally.

[t] The latest statistics on land use in England show that 33,600 hectares are vacant/derelict.[78] Calculations from Intelligent Growth Solutions and the James Hutton Institute demonstrate that using 33-35% (11,158–17,774 hectares) of derelict land to build vertical farms could provide every adult in the UK with 5-a-day.

[u] Hydroponic irrigation methods include drip irrigation[83], deep water culture[84], nutrient film technique[85] and flood and drain.[86] Aeroponics is a similar irrigation method, except plants are suspended in the air and water is atomised and nutrient-dense and applied to the root zone directly.

systems have the potential to grow 20% faster than with hydroponics, and the need for pesticides is significantly reduced or eliminated altogether.[91]

Despite reduced inputs and their production efficiency, stakeholders are concerned about the running costs and hidden carbon footprint of these systems.[92,93]

Artificial lighting used in these systems can account for up to 70–80% of electricity costs, although use of advanced LED light systems may reduce this.[88,94] Vertical farms require more energy than traditional greenhouses (38.8kWh per kg of produce versus 5.4KWh per kg, respectively),[95] but have 30 to 50 times greater water use efficiency.[96]

Most vertical farming systems currently only have the capability to grow herbs and leafy greens, and their viability depends on availability of local resources (primarily, water and land area).[97]

Peat-free transition

In wetland areas, waterlogging prevents the decomposition of plant matter which accumulates as a peat store of carbon.[v] Peat is extracted for use in horticultural growing media, owing to its physical, chemical and biological properties, and low economic cost.[99] However, extraction of peat requires stripping away the vegetation and drainage of the bog, emitting carbon during this process (PN 668). Further carbon is also emitted when it is used in protected horticulture.

To reduce these GHG emissions, the Government has implemented a phased reduction in the use of peat by the horticultural sector from 2026, allowing for certain technical exemptions, with a complete ban by 2030.[100] Alternative growing media are already in use,[w,101–104] but their acquisition and use at scale will present further challenges. Many peat alternatives do not possess the same qualities as peat that make peat a successful growing media.[105]

To support the productivity of the horticulture sector, the search for sustainable, economically viable and productive peat alternatives is ongoing.[106,107,108]

Biotic environment: monitoring and management of the plant crop

Disease and pest surveillance

Limitations on chemical control products such as neonicotinoids (CDP-2023-0025)[67,110] have led to innovations in IPM strategies (PB 51). This includes crop rotation and intercropping, biological pest control, and timely cultivation and harvesting.

Smart Protect is a European thematic network that helps growers to identify innovative IPM tools.[111] For example, SMAPPLAB is an insect trap with a camera and

[v] Peatlands are the most carbon-dense terrestrial ecosystem on the planet, capable of storing carbon for thousands of years. They contain 44% of all soil carbon, far exceeding carbon stored in all other vegetation types.[98]

[w] This includes wood-based materials such as pine bark and wood fibre, coir (coconut fibre), and composted organic wastes.

sensors that performs insect identification and calculates a daily catch count to inform growers about insect management.[112] CropMonitor Pro uses weather and climatic data to provide pest and disease risk predictions and optimal spray timing to support decision making.[113] Slugbot is an autonomous system that combines slug monitoring and precision application of bio-molluscicide treatment.[114]

Genome editing

Genome editing encompasses a variety of techniques that add,[x] remove, or modify DNA at targeted locations within the genetic code of living cells (the genome) (PB 50, PN 541, PN 633). The Genetic Technology (Precision Breeding) Act 2023[122] now excludes plants produced through gene editing technologies from existing Genetic Modified Organism (GMO) regulations.[y]

These are described as Precision-Bred Organisms (PBOs)[125] and the Act introduced two notification systems; one for precision-bred organisms used for research purposes and the other for marketing purposes, with the information published on a public register (CBP 9557). The EU has also recently proposed the reform of legislation regulating GMOs to similarly exclude plants produced by certain genomic techniques.[126]

Most genome edited plants under various stages of commercialisation aim to provide consumer benefits, such as additional health benefits.[115–120] But some crop protection traits have been introduced, such as resistance to powdery mildew to increase shelf life.[121]

However, genome editing remains an area of contention (PB 50, PN 633). Some commentators believe these crops cannot be separated from debates around trust in the food system, transparency and who benefits from technological changes (PB 50).[7,127]

Barriers to adopting innovations

There are several challenges that influence the pace or extent at which automation and robotics are adopted in the sector.

