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Growing a Green Economy

The importance of ornamental horticulture and landscaping to the UK

OHRG
ORNAMENTAL HORTICULTURE ROUNDTABLE GROUP

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The Ornamental Horticulture Roundtable Group

Formed in 2014, the OHRG is a coalition of organisations spanning the breadth and depth of the ornamental horticulture and landscaping industry. It includes bodies that represent the UK's 30 million gardeners as well as the societies and associations that represent businesses in the industry. The OHRG champions and grows the economic, environmental and social benefits of horticulture through its research. It works with government to find intersections between opportunities for industry growth and solutions to the policy challenges of climate change, our environment, health, and growing a sustainable 21st century economy and society.

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Key Findings

£41.8 billion

Total potential GDP footprint of the UK's ornamental horticulture and landscaping industries in 2030, compared with £28.8 billion in 2019

763,400

Total jobs contribution potential of the industry in 2030, compared with 674,200 in 2019

£8.7 billion

UK potential tax revenues attributable to the industry in 2030, compared with £6.3 billion in 2019

- The ornamental horticulture and landscaping industry has the potential to increase its direct, indirect and induced contribution to national GDP from £28.8 billion in 2019 to £41.8 billion in 2030. These figures incorporate the industry's supply chain and wage consumption multiplier effects.
- The number of jobs across the country that are supported by the industry has the potential to increase from 674,200 in 2019 to 763,400 in 2030. The increase in tax revenues to the exchequer linked to ornamental horticulture and landscaping have the potential to increase from £6.3 billion to £8.7 billion.
- These projections are based on favourable outcomes of a handful of key determinants of growth: the extent and quality of the UK's green spaces and infrastructure; access to labour and skills for businesses; achieving sustainable productivity and capacity gain; safeguarding the UK's biosecurity; forecast participation in gardening arising from demographic and socio-cultural change; and investment in research and development and horticultural science.
- Should least favourable outcomes to these market drivers occur, industry growth is projected to be far more modest. In this lower-case scenario we project the industry's contributions in 2030 to UK GDP at £32.2 billion (a £9.6 billion shortfall on its potential).
- Our report shows that the industry's potential contributions in 2030 are not limited to the economic realm. By 2030 the industry has the potential to increase its already major contributions to eco-system services and nature-based solutions to the challenges posed by climate change.
- There is a rich and growing evidence base for contributions made to UK natural capital by well-designed and managed green spaces. For instance, the Office of National Statistics reports that the cooling shade of urban trees saved £248 million in 2017 alone, and 27,000 lives were saved through vegetation removing air pollution.
- We assess that the industry is at a crossroads regarding growth in the next decade. Should key drivers of market growth tend towards favourable outcomes, then the industry could deliver major economic growth in the coming decade and help to underwrite the societal and environmental goals facing the UK in the coming decade and beyond.

The Future of Ornamental Horticulture and Landscaping

Introduction

The UK Ornamental Horticulture and Landscaping sector is hugely important to the success of the UK economy, providing significant economic and wider societal benefits. In 2018, the Ornamental Horticulture Roundtable Group (OHRG) published a landmark report in partnership with Oxford Economics which calculated the sector to be worth £24.2bn annually to the UK economy in terms of direct, indirect and induced GDP contributions, while also supporting 568,700 jobs. Moreover, there was emerging evidence of wider economic, environmental and societal benefits produced by the sector, such as the gains provided by natural capital. Following this the OHRG and the UK Government has identified an opportunity for the sector to play a significant role in helping the UK to 'build back greener' following the disruptive impact of Brexit and the COVID-19 crisis. In response, the OHRG has commissioned Foresight Factory and Oxford Economics to investigate drivers of potential growth, and to quantify this potential as well as assessing the environmental, social and other benefits that the sector could provide to the UK over the coming decade.

Indeed, the future of ornamental horticulture and landscaping is closely tied to the drivers shaping the development of the UK over the next decade: Brexit, a changing environment, public health and mental health developments and the changing landscape of UK cities. These seismic, sweeping changes to UK society will influence, and be influenced by, ornamental horticulture and landscaping and the way the industry shapes the future. This report traces four pairs of broad structural drivers and the scenarios that result from them, examining access to public green space and environmental change, new efficiencies in technology and changing access to talent, public and private health burdens and demographic change, and finally the changing face of life sciences such as horticultural and environmental sciences and the importance of biosecurity. Examining and projecting these drivers into the future we envision pairs of scenarios; for each driver set we propose a utopian vision of the future, in which government, industry and the public operate in concert to produce the best possible results, and a dystopian scenario, in which the various parties fail to act and as a result aren't able to accomplish positive development.

This report is the result of a five part process in collaboration with Oxford Economics. To begin, we conducted an extensive knowledge review of available research and literature. Following this we interviewed a number of experts across both ornamental horticulture and beyond, speaking with futurists about developments in technology more broadly and ornamental horticulture and landscaping experts about how the sector is changing and how it is likely to adapt further. With our research phase completed we constructed the various drivers, and after consultations with ornamental horticulture experts narrowed down our selection to the eight most impactful drivers. Through combining these drivers and consulting with experts once more, we arrived at our upper case and lower case scenarios, and our analysis of how the future of ornamental horticulture and landscaping is likely to change over the next decade.

While we have grouped the drivers in pairs to develop the scenarios, each of the drivers will affect the others. The development of access to, or benefit from, public green space is inextricably linked to public health; advances in plant science is tied with optimised efficiency; biosecurity underpins plant health throughout the UK and without policies that are correctly followed any efforts to improve plant coverage or green space across the country will come to nothing. We have taken these into account in the scenarios developed, and are confident that they represent the integrated drivers as a whole.

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Julia Thrift – Director, Town and Country Planning Association

Executive Summary

A vital and substantial industry

The UK Ornamental Horticulture and Landscaping industry plays a vital role in the our nation's economy, culture, health and environment. Planting, growing and maintaining gardens is an important leisure activity for tens of millions of people. The UK's beautifully landscaped and designed parks, and managed green spaces play a huge role in the lives of UK citizens and visiting tourists, and the nation's flower shows are world renowned. Spending on these green spaces drives economic activity through businesses that produce, retail, maintain service the plants, trees and other goods for these spaces. There is also a growing body of evidence to show that plants, trees and green spaces have a huge part to play in reversing the climate and biodiversity crises, and contributing to human health and happiness.

In 2018, an Oxford Economics evaluation of this industry's contribution to the UK economy showed that £12.6 billion in direct and £24.2 billion in total contributions from the industry to the UK economy in 2017. The same report provided evidence of the huge contribution that the UK's gardens and other green spaces provide to the environment as well as health and well-being. Indeed, an evaluation published by the Ornamental Horticulture Roundtable Group provides evidence for the industry supporting half of the goals of the 25 Year Environment Plan.

The UK at a crossroads

As we publish this report, the UK stands at a crossroads. The economy faces transformational change resulting from leaving the European Union, and the Covid-19 pandemic sees the UK economy facing huge challenges. Climate change is set drive the growth of new industries to help the UK and the world adapt and mitigate the effects of global warming. Nature-based solutions that benefit human health and well-being are set to play an ever-bigger part in our society. Indeed, over the course of 2020 faced with the challenges of the pandemic, millions more of us connected with nature through increased visits to natural green spaces and participation in gardening.

This report paints a picture of an industry with the potential to make a huge contribution to the UK's economic, social and environmental renewal in the next decade. Our analysis describes a scenario in which, compared with 2019, the industry supports an extra £13.0 billion to the UK economy in total GDP contributions by 2030, and provides green jobs in the form of an extra 39,000 people directly employed in the industry. In this vision of 2030, the UK's gardens and green spaces have expanded and mitigate the worst effects of climate change on our towns and cities. They're the heart of our urban spaces, improving urban cooling, reducing energy use, and alleviating flooding. Human wellbeing is improving thanks to the physical, social and mental health benefits afforded by increased access to nature. Wildlife, including pollinators, in and around our towns and cities is thriving as these green spaces are increasingly designed and planned to foster biodiversity gain.

The industry supports an extra £13.0 billion to the UK economy in total GDP contributions by 2030. The UK's gardens and green spaces have expanded and mitigate the worst effects of climate change on our towns and cities

A vision for the industry

In this vision of 2030 the industry itself has transformed in order to be able to supply and service the increasing demand for nature-based solutions and the public's increasing desire to connect with nature. This includes preventive solutions to adverse health and environmental outcomes. The industry has increased productivity and sustainability by training for new skills and implementing new technology and expanded facilities that produce more for less inputs. All of this has been enabled by advances in the life sciences that the industry has driven forward through its research and development. The nation's landscapers and designers are central to green infrastructure projects as wide-ranging as the tree planting and green infrastructure delivery for HS2 to the maintenance of the UK's parks and gardens. In this vision of 2030, research and development is contributing to a range of fields.

Science is helping to optimise the natural capital and social benefits of our green spaces.

Science is helping to optimise the natural capital and social benefits of our green spaces. It is driving innovation in production techniques such as the sustainable use of water and growing media. This revolution in science is establishing the UK as the global leader in nature-based solutions to climate change, for instance in breeding plants with the potential to make the world's cities and towns climate resilient and livable.

Risking a missed opportunity

However, this vision of 2030 cannot be taken for granted. The nation's love of gardening has been passed down from generation to generation to well over 30 million gardeners today. Our gardens and parks cover an area nearly four times that of Greater London. RHS Britain in Bloom and the RHS Chelsea Flower show are jewels in the crown of the nation's horticultural heritage. And thanks to factors such as this our analysis shows that the horticulture and landscaping industry is likely to remain as a substantial contributor to the UK's economy and natural capital over the next decade. Our lower-case scenario for the industry's contribution in 2030 though shows total GDP contributions falling short by £9.6 billion per year from their potential. Total tax contributions to the exchequer are £1.7 billion per annum lower by 2030 than in the upper-case scenario we describe. Within this lower-case scenario ornamental plant production is shown to decline slightly (from £882m to £872m in direct GDP contributions at constant 2019 prices), making the UK increasingly dependent on imports to meet its ambitious tree planting and green space aspirations. These shortfalls in potential economic contribution do not include the potential increases in costs to the public purse of increased spending on plant pest and disease control or costs to the health service which might accrue from increased obesity, anxiety and depression. Without the contributions that the industry can provide, health and environmental outcomes for the UK fall short of their potential, with fewer and fewer people – particularly urban dwellers – able to connect with nature. In this alternative vision of 2030, the ornamental horticulture and landscaping industry is a 'follower' not a leader in competing for international demand for nature-based solutions to climate change such as urban greening. This compounds difficulties in recruiting and retaining the talent the industry needs. As a consequence, the UK increasingly relies on overseas industries for the supply of plants, trees, and the green-space expertise it needs, reducing self-sufficiency and increasing biosecurity and plant health risks.

Eight determinants of growth

The difference between the best and worst cases in 2030 for the industry's contribution depend on the outcome to just eight key drivers.

1. The extent to which domestic gardens and green spaces increase or decrease as our housing stock develops
2. The extent to which public and other functional and community green spaces expand or continue to contract in our cities, towns and villages
3. The extent to which these green spaces are designed and maintained to optimise environmental, health, and social benefit to society
4. The extent to which businesses can expand capacity and productivity in a sustainable manner to meet increasing demand for gardening, managed landscapes and nature-based solutions to climate change
5. The extent to which the industry can secure the labour – permanent as well as seasonal – needed meet anticipated growth in demand
6. The extent to which participation in gardening continues to grow and remains accessible to gardeners, fully inclusive of the UK's diversity
7. The extent to which scientific research and development is funded and leveraged to enable all of the above
8. The extent to which the UK's biosecurity and plant health is maintained without stifling productivity or damaging the industry's supply chain

We assess that should favourable outcomes be secured for these drivers, then (all other things being equal) the contribution the industry makes to the UK economy, society, and delivery of the 25 Year Environment Plan is set to grow strongly. This would position the industry as contributor to helping the UK to achieve its net-zero and bio-diversity ambitions, and contributing to growth in the green economy.

Science is helping to optimise the natural capital and social benefits of our green spaces.

Chart 1: the total (direct, indirect and induced) GDP contributions of the industry 2019 to 2030 (£ millions at constant 2019 prices).

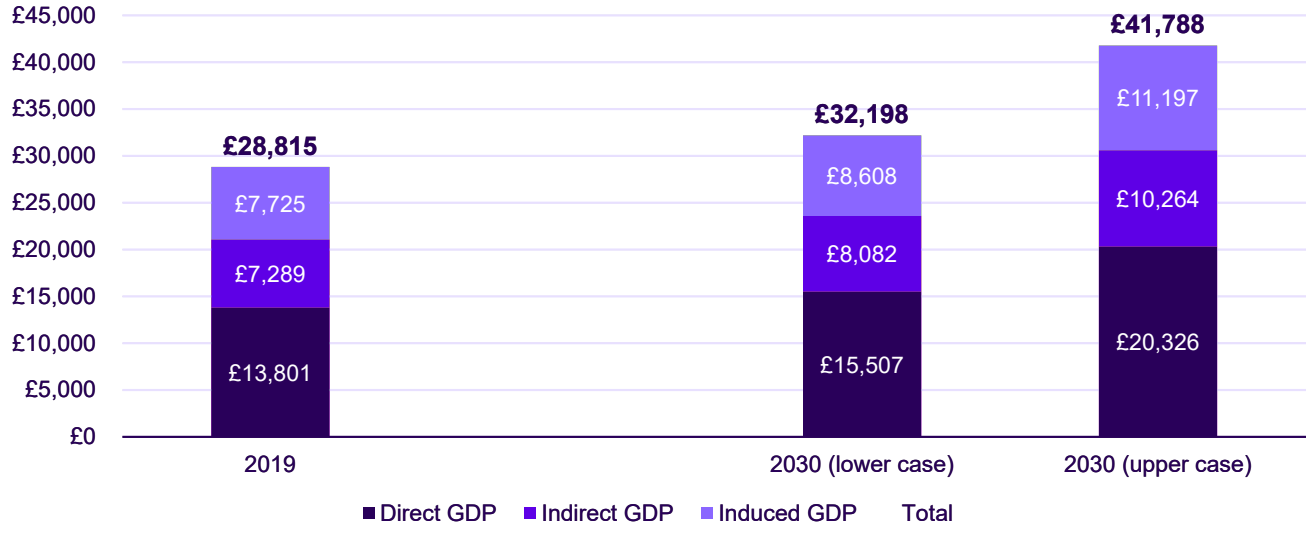


Chart 2: the employment supported by the industry 2019 to 2030 (upper and lower case scenarios)

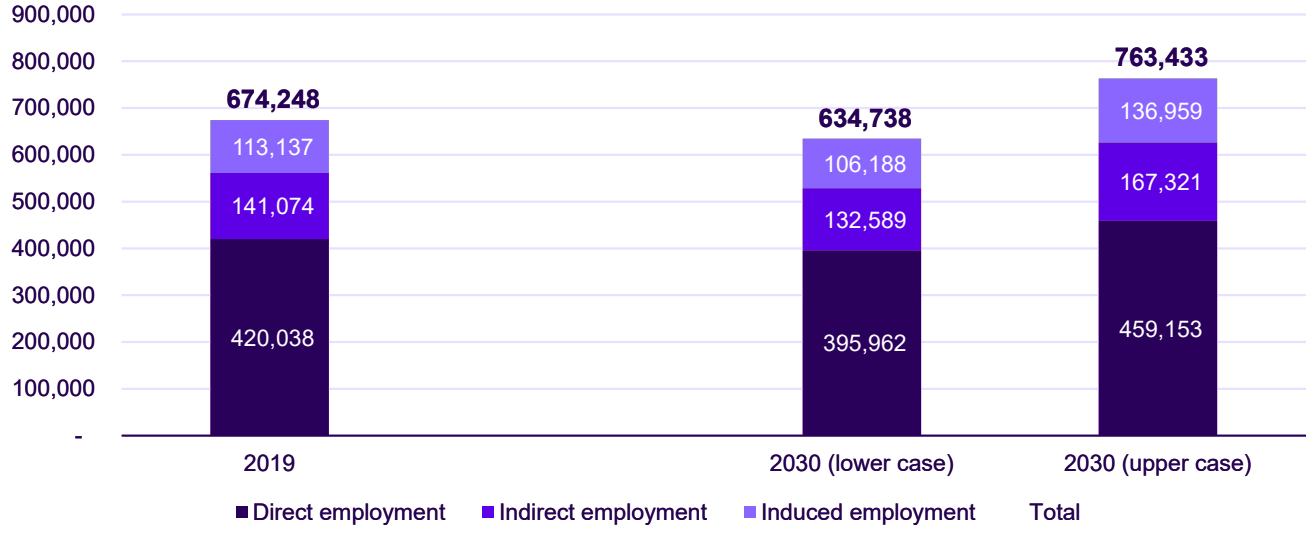
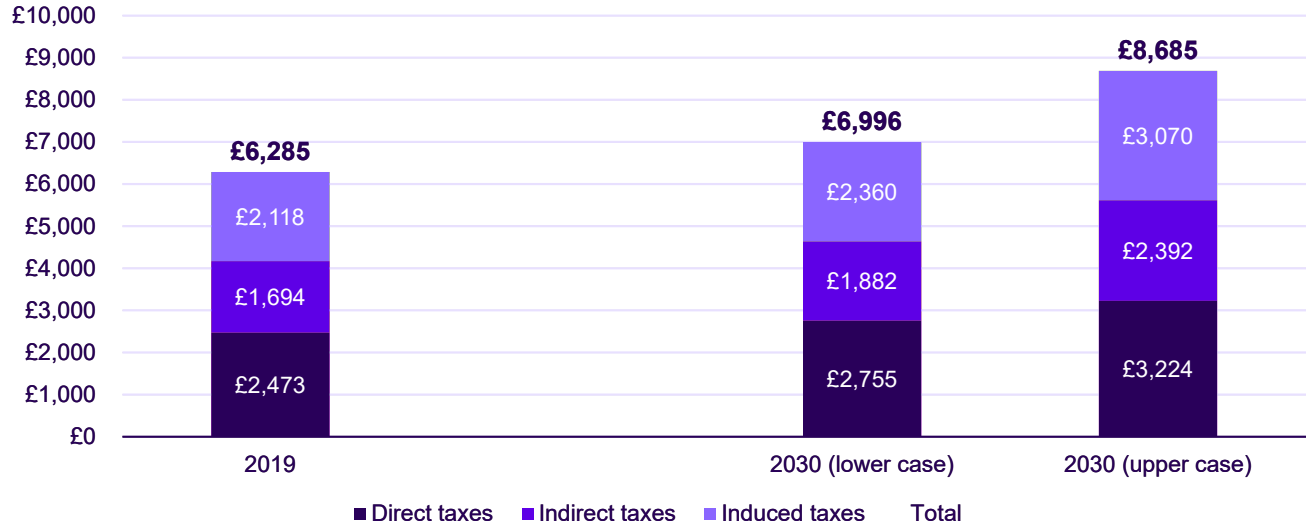


Chart 3: the total tax revenues supported by the industry 2019 to 2030 (£ millions at constant 2019 prices)



For each of the sectors within the ornamental horticulture and landscaping industry, growth has been projected to 2030 from 2019. A central growth forecast has been created based on Oxford Economcs' forecasts for similar areas of the UK economy. Lower and upper case scenarios for each sector of the industry were prepared based on the different impacts the eight key drivers are projected to have by 2030.

Table 1: 2019 and 2030 scenarios for direct GDP contributions of the ornamental horticulture and landscaping industry (£ millions at 2019 constant prices)

	2019	2030 (lower case scenario)	2030 (central scenario)	2030 (upper case scenario)
Garden manufacture	£511	£443	£511	£634
Ornamental plant production	£882	£837	£1,051	£1,282
Landscape services	£7,646	£9,052	£10,280	£12,343
Arboriculture	£590	£701	£793	£954
Retail	£2,156	£2,347	£2,379	£2,534
Wholesale	£565	£615	£623	£640
Tourism	£1,452	£1,512	£1,717	£1,938
Total	£13,801	£15,507	£17,355	£20,326

Table 2: 2019 and 2030 scenarios for total (direct, indirect and induced) GDP contributions of the ornamental horticulture and landscaping industry (£ millions at 2019 constant prices)

	2019	2030 (lower case scenario)	2030 (central scenario)	2030 (upper case scenario)
Garden manufacture	£1,320	£1,153	£1,320	£1,623
Ornamental plant production	£1,647	£1,568	£1,965	£2,391
Landscape services	£13,374	£15,869	£17,982	£21,530
Arboriculture	£2,138	£2,548	£2,874	£3,440
Retail	£4,112	£4,488	£4,538	£4,820
Wholesale	£1,357	£1,483	£1,498	£1,533
Tourism	£4,867	£5,089	£5,750	£6,450
Total	£28,815	£32,198	£35,927	£41,788

Table 3: 2019 and 2030 scenarios for direct employment of the ornamental horticulture and landscaping industry (£ millions at 2019 constant prices)

	2019	2030 (lower case scenario)	2030 (central scenario)	2030 (upper case scenario)
Garden manufacture	11,309	8,455	9,744	12,138
Ornamental plant production	17,798	15,575	19,546	20,738
Landscape services	238,114	219,381	249,060	253,508
Arboriculture	18,529	17,126	19,381	19,796
Retail	86,850	90,107	91,289	97,368
Wholesale	9,556	9,914	10,044	10,330
Tourism	37,883	35,404	40,064	45,282
Total	420,038	395,962	439,129	459,153

Table 4: 2019 and 2030 scenarios for total employment of the ornamental horticulture and landscaping industry (£ millions at 2019 constant prices)

	2019	2030 (lower case scenario)	2030 (central scenario)	2030 (upper case scenario)
Garden manufacture	23,747	17,872	20,461	25,177
Ornamental plant production	30,749	26,966	33,770	37,937
Landscape services	331,124	305,524	346,346	369,186
Arboriculture	43,419	40,248	45,415	50,805
Retail	116,151	120,657	122,008	129,899
Wholesale	22,546	23,477	23,699	24,221
Tourism	106,513	99,995	112,800	126,208
Total	674,248	634,738	704,578	763,433

Table 5: 2019 and 2030 scenarios for direct tax revenues contributed the ornamental horticulture and landscaping industry (£ millions at 2019 constant prices)

	2019	2030 (lower case scenario)	2030 (central scenario)	2030 (upper case scenario)
Garden manufacture	£123	£107	£123	£153
Ornamental plant production	£142	£135	£169	£183
Landscape services	£1,063	£1,263	£1,429	£1,471
Arboriculture	£146	£174	£197	£200
Retail	£532	£581	£587	£623
Wholesale	£135	£147	£149	£152
Tourism	£332	£347	£392	£441
Total	£2,473	£2,755	£3,046	£3,224

Table 6: 2019 and 2030 scenarios for total tax revenues contributed the ornamental horticulture and landscaping industry (£ millions at 2019 constant prices)

	2019	2030 (lower case scenario)	2030 (central scenario)	2030 (upper case scenario)
Garden manufacture	£327	£286	£327	£403
Ornamental plant production	£334	£319	£399	£462
Landscape services	£2,562	£3,046	£3,444	£3,876
Arboriculture	£530	£632	£713	£817
Retail	£1,028	£1,124	£1,134	£1,203
Wholesale	£341	£373	£377	£385
Tourism	£1,163	£1,216	£1,372	£1,539
Total	£6,285	£6,996	£7,767	£8,685

Chapter 1:

Public and private and commercial amenity green spaces: How their protection and expansion can deliver environmental value and economic growth

Chapter summary

The UK's non-domestic public, private and commercial amenity green spaces – parks, urban forests, and other urban and rural green spaces – deliver vital environmental and social benefits to UK society. However, the trend in the last 20 years has seen these spaces continue to shrink as a proportion of UK towns and cities. The extent to which these non-domestic green spaces are available and well-maintained is a key driver of potential growth in the economic and environmental contributions from the Ornamental Horticulture and Landscaping industry in the UK.