Capital investment

Stakeholders agree that capital investment is the biggest barrier; profit margins have been low over several years due to pressure from retailers to decrease consumer prices.[128] The most advanced innovations, such as vertical farming and robotics, have the highest initial start-up costs.[129,130] They have additional upgrading costs as they may lack compatibility with legacy infrastructure.[80]

Entering into a bidding round for larger initiatives, such as Innovate UK, often requires having a near ready-to-go project.[131,132] This requires upfront capital

[x] Most genome edited plants under various stages of commercialisation aim to provide consumer benefits, such as additional health benefits.[115–120] But some crop protection traits have been introduced, such as resistance to powdery mildew to increase shelf life.[121]

[y] The Genetically Modified Organisms (Deliberate Release) Regulations 2002[123] and the Environmental Protection Act 1990[124] no longer apply.

investment, with confirmed collaborators in place. Once a product is on the market, funding to scale production to the level required by industry is the next barrier.[80]

Horticultural growers' trust in innovations is already low, particularly market garden growers, given the risk of production failures.[133] Some stakeholders suggest that the government provide financial support for more cooperatives that encourage innovation by sharing the risk of capital loss, which may reduce inequalities with larger growers.

Technology readiness

Another barrier for automation and robotics is the readiness of the technology; not whether a type of robot *can* be built, but if it performs tasks with the same efficiency as human workers. Technology readiness levels (TRLs) are a measurement system used to "assess the maturity level of a particular technology".[z,134]

Autonomous selective harvesting robots require substantial private sector investments to get past TRLs 5 and 6, often known as the prototype stage. It is the area that receives the most funding, but the Review of Automation in Horticulture states that "if left to market forces, [selective harvesting at scale] will not be available for widescale adoption until well after 2030".[52]

Existing infrastructure (such as connectivity, charging points and storage) or the terrain of the farm is unlikely to be compatible with retrofitting new automation systems.[135]

Knowledge and skills dissemination

Horticultural sector knowledge exchange is fragmented due to the specificity of crop-by-crop knowledge, creating difficulties in sharing information about common challenges.[136–138] Growers may also be reluctant to share data about practices in a competitive market.

Some stakeholders perceive that the sector still lacks sources of independent advice following the wind-down of the Agriculture and Horticulture Development Board's involvement in horticulture.[139,140] However, industry-owned non-profit organisations such as Horticulture Crop Protection Ltd have since been established to provide certain services.[aa]

On-farm data gathering by robots evokes concerns relating to data usage, ownership and rights, particularly for growers leasing or renting innovations from private companies.[144]

Adopting new technological innovations would require knowledge exchange activities, but time and capital investment in training, as well as access to expertise, may be a barrier for growers. Existing workers would need to be upskilled with the technical

[z] TRLs are ranked 1–9 with TRL4 being validated by lab trials and TRL9 being successful mission operations. The UKRI Science and Technology Facilities Council use TRLs to determine project proposal suitability for specific funding opportunities.[134]

[aa] This includes crop protection, such as the Extensions of Authorisation for Minor Uses (EAMUs) programme which provides access to access to pesticides, fungicides and herbicides and also plant growth regulators such as auxins or cytokinins.[141–143]

knowledge and advice from those that build the robots. This further complicates existing challenges of time restraints for training seasonal workers.[145]

Ethical concerns

Reports vary as to what extent of labour displacement is possible.[146–148] However, at present, robots cannot completely replace human workers in a single task and some level of human supervision is required both practically and for health and safety legal requirements.[149–154] Despite this, some ethical concerns surrounding the perceived threat of labour displacement by robotics remain.

Some research suggests that supplementary automation may exacerbate inequalities between "low-skilled" and "high-skilled" labour.[155] Other reports suggest that use of robots for specific tasks may result in the loss of human workforce skills and experience.[156]

Some academic commentators are concerned that automation could culturally alienate society from food production.[157]

Planting the seed: opportunities for the future

Stakeholders agree that the horticulture sector will require technological innovation,[158] but many highlight that innovation is not a "silver bullet" to all challenges in the sector.[74,159]

Some argue that to tackle these issues, a systems approach will be required that considers horticultural policy alongside wider health and environmental policy. For example, the "Dutch diamond"/"quadruple helix" policy framework connects academia, industry, the government and civil society.[160]

The two core challenges for the sector are a lack of capital and a lack of workers. Options to address these challenges include:

- **Changing perceptions of the sector:** Incorporating "high-tech" innovations may not be sufficient to attract a new generation of workers. Commentators emphasise finding solutions to the exploitation of current and future migrant labourers and improving pay, staff benefits and working conditions.[28,161] The independent review[28] recommended promoting the various STEM skills involved in the sector as well as campaigns to demonstrate the value of the sector to the UK's economy and food security. These may also affect how the public values the sector's professions and increase their willingness to pay more.[154,162] The Netherlands has historically provided substantial secondary school horticulture training, contributing to the positive public image of the sector.[163]

- **Supporting growers to increase their profit margins:** Without more capital to invest, most growers cannot transition to more sustainable horticultural practices. Some commentators suggest implementing legislation to prevent sale of fresh produce in supermarkets at less than the cost of its production.[164] Others point to greater reform in the supply chain to ensure higher take-home income for growers.[64,165]

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