The difference between these two outcomes is worth £1.3b in direct GDP contributions to the UK economy from the design, supply, and maintenance of these spaces.

In this chapter we describe a lower and an upper-case scenario for how much GDP, tax, and employment contributions to the UK economy are affected by changes in the extent of non-domestic functional green spaces by 2030 (the economic impact of expansion or contraction of domestic gardens is covered separately in chapter 3). The extent to which the size of these non-domestic green spaces in the UK increase or decrease will significantly impact economic activity in the industry. For example, expanding public, private and commercial amenity green space in the UK will drive economic growth for the industry through increased tree/plant production to supply these spaces, and demand for services in landscaping, arboriculture, design, and maintenance of these spaces. In the lower-case scenario this non-domestic green space contracts from its current extent of 118,000 hectares to 111,000 hectares, reflecting historical trends. In the upper-case scenario, a modest reversal of this trend is assessed, with urban greening initiatives driving an increase in space to 121,000 hectares. The difference between these two outcomes is worth £1.3b in direct GDP contributions to the UK economy from the design, supply, and maintenance of these spaces. The following table shows the differences this protection of these green spaces makes to the UK economy.

The cooling shade of trees and water saved the UK £248 million by maintaining productivity and lowering air conditioning costs on hot days in 2017.

Table 7: the difference in economic contributions between upper and lower case scenarios[1] for the area of non-domestic public, private and commercial amenity green spaces in 2030.

	Difference between upper and lower scenarios
Direct GDP contributions	£1,320 m
Indirect GDP contributions	£1,074 m
Induced GDP contributions	£784 m
Total GDP contributions	**£3,179 m**
Direct employment	31,064
Indirect employment	19,581
Induced employment	9,625
Total employment	**60,271**
Direct tax revenue	£234 m
Indirect tax revenue	£248 m
Induced tax revenue	£215 m
Total tax revenue	**£698 m**

Indeed, these green spaces along with the green spaces provided by domestic gardens and allotments play a vital part in delivering environmental services to towns and cities. For instance, the ONS reports that the cooling shade of trees and water saved the UK £248 million by maintaining productivity and lowering air conditioning costs on hot days in 2017. The value of London's trees was estimated to be £130m annually in terms of pollution sequestration. A "mid-estimate" of the reduction in crime due to well managed green space is about 2%, with potential cost savings of £361 million per year. The direct economic value of public parks and green spaces to communities and residents has been estimated to generate a return on investment of 25:1 for London and Birmingham: every £1 spent on the provision and maintenance of these spaces returns 25 times that investment in terms of value for residents. In this chapter we also model the natural capital contributions of public, private and commercial amenity green spaces in combination with the space of the domestic gardens attached to the UK's housing stock (the GDP, tax, and employment impacts of any expansion or contraction of domestic gardens are detailed in chapter 3).

Every £1 spent on the provision and maintenance of these spaces returns 25 times that investment in terms of value for residents.

As part of our research, we modelled upper and lower case scenarios for the extra natural capital asset value derived from the combined area of domestic and non-domestic public, private and commercial amenity green spaces. These asset valuations depend on the extent to which the spaces expand or contract by 2030 using analysis from the OHRG – we have not attempted to model any impact from qualitative change in the performance of these green spaces. This expansion or contraction uses the same parameters for non-domestic functional green spaces noted above, and uses data on domestic garden size and house building to develop upper and lower case estimates for the extent of domestic garden space by 2030. An annualised asset value per hectare is used to estimate the difference in natural capital value provided in these upper and lower case projections, using published studies on the natural capital value of urban green spaces. The OHRG estimates using government and industry sources that currently the total domestic and non-domestic functional green space in the UK is 773,000 hectares. In a lower case scenario where domestic and non-domestic green space contracts by 8,600 hectares by 2030, asset value is impaired by £1.2b per year. In a scenario where this green space expands by 58,000 hectares through urban and other greening initiatives, there is an annualised asset value gain in terms of environmental, health, social and property benefits of £8.4b per year[2].

There is an annualised asset value gain in terms of environmental, health, social and property benefits of £8.4b per year

1 The upper case scenario is based on 121,000 hectares, and the lower case is based on 110,000 hectares and is based on modelling of historical data form government and other sources on the extent and rates of expansion/contraction in this space.

2 The figures for the change by 2030 in the area of domestic and non-domestic garden space are based on modelling based on factors which include data on the total reported space of domestic and non-domestic green spaces from industry and government sources. Data such as projected house building and historical trends in the total and average area of different urban green space has been used to develop the different scenarios for 2030.

Table 8: OHRG upper and lower case scenario estimates for the change by 2030 in annualised asset value provided by the UK's domestic and non-domestic managed green spaces[3].

	2030 lower case	2030 upper case
Change in annualised health, environmental, property, and social asset value compared with 2019	-£1.2 b	£8.4 b

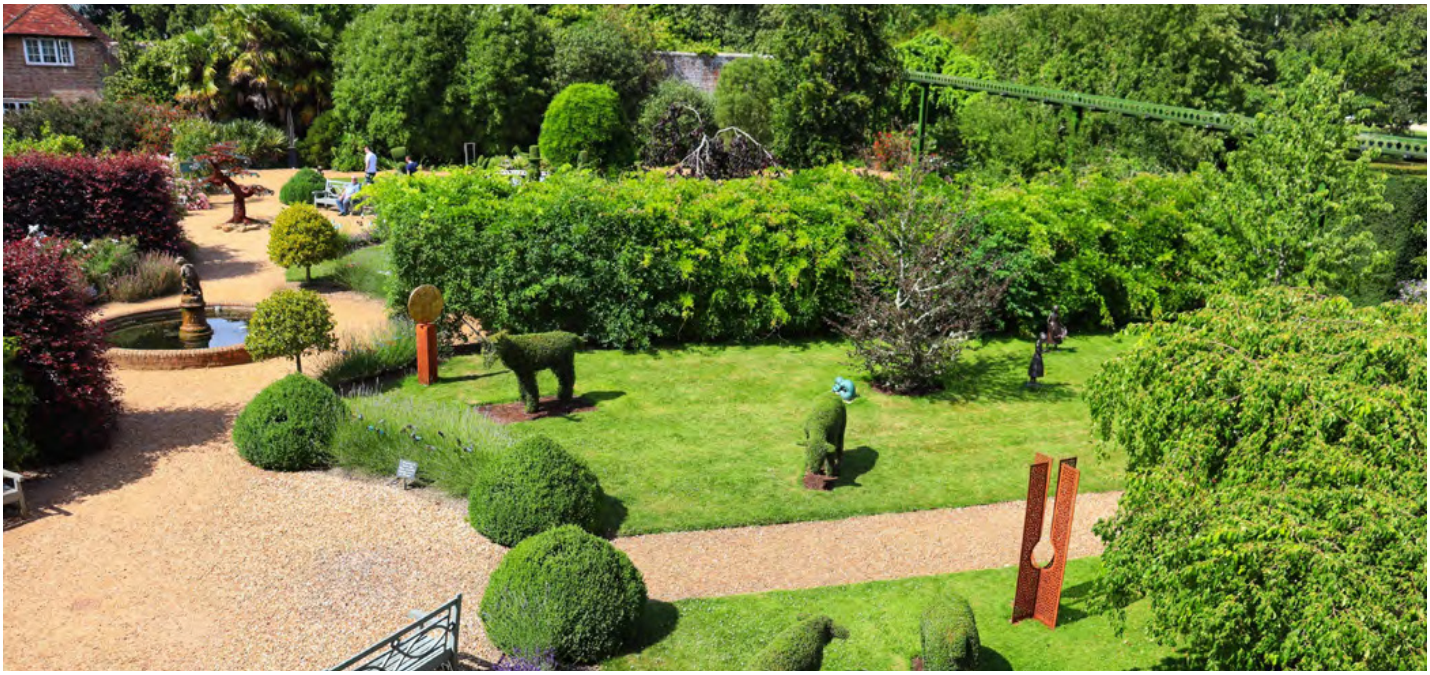
In this chapter we examine upper and lower case scenarios developed from the potential outcome of two key drivers influencing the Future of Ornamental Horticulture and Landscaping: The future growth of UK public, private and commercial amenity green spaces, and natural capital gain from all urban greening. Below we describe each driver. In Section 2, we examine the combined impact of these two drivers on the UK in 2030. In Section 3 we describe the upper and lower case scenarios, developed from the evidence presented in Section 2. Finally, in Section 4, we provide details of the economic modelling undertaken to describe the potential impact of such scenarios on the potential contribution of the UK ornamental horticulture and landscaping industry to the UK economy.

Section 1: The Key Drivers

Below we outline a summary of two key drivers that will shape the future contribution of the UK ornamental horticulture and landscaping industry to the UK economy, as well as the primary features of each driver that will propel such growth potential.

Driver 1 – The extent and quality of public, private and other non-domestic green spaces

- Access to public, and other amenity green space has a significant influence on social, physical and mental health
- Public and other green space encourages and enables exercise and biophilia (a connection to nature)
- Air pollution and airborne particulate matter and noise pollution pose a significant threats to public health – both of these problems are reduced by the presence of urban trees and vegetation
- Social cohesion and a reduction of crime are both correlated with an increase in good quality urban green space
- Greater provision of green space has driven economic activity in the supply of plants, landscaping and maintenance services.



3 Upper case scenario for 2030 is based on an increase of 58,600 hectares; lower case scenario is based on a decrease of 8,600 hectares. The 2019 estimated extent of domestic and non-domestic green spaces used for this analysis is 773,000 hectares.

Driver 2: Environmental gain from Urban Greening

- Climate change poses one of the most important and devastating existential threats to humanity, with rapid increases in urban problems expected in the coming decade
- Urban and rural green space can directly mitigate the effects of climate change, while also providing some relief from heat and extreme weather and fostering biodiversity
- Urban and rural green space can mitigate climate change effects in a sustainable, long-term way – while also providing beautiful natural assets
- Taking natural capital and nature-based solutions to health, social and environmental problems into consideration can transform an accounting of the UK economy and how value is derived
- The effects of natural disasters (such as flooding) can be mitigated by managed green space
- Urban trees, green roofs, living walls and green space can be cost effective ways to sequester carbon and deliver eco-system benefits
- Biodiversity underpins the entire ecosystem of the UK – protecting it is a national priority. Through properly managed green space, biodiversity gain can be supported and accelerated.

Section 2: Joint Impact of the Drivers – Potential Positive and Negative Outcomes

Part 1: Potential Positive Outcomes

Climate change is a burgeoning existential crisis. Impacts are becoming more apparent in UK towns and cities in the form of flash flood events, increasingly hot conditions, and the strain placed on the publics everyday lives and eco-systems. Urban habitation, especially in the larger cities around the UK, will rapidly become less comfortable for the population. Those without access to shade, green spaces, or expensive and energy consuming technologies such as air conditioning, will increasingly bear the brunt of the effects of climate change and global warming.

The UK broke 8 separate "highest temperature" records in the last decade

Urban centres are the areas that will have the largest increase in temperature over the next decade. The UK broke 8 separate "highest temperature" records in the last decade[4]. "Urban heat islands" are a significant cause of this increase in heat: night-time urban air temperatures have been recorded that were 10° higher in London than in adjacent rural areas.[5] Concurrently, 83% of the UK currently lives in urban spaces – set to rise to 86% by 2030.[6] The necessity of summer heat alleviation and winter heat insulation in urban centres is clear.

Green roof temperatures can be 15 - 20° cooler than conventional roofs and can reduce city-wide ambient temperatures by up to 2.7°.

4 The Met Office, Jan 2020
5 Forestry Commission: Madalena Vaz Monteiro, Phillip Handley, James I. L. Morison and Kieron J. Doick, January 2019
6 United Nations, Department of Economic and Social Affairs, Population Division (2018). World Urbanization Prospects: The 2018 Revision, Online Edition

Urban vegetation, and the development of carefully planned and managed urban green space, are one of the most cost-effective ways to make these environments liveable. In London, green spaces already account for cooling effects: a single large park in the city can account for a temperature decrease of 4°.[7] The use of this green space as a source of heat reduction is already providing cost savings: cooling from urban trees and vegetation was predicted as saving up to £22 million in annual energy consumption across inner London alone.[8] The ONS reports that "the cooling shade of trees and water saved the UK £248 million by maintaining productivity and lowering air conditioning costs on hot days in 2017", an ongoing benefit that will become more pronounced as climate change raises maximum temperatures significantly.[9] As cities grow hotter, green space will not only have a cooling effect, but will also provide a space for urban dwellers to cool off, especially if there are ponds or lakes also present. This green space is a necessity for many residents.

Green roofs and living walls are another area of increasing potential: green roof temperatures can be 15 – 20° cooler than conventional roofs and can reduce city-wide ambient temperatures by up to 2.7°.[10] These types of heat and CO2 reduction can be developed concurrently, with multiple strategies working towards a single goal. Flooding is another area of concern with climate change, and urban trees can act as Sustainable Urban Drainage Systems (SUDS) that mitigate runoff which can cause extensive problems. A study in Manchester found that urban tree units reduced runoff even more than grass – on average 170% of its area in summer and 145% of its area in winter.[11] With tropical storms and heavy rainfall projected to increase dramatically over the next decade, the use of trees to prevent catastrophic damage would be a cost effective, powerful insurance policy.

While mitigating the effects of climate change will be important in the future, mitigating the amount of CO2 the UK emits will also be critical, as will taking CO2 out of the atmosphere. A new study has shown that melting permafrost will now increasingly release enormous amounts of greenhouse gases into the atmosphere, regardless of cutting emissions to zero.[12] This makes the extraction of carbon dioxide out of the atmosphere a new priority.

The value of London's trees was estimated at £130m a year in terms of pollution sequestration.

Carbon capture and sequestration can be implemented in many ways, and Canada has historically been the world leader in developing factories and plants to capture it. However, this has proved to be extremely expensive and inefficient: Canada hopes to capture 2.7 megatonnes of CO2 per year but emitted over 700 megatonnes in 2017 alone. The use of trees, green space and their soils to capture carbon has the potential to be much more cost effective. It can be difficult to measure just how much London's plane trees are able to capture carbon, but research has suggested that in Camden alone they represent 380 tonnes of carbon per hectare. The value of London's trees was estimated at £130m a year in terms of pollution sequestration.[13] With additional urban green space development and continued protection existing spaces, the UK will be able to sequester increasing levels of carbon while cutting back on energy use.

While integral in the context of carbon sequestration and capture and the fight against climate change, trees and urban vegetation is crucial for air pollution and the reduction of particulate matter in UK cities. Air pollution is a significant problem in UK cities, although much has been done already to protect citizens from the dangerous levels seen in other urban spaces. New studies are showing that as much as 15% of global COVID-19 deaths in 2020 have been influenced by air pollution[14] – highlighting the necessity of applying clean air measures to protect against a multitude of conditions. The ONS has also more generally described the benefits of using vegetation to protect against air pollution: they report that "around 27,500 lives were saved through vegetation removing air pollution in 2017."[15] The value of removing air pollution by vegetation alone to the UK was calculated at £1.3bn in savings to the NHS in 2017, a figure that is steadily falling as UK air becomes cleaner over time. The additional reduction in pressure on the NHS, especially at times of struggle and crisis, such as with health complications due to climate change (such as with heat problems, or natural disasters) are inestimable. Consequently, the value of a pre-emptive system for improving health cannot be overstated.

7 Forestry Commission: Madalena Vaz Monteiro, Phillip Handley, James I. L. Morison and Kieron J. Doick, January 2019
8 Ibid
9 ONS: UK Natural Capital Accounts, 2019
10 EPA: Using Green Roofs to Reduce Heat Islands
11 Urban Forestry and Urban Greening: D. Armson, P. Stringer, and A.R. Ennos, 2011
12 Randers, J., Goluke, U. An earth system model shows self-sustained melting of permafrost even if all man-made GHG emissions stop in 2020. Sci Rep 10, 18456 (2020)
13 Wilkes, P., Disney, M., Vicari, M.B. et al. Estimating urban above ground biomass with multi-scale LiDAR. Carbon Balance Manage 13, 10 (2018). https://doi.org/10.1186/s13021-018-0098-0
14 Andrea Pozzer, Francesca Dominici, Andy Haines, Christian Witt, Thomas Münzel, Jos Lelieveld, Regional and global contributions of air pollution to risk of death from COVID-19, Cardiovascular Research, Volume 116, Issue 14, 1 December 2020, Pages 2247–2253, https://doi.org/10.1093/cvr/cvaa288
15 ONS: UK Natural Capital Accounts, 2019

The role of green space in mediating stress and encouraging greater social cohesion is a significant benefit of green space that contributes directly to social capital, well-being, social, physical, and mental health in the UK. A recent UK study has shown that access to and the use of green space is vitally important in reducing stress and establishing community in an area.[16] Research findings of this nature have also been replicated in Sheffield, where 61% of the city is green space and claims to be the greenest city in Europe. Research has shown that "83% more individuals engaged in social activity in green spaces as opposed to sparsely vegetated or concreted ones"[17] – and that crime in areas with extensive green space is reduced. A "mid-estimate" of the reduction in crime due to well managed green space is about 2%, with potential cost savings of £361 million per year.[18] The reduction in crime and increased community cohesion can work as a feedback loop, making these spaces more attractive, and thus encouraging more community and less crime. The direct economic value of public parks and green spaces to communities and residents has been estimated at 25:1 for London and Birmingham: every £1 spent returns 25 times that value for residents. For Sheffield this number is even higher, at 34:1.[19] [20]

83% more individuals engaged in social activity in green spaces as opposed to sparsely vegetated or concreted ones

Biodiversity is a key component of the UK fight for sustainability, and biodiversity collapse could lead to significant impacts on the welfare of UK populations, climate change strategies and ornamental horticulture and landscaping. The UK government's commitment to halt the decline of biodiversity by 2020 was admirable. If these aspirations are built on and taken in tandem with the development of managed green spaces could put into place protective strategies for biodiversity (including cultivated biodiversity in line with Aichi Target 13 of the Convention on Biological Diversity) that deliver on multiple fronts for the UK. In the government Biodiversity Strategy[21] an aim has been to have 17% of land and inland water spaces conserved by 2020, and this can be developed with the help of UK green space development to ensure that it is also contributing the maximum amount of environmental benefit. A pertinent effect of managed biodiversity preservation will be to bring Britons out of their homes to enjoy the unique British wildlife and use these spaces, further encouraging their protection.

Well managed green space across the country is the potential to grow garden tourism.

A result of the preservation (and hopeful eventual increase) of well managed green space across the country is the potential to grow garden tourism. Domestic visits to all attractions have decreased over the last five years – except parks and gardens, which have seen an increase in numbers. Garden tourism generated £2.9 billion in 2017, and an additional £1.8 billion for related industries, employing 33,000 people.[22] With added investment and support from government, the UK could not only improve its current facility, but be a world leader in garden tourism, with visitors developing tourism across the country.

Through the support, development of and investment in outdoor green space, the UK can dramatically reduce the pressures of climate change and public health burdens while improving the economy and well-being for all its citizens. Cost savings to the NHS and other branches of government will be significant, while alleviating pressure on individuals – who in other countries, such as in parts of the US, have constant threats of climate change enhanced flooding and forest fires to contend with. With adequate foresight and preparation, the UK can be kept safe from these and other threats, while generating more sustainable wealth.

Part 2: Potential Negative Outcomes

In a future without government support and an increasingly disinterested public, green spaces risk being repurposed to accommodate for housing with little focus on garden space. Due to climate change, cities and urban spaces will grow increasingly warmer and, without urban green space and urban forestry benefits, citizens in these environments will have limited relief.

16 "It made me feel brighter in myself" The health and well-being impacts of a residential front garden horticultural intervention: Lauriane Suyin Chalmin-Puia,c,1, Jenny Roeb, Alistair Griffiths, Nina Smythd, Timothy Heatone, Andy Claydena, Ross Cameron (2021)
17 Sullivan et al. (2004)
18 Ibid
19 Natural Capital Accounts for Public Green Space in London: Vivid Economics 2017
20 Hölzinger, O. and Grayson, N. 2019: Birmingham Health Economic Assessment & Natural Capital Accounts: Revealing the True Value of Council-managed Parks and Greenspaces. Birmingham City Council, Birmingham
21 Biodiversity 2020: A strategy for England's wildlife and ecosystem services, DEFRA, 2011
22 Oxford Economics, 2018

People who live within 500 metres of accessible green space are 24% more likely to meet 30 minutes of exercise levels of physical activity.

Indeed, a lack of support for the use and management of green spaces will see increased rates of obesity, diabetes, and other health problems, which will have far reaching complications in the future. Studies show that 10% more greenspace in the living environment leads to a decrease in the number of symptoms that is comparable with a decrease in age by 5 years – replicated across a number of different urban environments.[23] The lack of availability of public green space could also exacerbate existing problems with inactivity: 1 in 4 British women and 1 in 5 men do not get 30 minutes of physical activity a day, contributing to 34,000 premature deaths in the UK each year.[24] Without space to exercise, or simply to walk, this number could grow considerably. For example, people who live within 500 metres of accessible green space are 24% more likely to meet 30 minutes of exercise levels of physical activity.[25]

The lack of urban trees, SUDS and other protection afforded by vegetation and green spaces could result in extensive flood damage, leading to many citizens' homes and livelihoods coming under threat. Indeed, 1 in 6 UK properties are at risk from flooding. Flooding events are becoming both increasingly likely and increasingly serious across the UK.[26] By 2080, within a 3.9° climate warming scenario, 10% of those living near a river, and 45% of those living on the coast will be affected by floods.[27]

The effects and pervasiveness of PM2.5 (the most dangerous form of air pollution to human health) will increase with a lack of urban trees and vegetation to filter the air. Woodland and vegetation is responsible for the removal of the majority of PM10, PM2.5 and SO2 – without it, this type of pollution will result in increased strain on the NHS and associated services. Birmingham City Council estimated that their green spaces were worth £19.4 million in terms of offsetting health problems related to air pollution.[28]

Birmingham City Council estimated that their green spaces were worth £19.4 million in terms of offsetting health problems related to air pollution.

In our lower case scenario, we envisage a vicious cycle. A lack of funding, maintenance and use of green space will cause local councils to reprioritise the space. This will lead to exacerbated health issues, increased damage due to climate change, and radically more discomfort for urban individuals spending time outdoors. This will lead to individuals turning to air conditioning to alleviate heat, the development of mental health issues and stress, and using the NHS service for their alleviation (40% of GP visits in 2018 were for mental health issues[29]). This in turn will deprioritise remaining green space, exacerbating these issues further.

23 de Vries S, Verheij RA, Groenewegen PP, Spreeuwenberg P. Natural Environments—Healthy Environments? An Exploratory Analysis of the Relationship between Greenspace and Health. Environment and Planning A: Economy and Space. 2003;35(10):1717-1731. doi:10.1068/a35111
Parliament Office of Science and Technology, POSTnote 538 October 2016
24 Parliament Office of Science and Technology, POSTnote 538 October 2016
25 Natural England, Green space access, green space use, physical activity and overweight, 2011
26 Environment Agency: Flooding in England: A National Assesment of Flood Risk, 2009
27 Physical and economic consequences of climate change in Europe: Juan-Carlos Ciscar, Ana Iglesias, Luc Feyen, László Szabó, Denise Van Regemorter, Bas Amelung, Robert Nicholls, Paul Watkiss, Ole B. Christensen, Rutger Dankers, Luis Garrote, Clare M. Goodess, Alistair Hunt, Alvaro Moreno, Julie Richards, Antonio Soria – Proceedings of the National Academy of Sciences Feb 2011, 108 (7) 2678-2683; DOI: 10.1073/pnas.1011612108
28 Hölzinger, O. and Grayson, N. 2019: Birmingham Health Economic Assessment & Natural Capital Accounts: Revealing the True Value of Council-managed Parks and Greenspaces. Birmingham City Council, Birmingham
29 GP Mental Health Training Survey Summary, Mind, 2018

Section 3: The Upper and Lower Case Scenarios for the UK in 2030

In this section we describe two scenarios that demonstrate positive and negative possible outcomes facing the UK in 2030. In the upper case scenario our green spaces are protected and expanded, driving increased economic and environmental contributions to the UK. In the lower case scenario our green spaces continue to contract, impairing environmental and economic contributions of the horticulture and landscaping industry to the UK.

Upper Case Scenario: Our Green and Pleasant Land

In 2030 the ornamental horticulture and landscaping industry's contribution will have far reaching effects on mitigating and adapting to climate change. The provision of increased and better access to well-designed and maintained green spaces will alleviate many of the pressures faced by UK society, including the stresses of modern living and burgeoning health issues. Biodiversity thrives, and an increasing range of high-performing nature-based solutions to the UK's environmental and social challenges emerge.

The expansion of access to well-planned non-domestic functional green space envisaged in our scenario delivers extra economic growth, with the in the ornamental horticulture and landscaping industry worth £17.8 billion in direct GDP contributions and directly employing 449,00 in 2030. The incremental value added to the UK's natural capital from expansion in domestic and amenity green spaces, based on modelling from the OHRG, is £8.4b compared with 2019.

Urban development occurs without harmful impacts on the environment and public health, and the UK's towns and cities are recognised globally as among the most liveable and sustainable in the world. At the same time, this provides cost savings to government, and allows for a sustainable future where negative environmental and health impacts on those living in urban spaces are continually reduced.

In this scenario of 2030:

- Providing more and better access to public green space drives major benefits for both the environment and public health
- This provides extensive cost savings to government as well as delivery against key areas of the 25 year environment plan while boosting GDP contributions to the UK economy from ornamental horticulture and landscaping
- This rebalancing provides a sustainable model for the future, providing long term benefits without needing constant change or iteration

Lower Case Scenario: Grey Britain and Northern Ireland

The continued loss of green space in and around UK towns and cities, coupled with rising temperatures and pollution, creates a vicious cycle in this vision of 2030. The outdoors becomes a place of increasing grey urban sprawl, driving greater discomfort and stress for the UK's citizens. As a result of these problems, the UK population grows increasingly detached from nature and spend more time indoors; compounding both mental, social, and physical health problems. Falling access to green space, as well as a lack of funds for their proper maintenance, prompts local governments to repurpose these areas. This further increases average urban temperatures and exacerbates some of the worst problems of urban environments.

The lack of provision of this green space limits the economic contribution of the UK ornamental horticulture and landscaping industry. In this scenario expected direct GDP contributions of £16.5bn are provided by the industry, compared to £17.8bn in the upper scenario. This decline in economic contribution is driven by falling demand for UK-grown plants to supply these declining spaces and the services for their design and maintenance. What's more, the falling scope for communities and industry to lead on local environmental, social and health initiatives in this scenario places more of the burden on addressing these issues on local and national governments.

In this scenario of 2030:

- With less access to green space and nature based solutions, health and environmental problems will feed on each other to create a vicious cycle of discomfort and stress
- Lack of funds, use and understanding causes green space to be deprioritised by local councils and planners, thus worsening existing problems
- An expensive and stressful overburdening of the NHS takes place, leading to a weakening of the system overall, and creating fragility in both public health and government

Section 4: Economic Model

For this report Oxford Economics has created a central projection of the value of the ornamental horticulture and landscaping industry in 2030. This is based on the industry and its specific sectors (landscaping, arboriculture, garden retail, garden manufacturing, ornamental plant production and garden tourism) reflecting projected growth in similar sectors of the UK economy.

Variation on this projection of industry value is then calculated based on the effects of expanded or contracted non-domestic functional green space. In the lower case scenario, this green space (currently 118,000 hectares) contracts by 7.1%, which reflects the historical rate of decline in this green space between 2001 and 2018 reported by Public Health England.[30] In the upper case scenario, a modest expansion of 2% is assumed to occur reflecting local, regional and national government ambitions around tree planting and urban greening.

For the modelling, economic activity increases or decreases in proportion to this change in green space in different sectors of the industry. The amenity proportions of landscaping and arboriculture (estimated at 80% and 75% of these sectors respectively) is adjusted, as is the amenity supply sector of ornamental production (24%) which is economically active in supplying plants for these green spaces. Garden tourism is assumed to grow/decline in line with changes in space. Garden retail is unaffected by this driver. Second order effects on manufacture for horticulture (for instance of tools, equipment, fertilisers and so forth) are also modelled to take account of the impact of expanding or contracting green space.

The following table shows the total effect on the contribution the ornamental horticulture and landscaping industry to the UK in 2030 attributable to the expansion or contraction of this non-domestic public, private and commercial amenity green spaces functional green space (equivalent modelling for domestic gardens is provided in chapter 3).

30 Improving access to greenspace; A new review for 2020, Public Health England, pg 15

The difference in green space between the upper and lower scenarios multiplied by the £143,000 per hectare value provides a differential of £9.6 billion in annualised asset value provided by the upper and lower case scenarios for 2030 – in other words delivering the additional domestic and non-domestic green spaces described would add £9.6 billion to the UK's natural capital asset value.

Table 9: the difference in economic value delivered by the industry depending on upper and lower case scenarios for the provision and protection of amenity and public green spaces by 2030

	2019	2030 (lower case scenario)	2030 (upper case scenario)
Direct GDP contributions (£m)	£13,801	£16,467	£17,787
Indirect GDP contributions (£m)	£7,289	£8,353	£9,428
Induced GDP contributions	£7,725	£9,099	£9,883
Total GDP contributions (£m)	**£28,815**	**£33,919**	**£37,098**
Direct employment	420,038	418,138	449,202
Indirect employment	141,074	136,609	156,191
Induced employment	113,137	111,951	121,577
Total employment	**674,248**	**666,699**	**726,970**
Direct tax revenue (£m)	£2,473	£2,895	£3,129
Indirect tax revenue (£m)	£1,694	£1,945	£2,193
Induced tax revenue (£m)	£2,118	£2,495	£2,710
Total tax revenue (£m)	**£6,285**	**£7,335**	**£8,032**

Work to assess the natural capital contributions of the UK's green spaces lay beyond the scope of the economic models used in this report and required different modelling to be performed. To estimate the natural capital gain or loss accruing from urban greening (which includes domestic gardens), the OHRG used the following approach and supplied modelling independently for this report. Firstly, projections for domestic garden area and allotments were made to 2030. In the lower case scenario, an estimate of 655,000 hectares or domestic gardens and allotments as of 2019 is used as a baseline, drawing on source data from the ONS and industry surveys of domestic garden space. Using historical house building data and government house building aspirations, we project a net addition to the UK's housing stock of 2.4 million by 2030. In the upper case scenario, we assume that 85% of these new homes will have gardens, with an average area per garden of 226 square metres. This is the same as the current housing stock. In the lower case scenario we assume that in this new housing half the proportion of new houses have their own garden (42.5%) and that the gardens provided are half the size of the average for the current housing stock (108 square metres). Within the existing housing stock, in the upper case scenario we assume a 1.75% increase in garden area (including the potential for green roofs and walls) and vegetation over 10 years, and in the lower case scenario a 1.75% decrease. For context, within the existing housing stock, the upper case scenario equates to a gain in garden/vegetated space equivalent to a two-by-two metre square area per household.

These areas are added to the previously noted assumptions around non-domestic green space expansion or contraction to get to a total upper and lower case projection in 2030 for functional green space area. In the upper case we have 832,000 hectares, and in the lower case scenario we have 764,000 hectares, a difference of approximately 67,000 hectares between the two scenarios for 2030.

To estimate a natural capital value per hectare, data was taken from three sources. Vivid Economics' assessment of the natural capital value of London's public Green spaces[31] provides an annualised estimated value per hectare of £159,700 per hectare. For a similar study in Birmingham[32] a figure of £126,000 can be calculated, giving a mid-point estimate of £143,000 per hectare. A key assumption here in the absence of other data is that domestic gardens provide similar levels of natural capital benefit as non-domestic functional green spaces. This assumption is based on evidence of similar performance in terms of soil carbon sequestration and mitigation of urban heat island effects, although there is a need for further research into this area. As such the results of this modelling should be treated as indicative of the scale of benefit provided rather than conclusive. The difference in green space between the upper and lower scenarios multiplied by the £143,000 per hectare value provides a differential of £9.6 billion in annualised asset value provided by the upper and lower case scenarios for 2030 – in other words delivering the additional domestic and non-domestic green spaces described would add £9.6 billion to the UK's natural capital asset value.

Table 10: the difference in estimated annualised natural capital value provided by the lower and upper case scenarios for available green space compared with 2019

	2030 lower case	2030 upper case
Change in annualised health, environmental, property, and social asset value (2030 compared with 2019)	-£1.2 billion	+£8.4 billion

31 Natural capital accounts for public green space in London, VividEconomics. Table 9 pg 22
32 CEEP, Birmingham Health Economic Assessment & Natural Capital Accounts Revealing the True Value of Council-managed Parks and Green Estate, July 2019

Chapter 2:

Labour supply and Sustainable business productivity: their roles in enabling growth from ornamental horticulture and landscaping

Chapter summary

The ability of the ornamental horticulture and landscaping industry to secure access to enough labour with the appropriate skills to meet demand is essential to achieving growth. The ability to achieve sustainable productivity and capacity growth is also a key driver of the level of growth achievable by 2030. Advances in automation technologies as well as efficient and effective use of resources such as machinery, glasshouses, growing media, water, horticultural materials, transport and energy are also key to this.

Our analysis shows that, based on 2019 data, the industry is facing a potential shortage in labour supply that could limit the industry's capacity to grow. If these shortfalls remain at levels identified in the OHRG's research into labour and skills in 2019, then the cost to the UK's economy is projected to be £1.4 billion per year in lost direct GDP contributions by 2030.

If these shortfalls remain at levels identified in the OHRG's research into labour and skills in 2019, then the cost to the UK's economy is projected to be £1.4 billion per year in lost direct GDP contributions by 2030.

Table 11: the difference in economic contributions between upper and lower case scenarios for the industry based on projected access to labour in 2030[33]

	Difference between 2030 upper and lower scenarios
Direct GDP contributions (£m)	-£1,374
Indirect GDP contributions (£m)	-£519
Induced GDP contributions (£m)	-£728
Total GDP contributions (£m)	**-£2,621**
Direct employment	-31,822
Indirect employment	-7,694
Induced employment	-8,611
Total employment	**-48,126**
Direct tax revenue (£m)	-£210
Indirect tax revenue (£m)	-£122
Induced tax revenue (£m)	-£199
Total tax revenue (£m)	**-£531**

In terms of productivity, there are substantial economic gains to be made by the sector through development of skills, implementation of modernised technologies and facilities, improvements in business processes and administrative overheads, and more sustainable use of resources such as water, materials, and energy. Much of this relies on the application of research and development to enable productivity growth.

Table 12: the difference in economic contributions between upper and lower case scenarios for the industry based on projected sustainable productivity and capacity growth in 2030[34]

	Difference between 2030 upper and lower scenarios
Direct GDP contributions (£m)	£2,460
Indirect GDP contributions (£m)	£948
Induced GDP contributions (£m)	£1,285
Total GDP contributions (£m)	**£4,693**
Direct employment	1,903
Indirect employment	13,753
Induced employment	14,997
Total employment	**30,654**
Direct tax revenue (£m)	£71
Indirect tax revenue (£m)	£224
Induced tax revenue (£m)	£352
Total tax revenue (£m)	**£647**

Automation and robotics, in combination with a workforce of sufficient scale and with the skills to exploit it, has the potential to enhance efficiency and productivity across the ornamental horticulture and landscaping industry in the 2020s. Such technologies – designed to save time and labour – will be vital for the future growth of the sector. To date

33 Labour shortage figures are based on the findings of independent research in 2019 into labour shortages in different sectors of the industry by Pye Tait for the OHRG. Shortfall rates per sector used for the modelling are: ornamental plant production 20%, landscaping 10%, arboriculture 10%, retail 2%, tourism 2%. Second order effects are assessed for manufacturing and wholesale.

34 The lower case scenario is based on sectors of the industry shadowing forecast economic growth for similar sectors of the UK economy. The upper case scenario is a CAGR of 1.6% in productivity in excess of that forecast for similar areas of the UK economy for all sectors of the industry except for tourism, retail and wholesale whose productivity and capacity is minimally if at all affected by the drivers described in this chapter.

Research commissioned by the OHRG showed in 2019 that, across the UK horticulture and landscaping sector, 10% of supervisor roles remain open.

the UK has made significant advances and investment in these technological areas – such as the AHDB's SmartHort programme and the announcement of the global centre of excellence in agri-robotics research at the University of Lincoln. Raising the profile and resourcing of these domestic institutions can turn the UK into a centre for life sciences more generally, and horticulture and landscaping specifically.

Concurrently, new research is focussing on zero emission greenhouses and the transformation of waste products into useable, useful outputs. Incentive driven sustainability also drives new technology, especially for production glass-houses and the decarbonisation of their distribution and transport networks. Systems such as the Dutch Green Label accreditation system is a key example in this space. Through this type of planning system, UK glass-houses can also be increasingly modernised and expanded in the 2020s. The scope for applying these types of technologies spans the whole supply chain. For instance, drone technologies and geographical information systems are already beginning to transform landscaping and green space management and maintenance, and also have potential for driving productivity in tree inspections in arboriculture. The development and use of geographical information systems is, even now, driving greater efficiency and efficacy in tree inventory record keeping and management.

However, none of this will be possible without the development of new skills and an integrated immigration policy as well as improved recruitment into the industry from within the UK and abroad. All such technologies outlined above – both in terms ways of working and implementations of new techniques – require a highly-skilled workforce. Furthermore, the skills requirements of growers are changing in general, with a much greater need for supervisory and management skills, environmental awareness, as well as functional, digital and horticultural skills. Research commissioned by the OHRG showed in 2019 that, across the UK horticulture and landscaping sector, 10% of supervisor roles remain open; 14% of skilled trade roles remain open; 11% of professional/technical roles remain open. Consequently, the sector faces the dual challenge of meeting the resourcing requirements of today, while also ensuring access to the emerging skill demands of the coming decade.

Moreover, reduced access to seasonal labour is another challenge facing the industry in the 2020s. Seasonal labour is required by the industry in order to meet seasonal peaks in demand for labour around cropping cycles for different types of plants. Indeed, in the Netherlands, which leads on automation and productivity, 30% of the labour input to ornamental horticultural crops is still from seasonal labour. Brexit, combined with complicated immigration policies, could limit the availability of high skilled seasonal and permanent labour, limiting growth potential.

Against this backdrop, it is clear that the development and use of new technology will be key to achieving improved productivity and delivering growth. However, if the industry is not able to solve the emerging skills gaps it faces, it will struggle to achieve its full growth potential. The industry will need to attract, develop and retain the sector specific knowledge and skills to deliver its outputs productively and competitively. Additionally, and even more immediate, without adequate access to seasonal labour, the industry will be competitively hamstrung – compared to the inexorable progress of industries such as those in the Netherlands.

In the Netherlands, which leads on automation and productivity, 30% of the labour input to ornamental horticultural crops is still from seasonal labour.

In this chapter we examine upper- and lower-case scenarios based on two drivers of future growth in the ornamental horticulture and landscaping industry: access to labour, and productivity and capacity growth. Below we describe each of the drivers. In Section 2, we examine the combined impact of these two drivers on the UK in 2030. In Section 3 we describe the upper and lower case scenarios, developed from the evidence presented in Section 2. Finally, in Section 4, we provide details of the economic modelling undertaken to describe the potential impact of such scenarios on the potential contribution of the UK ornamental horticulture and landscaping industry to the UK economy.

Section 1: The Key Drivers

Below we outline a summary of two key drivers that will shape the future contribution of the UK ornamental horticulture and landscaping industry to the UK economy, as well as the primary features of each driver that will propel such growth potential.

Driver 1 – Access to labour and skills:

- A skills gap has the potential to significantly impact productivity and restrict growth across the ornamental horticulture and landscaping industry
- The supply of labour following the UK's exit from the EU will be affected by policy governing access to workers from overseas, whether seasonal labour related to crop production, or access to technical specialists in areas as diverse as crop production and green space design
- A digital and technological skills gap has the potential to slow the adoption of key technologies in the industry, including automation
- A gap in specific knowledge and skills for different roles exists, and a large proportion of this labour has historically been supplied by the EU. The skills needed in the industry to remain competitive and productive will rely on the development and promotion of different careers outreach and skills development programmes in the industry, as well as succession planning in developing the next generation of horticultural and landscaping workers and scientists.

Driver 2 – Sustainable Business Productivity

- New technology, especially in the fields of automation, water efficiency, robotics and efficiency, enable productivity growth, responsibly sourced growing media, sustainability and efficiency gains
- New facilities, particularly for glasshouses, enable more sustainable business efficiency
- Labour and time saving technology frees up skills productivity across the ornamental horticulture and landscaping industry
- Technology aligned with sustainability goals is emerging, enabling productivity gains as well as mitigating different problems such as water pollution, greenhouse gas emissions, green space management and irrigation, and energy inefficiency.

Section 2: Joint Impact of the Drivers – Potential Positive and Negative Outcomes

Part 1: Potential Positive Outcomes

The development and usage of labour-saving technology has already been instrumental in enabling better productivity and results across the horticulture and landscaping industry. Robotics, AI, machine vision and circular systems can be combined with training and skill opportunities to ensure that the industry is not only improving productivity, but keeping ahead of competition in other markets. Labour saving technology is key to this process, allowing the workforce to save time, costs, and improve the quality of outputs and service.

The machines can stick 3,500 cuttings per hour which is at least 20% faster than the fastest people in the company

Automation and robotics are key areas in which productivity gains are being seen by nurseries across the world. In Dutch horticultural centres and nurseries, the use of Internet of Things technology enables both remote operation – in which an individual can control a process from another location – as well as assisting with productivity. A specific system in development for Perry van der Haak allows 4,000 individual production benches to be controlled remotely by computer or mobile phone, minimising the time spent by staff moving plants from one place to another.[35] Another system in The Netherlands by Deliflor is a propagator. When the roots arrive on the premises, they are placed onto a conveyor belt and sorted, before being fed into different "sticking machines". According to Bruce Harnett, Managing Director of Kernock Plants, who analysed the use of this machinery: "The machines can stick 3,500 cuttings per hour which is at least 20% faster than the fastest people in the company, and 40% faster than the average worker. This speed can of course be sustained over a longer period of time by robots, with shifts normally operating from 5am to 9pm."[36]

The key feature of robotics and automation in this context is not necessarily the speed, but the consistency. Humans tire, and manual labour consisting of a series of repetitive tasks can produce mistakes; machines, as long as they have the right inputs, can work indefinitely. For the cost of $28,000 per robot (2015 pricing), nurseries can buy "Harvies", a "pot plant moving robot" by Harvest Automation. These can move pot plants from one location to another, guided by magnetic strips. Bruce Harnett in his evaluation reports that they are less flexible than human workers – they do not perform well on uneven ground, for example. However, their utility lies in the fact that they do not tire, and that they don't need any significant change in infrastructure or workflow to make an impact. According to Terri McEnany, President of Bailey Nursery, who Harnett interviews: "[the robots] just keep going at a constant speed, avoiding physical exertion for their staff and releasing labour to areas of the business."[37] Harvest Automation assists with maintenance and induction, keeping complications to a minimum.

Smart irrigation can reduce the water needed in an area by 30%.

35 Automation and Robotics in 6 Dutch Horticultural Nurseries, AHDB, 2019
36 Intensive Horticulture – Man versus Machine, Bruce Harnett, December 2015
37 Ibid

Robotic assistance is not a silver bullet that will instantly revolutionise the sector; it is one of many developments.

Beyond plant production, drone mapping, rainwater capture and smart irrigation of green spaces use emergent technologies to save time, labour and preserve resources. While Google Earth has proved an invaluable tool for landscape architects, drone photography can provide much better image quality and detail while also enabling a view of how a site looks now.[38] Smart irrigation and smart rainwater capture has also been used to great effect. In Australia, where water scarcity is a significant and constant problem, urban green space managers have been able to leverage key data channels including soil moisture, satellite imagery and weather forecasts in order to tailor irrigation to the exact requirements of the geography and biodiversity of an area. Smart irrigation can reduce the water needed in an area by 30%, while also using recycled water for maximum effect.[39]

There are a variety of benefits to automation, when applied carefully and thoughtfully. Automation can help many operations operate with lower staff numbers while also developing and retaining staff for other areas of the business. Harnett, in another interview with a plant production facility, claims that "Marcel, the owner director, told me that the system's constant production enables them to retain their best staff all year round."[40]

These types of technology are designed to save time, labour, to speed production and preserve the most skilled staff for the most human tasks. Another set of technology is able to drive efficiency through optimising yield, productivity and sustainability via the use of circular systems, machine vision and analytics. The UK has made considerable advances and investment in research and development in this area, for instance through the AHDB's SmartHort programme and the announcement of the global centre of excellence in agri-robotics research at the University of Lincoln. Research and knowledge transfer from these initiatives has the potential to fuel innovation and productivity growth in ornamental horticulture. The potential for productivity gain through technology is by no means limited to production horticulture. The use of aerial drone mapping in site surveys for landscape and green space design projects increases accuracy, decreases lead times, and saves labour costs when compared with more manual approaches to site surveys.

Despite the benefits of automation, many experts in the industry report that in the short term, automation potential is limited, the examples above notwithstanding.[41] Aside from the financing required to make investments of this nature, much of the work requires human-favoured tasks, such as "human intuition, hand-eye coordination, and skill", that robots do not yet possess in the same ways. This once again focuses the importance of human labour, and that robotic assistance is not a silver bullet that will instantly revolutionise the sector; it is one of many developments.

While many businesses across the horticulture and landscaping industry will aim to implement circular horticulture and other types of optimised efficiency methods for sustainability reasons, there is a significant and powerful additional reason to do so: these methods can lower costs and improve output yields and service quality.

38 https://land8.com/drone-applications-for-landscape-architecture/
39 https://www.swansystems.com.au/urban-green-space-water-conservation/
40 Ibid
41 2019 Horticulture Sector Skills Survey, Report for the OHRG, Pye Tait, 2019

The immediate ability to source seasonal workers, as well as workers with the skills needed to ensure the different sectors of the horticulture and landscaping industry remain productive and competitive, is critical to delivering a platform for future growth.

There are a variety of ways that businesses across the industry can implement change, including reducing energy use, recycling water and reducing or capturing emissions. Recycling irrigation water for ornamental horticulture growers has been shown to increase costs for growers – but "in almost all cases for which at least a portion of a retail consumer premium was returned to growers, the premium was adequate to compensate for recycling investment costs."[42] Less reliance on mains water also makes the continuity of the supply of water to growers or retailers less of a business continuity issue. Regulation in the EU, for example, will focus on how much pollution discharge water will put in the water table: this is tending towards a "zero-emission greenhouse in 2027, meaning that discharge water can then no longer contain any nitrogen (or phosphate)."[43] Researchers around the world are working on zero emissions greenhouses and the transformation of waste products into useable, useful outputs (for example, biofuel).[44] Dutch sustainability regulation is mandating zero emissions for new products in 2030, and new greenhouses avoid gas for heating altogether, using renewable electric power for LEDs and heat pumps to humidify the space. Key to this is also the recycling and usage of all water, ensuring that none of it needs to be purified or discharged into the sewers, and that a closed system is maintained.[45]

Production glasshouses and the decarbonisation of their distribution and transport networks are a significant area in which sustainability can be enabled through incentives. The Green Label accreditation system in the Netherlands accrues tax breaks for investment into glass-house sustainability, or to extend or replace less sustainable facilities.[46] Through this type of approach, UK glass-houses have the potential to be modernised and expanded, making them more sustainable and efficient. This expansion is likely to be required to meet increasing consumer and amenity customer demand driven by expanded green space and increased consumer interest and participation in gardening, both of which are key drivers of growth for the sector.

42 Cao, X., Bosch, D., & Pease, J. (2017). Recycling Irrigation Water on Ornamental Nursery Operations: Could Consumer Premiums Compensate for Grower Adoption Costs?, HortScience horts, 52(12), 1780-1789. Retrieved Dec 8, 2020, from https://journals.ashs.org/hortsci/view/journals/hortsci/52/12/article-p1780.xml

43 Joaquim Miguel Costa, Els Berkmoes, Ellen Beerling, Silvana Nicol, Juan Jose, Javier Garcia, Rafaela Cáceres. EIP-AGRI Focus Group –Circular horticulture, Mini-paper –Water use in greenhouse horticulture: efficiency and circularity, 2019.

44 Ketil Stoknes mfl: Efficiency of a novel "Food to waste to food" system including anaerobic digestion of food waste and cultivation of vegetables on digestate in a bubble-insulated greenhouse. Waste Management, 2016. https://doi.org/10.1016/j.wasman.2016.06.027

45 KAS2030: Duurzaam telen met toekomst: https://www.wur.nl/nl/Onderzoek-Resultaten/Onderzoeksinstituten/plant-research/glastuinbouw/show-glas/KAS2030.htm

46 Green Label KAS Overview: https://www.groenlabelkas.nl/29/home.html

Energy use and the adoption of renewable sources as well as water use are areas in which there is potential for savings, while improving efficiency and cutting down on GHG emissions. A single missing pane of glass in a greenhouse can "increase the annual heat loss in high-input glasshouse production by around 1,200 kWh and, at 2.5p/kWh (current energy prices), this will cost nearly £40 per year"[47] Between "5% and 30% of instantaneous greenhouse heating demand can be due to air leakage"[48] – a difficult problem for outdated facilities without access to financing to make capital investments in modernisation or expansion or to work through the planning system. Similar principles would apply to other areas of the garden industry, for instance in garden centre buildings and glass structures. Researchers and growers are finding a host of new ways to improve efficiency, proactively solve energy use problems and use new technologies to reduce energy wastage and cut costs. These range from changing types of lighting, types of glass, maintaining control systems and using energy meters, to using different humidity control mechanisms. While most glasshouses now have basic automation that can perform these tasks, more advanced equipment, analytics and IoT tools could drive further productivity and sustainability gains.

A variety of different propositions have emerged that enable growers to outsource some of the labour of detailed monitoring to machines. Brands such as "Intelligent Growth Solutions"[49], Root.AI[50] and Sensing+[51] enable growers to remotely monitor specific plants, control temperature, emissions and water through an app and scale the amount of automation that is required. For some growers, heat and water can be automated entirely, with these new products taking on much of the labour involved in watering and climate control and freeing up workers for other tasks; for some, the challenges of the particular location or geography make wide-scale automation difficult, but still allows for smaller scale assistance. These technology solutions can save time, money, labour and reduce emissions, while increasing yields and creating more sustainable growth operations.

However – none of this is possible without the development of new skills. All these new technologies, ways of working and implementations of new techniques require a skilled workforce. Furthermore, the skills requirements of the industry are changing in general, with a much greater need for supervisory and management skills, environmental awareness, as well as digital and horticultural skills than ever before.

In an ideal world, new employees would be consistently entering the market, and would be trained in these specific technology and digital skills –such as to set up an automated system for sustainable energy use. However, this is not always the case and in the 2019 Ornamental Horticulture Skills Survey, Pye Tait demonstrates that there is a potentially sizeable gap between the skills that are currently possessed and those that will be in demand in the future. For example, just 33% of professional respondents claimed in the survey that a "future importance of automation, robotics and AI will moderately increase".[52]

While digital skills are important, others such as environmental awareness, supervisory management capability and skilled technical roles are also identified as gaps. The skills survey highlights the importance of environmental awareness: from a high base it will increase further by 12% for managers, 14% for professionals, 10% for skilled trades and 14% for general employees respectively.[53] This correlates with the growing importance of knowledge of water scarcity and climate change which will increasing impact the sector. The importance of environmental awareness is equally present for arboriculture and landscaping: the gap between current skill and future need for both of these sub-sectors are even more pronounced than that of ornamental production.[54]

The gap between current and future requirements for people management and supervisory skills differ from sub-sector to sub-sector. For arboriculture there is a much less pronounced supervisory skills gap than for people management[55]; for landscaping both have a significant gap[56]; for ornamental production both are less pronounced[57]. The availability of capable managers and supervisors is key to delivering

According to the ONS, 99 per cent of seasonal agricultural workers are from EU countries.

47 Energy Management in Protected Cropping, AHDB, 2019
48 Ibid
49 Intelligent Growth Solutions: https://www.intelligentgrowthsolutions.com/
50 Root.AI: https://root-ai.com/
51 The Yield: https://www.theyield.com/products/sensing
52 2019 Horticulture Sector Skills Survey, Report for the OHRG, Pye Tait, 2019
53 Pye Tait 54
54 Pye Tait Landscaping 16, Pye Tait Arboriculture 15
55 Pye Tait Arboriculture 15
56 Pye Tait Landscaping 16
57 Pye Tait 54

productivity gains – without a significantly closed gap (especially in the case of people management for arboriculture) there will be a significant loss of productivity and much of the delivery of the agendas outlined in this report will stall.

The development of a world class technically skilled and green skilled workforce would come with an integrated immigration policy, where individuals with the specific skills needed for both technological application and green skills could have a fast-tracked way to work in the UK. This would ensure that access to the best quality talent was always possible, while making the UK a destination for skilled talent more generally. By raising the profile of and resourcing for UK universities, horticultural science centres, and technology centres, such as University of Lincoln Centre for Autonomous Systems[58], the UK can be a centre for not only ornamental horticulture technology, and horticultural science as part of the life sciences can be a key part of this overall direction of promoting scientific endeavours more generally.

Over the entire ornamental horticulture sector, 10% of supervisor roles remain open; 14% of skilled trade roles remain open; 11% of professional/ technical roles remain open.

The immediate ability to source seasonal workers, as well as workers with the skills needed to ensure the different sectors of the horticulture and landscaping industry remain productive and competitive, is critical to delivering a platform for future growth. In ornamental production, crop production is directly dependent on availability of seasonal labour which cannot easily be supplied from the UK. In the landscaping industry, workers will increasingly need to be attracted to the industry from towns and cities – non-traditional recruiting grounds for the industry – where managed green spaces have the potential to expand in the coming decade. If ornamental growers don't get access to the seasonal workers they need, they won't be able to produce their crops unless they secure labour from within the UK – which is much more difficult. In September 2018, the Migration Advisory Committee in its report EEA migration in the UK, said, "The labour market for seasonal agricultural labour is completely separate from the market for resident workers in a way that is unlike any other labour market. According to the ONS, 99 per cent of seasonal agricultural workers are from EU countries and it is difficult to imagine a scenario in which this workforce can come from the resident labour market." Lack of seasonal labour availability risks constraining economic growth in the industry by 2030, with demand supplied instead by imported plants. Likewise, without the recruitment of grounds maintenance experts and arboriculturists, the economic value from the expanded green spaces mentioned earlier in this report will not be able to be delivered.

58 Lincoln Centre for Autonomous Systems

The industry and individual organisations in horticulture and landscaping have in the past provided career outreach, and plan to develop this in future, but it will be critical throughout the coming decade in terms of capacity that the industry secure access to seasonal labour from overseas where it cannot be found in the UK to meet anticipated increases in demand. In the Netherlands, which leads on automation and productivity, a sizeable portion of the labour input to ornamental horticultural crops (almost 30%) is from seasonal labour, equivalent to 30,000 contract workers.[59] This access to labour in the UK is set to almost completely cut off by the new immigration policies which do not provide for labour from overseas to come to the UK and work on horticultural crops. Robots and automation will not be able to pick up the slack from a lack of seasonal labour supply as they do not have the human or selectivity skills to replicate this work. Without this labour supply there is potential for significant and potentially devastating disruption, resulting in a shortfall in UK supply for increasing demand for plants and trees, with the gap being filled by imports.

The UK, ideally, would be able to develop the skills required to operate this new technology while attracting the best talent around the world. Through the combination of embracing technological efficiency with improving skills and making the UK attractive to foreign talent, the country can be a market leader not only for innovation and efficiency, but also for workforce skills and having the best training in the world. These skills would be fundamentally transferable. The apex of this policy would be the conformity with the Green Industrial Revolution[60]: the 10-point plan to revitalise the UK economy around sustainable and innovation led lines. Through skills training and appropriate attention paid to UK ornamental horticulture and landscaping, the sector could be part and parcel of government's new focus, creating new green jobs and skills that also prepare the workforce for new technology and innovation.

Part 2: Potential Negative Outcomes

A slow decline awaits the UK horticulture and landscaping industry over the next ten years if skills fail to develop, if access to talent is restricted, and if succession plans are not in place and supported by staff with the necessary management, scientific, and technical capabilities. Indeed, the ability of the industry to recruit and retain workers with the functional and practical skills required across disciplines as wide ranging as landscape design, green space maintenance, tree surgery, or crop irrigation in ornamentals production. If there is a combination of no significant advances in uptake of new technology, coupled with the impacts from automation and shortage of labour across a range of skill sets in the short to medium term, we will see a vicious cycle of the industry being unable to grow or generate enough in the short term to fund further investment in efficiency and other technology that could be the long-term future of the industry. In this scenario, the latent demand and growth opportunities identified elsewhere in this report would either be missed or satisfied by overseas industries. This necessary access to labour is required to meet the increasing demand surfacing through the other drivers and scenarios: the expansion of gardens, better health and exercise for the population, increased biodiversity and more.

The skills gap in the UK is a key challenge across almost every industry: there is a lack of the required skills across digital as well as the specific technical skills that industries need. This is also true in ornamental horticulture and landscaping, where a domestic skills gap is exacerbated by a lack of access to overseas talent that make up the difference. Over the entire ornamental horticulture sector, 10% of supervisor roles remain open; 14% of skilled trade roles remain open; 11% of professional/technical roles remain open.[61] When asked what the main reasons are for workers not having the right skills, the most common reason (at 24%) was being "unable to find people who already have the right knowledge and skills."[62] Across every skilled trade in the Pye Tait survey there is a difference between the skills individuals currently possess, and what will be needed in the future. In the same survey, 23% of the labour force is referenced as non-UK EU resident for plant production: a significant number that if brought down, would be difficult to fill with British workers.[63]

The main areas of skills shortage in ornamental horticulture and landscaping relate to supervisory, management and technical competences across the different sectors, as well as the sector-specific skills needed in landscape design, arboriculture and retail. Attracting and retaining sufficient apprentices to the industry is also a pressing need in terms of labour supply. A common skills gap in the longer term across the sectors of the industry is in "automation,

59 Statistics Netherlands (CBS): "Nearly 30 thousand contract workers in agriculture", April 2020
60 Financial Times: Boris Johnson: Now is the time to plan our green recovery, November 2020
61 2019 Horticulture Sector Skills Survey, Report for the OHRG, Pye Tait, 2019
62 Ibid
63 2019 Horticulture Sector Skills Survey, Sub-Sector Report: Ornamental Plant Production. Report for the OHRG, Pye Tait, 2019

23% of the labour force is referenced as non-UK EU resident for plant production.

robotics, AI", which have the most pronounced difference between the current level and future need.[64] This is from a relatively low base – due to the low numbers who currently possess these skills, the gap between current and future use is even more significant. This is an area also proposed to have a significant longer term future impact on the industry, making the skills shortage even more pronounced and important. Indeed, 75% of large ornamental horticultural businesses use some form of automation already, stressing the importance of developing these skills now. If these skills and the supervisory and management capabilities to deploy them successfully continue to be undeveloped, longer-term UK efficiency will be significantly impacted, and other markets will have an edge over UK national yield and output.

The challenge gets more pronounced when viewed in conjunction with immigration policies. Now that Brexit has begun to impact on the availability of seasonal and other overseas labour there is an emerging dual problem – no automation to fill in these job roles and uncertainty over future labour availability in the short term and coming decade. Already in 2017, 59% of growers claimed that they were not able to source enough seasonal labour and, in spite of currently high levels of unemployment in the wake of the COVID-19 pandemic, local labour availability is not aligned with areas of highest ornamental production. This shortage – already significant 3 years ago, and which will only grow in importance now – caused increased recruitment costs, higher wages and overtime and delayed investment decisions[65]: British productivity and efficiency was reduced considerably. With immigration policies now threatening access to labour, British UK ornamental horticulture and landscaping businesses will not have sufficient capacity to meet new demand and resulting growth opportunities from horticultural products and services. The lack of development and affordability of automation and other ways to fill in that gap will make the industry suffer, making the UK less competitive compared with overseas businesses; imported plants produced more sustainably and cost-effectively would take their place, choking output.

Furthermore, a lack of high skilled labour from production technicians to designers and scientists is another difficulty for the industry and represents a challenge for the entire British economy. Skills shortages are the second most

64 Ibid
65 NFU: UK Horticulture Labour Use, 2017

pressing driver of future change for micro, small and medium horticulture businesses[66] – and the most pressing for large businesses. The technologies described above, including automation, machine vision, IoT and predictive analytics, all require significant training to be able to use effectively, and, ideally, the UK would produce these new products for domestic use and export. Without support for technology skill development – in the form of better university support, more support for UK technology centres and access to training for more senior stakeholders in businesses – the UK ornamental horticulture and landscaping industry will consistently fall behind, potentially damaging the Prime Minister's vision for a Green Industrial Revolution.

If the UK is not able to solve the skills gaps it faces it will struggle to achieve its growth potential. The industry will need to attract, develop and retain the sector specific knowledge and skills to deliver its outputs productively and competitively. It will need to develop the supervisory and management skills and capabilities to deploy emerging technologies successfully in businesses in the sector – to drive productivity and sustainability over the next decade. Additionally, without adequate access to seasonal labour, the industry will be competitively hamstrung compared to the inexorable progress of industries such as those in the Netherlands, the US and China. The UK has some of the best institutions in the world, coupled with institutional ornamental horticulture knowledge that sets it apart from other markets, but is currently not capitalising on its potential.

Section 3: The Upper and Lower Case Scenarios for 2030

As outlined above, the two drivers have direct and intertwined implications, potentially positive and negative. By taking these and examining the best- and worst-case outcomes, below we set out a vision of two scenarios that demonstrate the positive and negative possible outcomes facing the UK in 2030.

Upper case scenario: Flourishing Horticulture

Through promotion of careers in the industry and co-ordination and continuous improvement of skills development across the industry, the UK horticulture and landscaping industry will have strengthened its position as a home for highly skilled horticulturists, scientists, and landscape professionals that can use new technologies to increase sustainable productivity growth across the sector. Access to seasonal labour will have provided the labour needed to satisfy demand for plants and trees which has soared over the 2020s. A sustained focus on education and skills development in the industry has made the UK a global destination for high skilled workers and scientists in 2030 who bring the talent and knowledge to underpin growth. Technology adoption and the recruitment and retention of workers with the practical and functional skills to apply it has grown productivity and now enables skilled talent to achieve its full potential. Horticulture and landscaping, thanks to investment in new technologies and circularity, has become recognised as being at the forefront of sustainable business. The industry is helping to transform the UK into a global beacon for horticultural and green space science and technology, creating a bedrock for efficiency and innovation. Partnership working between the public and private sectors on skills and education as well as investment in the adoption and development of new technology has established the UK internationally not only its horticulture and landscaping sector, but also for the green spaces knitted into the fabric of its landscapes, towns and cities.

In this scenario of 2030:

- The UK is one of the world's leading nations in terms of productivity and talent needed to exploit new and emerging opportunities
- The UK is a world leader for horticulture and life sciences education, skills, knowledge and training
- The UK is renowned for innovation and excellence in the life sciences, in particular horticultural science, that underpin horticulture and landscaping
- The UK has sufficient labour from the UK and overseas to meet seasonal peaks in demand
- The UK develops an ever more skilled labour pool through its education and training system; it also fosters a culture of success and forward progress, making it the number one destination for horticulture and landscaping students and growers.

66 2019 Horticulture Sector Skills Survey, Report for the OHRG, Pye Tait, 2019

Lower case scenario: Horticultural sunset

With complicated and restrictive immigration policies, coupled with limited government support for horticultural education, the UK horticulture and landscaping industry has become less productive and competitive than overseas competitors. Its GDP contributions to the UK have failed to keep up with its potential to grow, an in spite of increased demand the industry has seen only modest growth in its contribution to UK GDP and employment . New demand for plants, trees and the expertise to engineer the green spaces for which they are destined is met increasingly by imports and overseas businesses due to the UK industry being lacking the capacity to supply demand. Technology adoption lags behind that of global competitors, leading to UK horticulture and landscaping becoming an increasingly marginal sector compared with other industries; the capacity and productivity of UK producers becomes become less sustainable and commercially competitive in global terms due to trailing global competitors in innovating in the use of inputs such as water, nutrients and energy. Those in the UK with an interest and passion for horticulture and the emerging green sciences increasingly have found themselves having to move away to study and work in countries with world leading horticulture and landscaping sectors, a brain drain to the UK's environmental and economic detriment.

In this scenario of 2030:

- The UK horticultural and landscaping industry begins to lose its international standing and enters a slow decline.
- UK horticulture and landscaping careers outreach and skills development programmes lack the resource and support to attract entrants to the industry and grow their skills, precipitating a slow decline in the UK industry's capacity
- Competing overseas industries are able to develop new technology that drives sustainable efficiency, and reap the economic rewards that increasing global demand for science and technology relating to plants and green spaces
- The skills gap widens, requiring the import of more overseas labour and facing a lack of sufficient labour at home. Quality of talent drops, and production and efficiency are increasingly outpaced by other markets.
- A lack of seasonal labour results in delays and inability to complete many of the urban greening, landscaping and ornamental production projects.

Section 4: Economic Model

The two drivers in these scenarios – access to labour and sustainable productivity and capacity gain are modelled to generate upper and lower case scenarios for the industry in 2030.

For labour supply, the premise of the analysis is that shortfalls in labour supply will reduce growth potential – e.g. the industry will fall short of its potential. In order to assess this, data from the OHRG's research on reported labour shortages in the key sectors of the industry were used. The principle used is that a one-to-one correlation between labour supply and output exists – e.g. a 1% shortfall in labour supply will lead to a 1% shortfall in output. For the modelling, where data on a sector does not exist (for instance garden manufacture or wholesale), and assumption is made that labour supply will be adequate and second order effects resulting from shortages in other sectors are modelled. From the OHRG's report into labour and skills in the industry, sector-by-sector levels of shortfall are used to model the overall impact on the industry. In ornamental production, a 20% labour shortage is modelled. For landscaping and arboriculture, a 10% figures is used. For garden retail and tourism where there are comparatively few shortages a figure of 2% was used. The following table shows the annual negative impact on the industry's contribution to the UK economy that would result from these levels of labour shortfall.

Table 13: the difference in economic value delivered by the industry depending on upper and lower case scenarios for access to labour by 2030

	2019	2030 (lower case scenario)	2030 (upper case scenario)
Direct GDP contributions (£m)	£13,801	£15,981	£17,355
Indirect GDP contributions (£m)	£7,289	£8,447	£8,966
Induced GDP contributions	£7,725	£8,878	£9,605
Total GDP contributions (£m)	**£28,815**	**£33,306**	**£35,927**
Direct employment	420,038	407,308	439,129
Indirect employment	141,074	139,686	147,380
Induced employment	113,137	109,458	118,069
Total employment	**674,248**	**656,452**	**704,578**
Direct tax revenue (£m)	£2,473	£2,836	£3,046
Indirect tax revenue (£m)	£1,694	£1,966	£2,087
Induced tax revenue (£m)	£2,118	£2,434	£2,633
Total tax revenue (£m)	**£6,285**	**£7,236**	**£7,767**

In terms of productivity and capacity gain, a review of productivity across the Netherlands horticulture industry was conducted which identified a compound annual growth in GDP of 1.6% per year. This 1.6% is used to illustrate additional growth over and above that which would be expected were sectors of the industry to shadow similar sectors of the UK economy. To validate this, a brief literature review of the contributions of increased research and development as well as training and development activity to productivity was conducted. Research for The Institute for Fiscal studies[67] has reported that a 1% increase in the proportion of staff trained is associated with a 0.6% increase in productivity. The impact of research and development on productivity is less easy to quantify, as R&D typically has spill over benefits across and beyond an industry as multiple firms benefit from others' R&D. Again research for the Institute of Fiscal Studies[68] shows a positive impact on investment in R&D. For a firm an increase in R&D investment of 10% is associated with an increase in productivity of 0.7%, though this does not take into account spill over benefits for an industry which are much higher, nor does it take into account methods of delivering research and development in the ornamental horticulture industry where R&D delivered by bodies such as the Agriculture and Horticulture

67 The impact of training on productivity and wages: evidence from British panel data. Dearden, Reed, Van Rearden
68 How important is business R&D for economic growth and should the government subsidise it? Griffiths, 2000

Development Board, Royal Horticultural Society, and academic institutions has been freely available to firms operating in the sector. These figures, taken with opportunities particular to the industry to eliminate administration, apply automation, and so forth suggest a 1.6% CAGR in productivity over that of similar sectors of the economy for the industry is realistic given the skills and productivity challenges identified in this chapter. The following table shows the impact of such an increase in productivity that would deliver to the UK economy.

Table 14: the difference in economic value delivered by the industry depending on upper and lower case scenarios for sustainable productivity and capacity gain by 2030

	2019	2030 (lower case scenario)	2030 (upper case scenario)
Direct GDP contributions (£m)	£13,801	£17,355	£19,815
Indirect GDP contributions (£m)	£7,289	£8,966	£9,914
Induced GDP contributions	£7,725	£9,605	£10,890
Total GDP contributions (£m)	**£28,815**	**£35,927**	**£40,619**
Direct employment	420,038	439,129	441,032
Indirect employment	141,074	147,380	161,134
Induced employment	113,137	118,069	133,066
Total employment	**674,248**	**704,578**	**735,232**
Direct tax revenue (£m)	£2,473	£3,046	£3,117
Indirect tax revenue (£m)	£1,694	£2,087	£2,311
Induced tax revenue (£m)	£2,118	£2,633	£2,986
Total tax revenue (£m)	**£6,285**	**£7,767**	**£8,414**

Chapter 3:

Trends in gardens, healthy habitats, demographic change & new gardeners – how they point to growth in the horticulture and landscaping industry

Chapter summary

Today, over 80% of the UK population lives in an urban environment, a number forecast to grow by 2030. At the same time, 54% of the total surface area of front gardens is grey and only 62% of household gardens have vegetation, even though 87% of households have gardens.[69] The removal or reduction of gardens from homes is a serious and destructive influence on citizen's lives, health and wellbeing. In 2020, around 30 million British adults reported that they garden in their spare time, and COVID-19 energised this behaviour. While older adults are the most likely to garden in the UK, under 45s account for a quarter of all spending on garden plants. These younger adults were over-represented in the 3 million adults who took up gardening during the lockdown of 2020.[70] Building on such new opportunities, accelerated by COVID-19, and engaging new demographics, will be central to unlocking the growth potential of the sector in the 2020s.

The size, extent of vegetation, and overall area of domestic gardens (including balconies, window-sills, and patios) has a substantial impact on the economic contribution the industry is forecast to make to the UK economy. Based on modelling of housing growth, garden area as well as potentially 'greenable' domestic areas like roofs and walls, an upper case scenario was developed in which 711,000 hectares of domestic gardens and green spaces exist in 2030, compared with a lower case of in which there are 655,000 hectares (the extent of non-domestic green spaces such

54% of the total surface area of front gardens is grey and only 62% of household gardens have vegetation, even though 87% of households have gardens.

69 Davies, Zoe G. and Fuller, Richard A. and Loram, Alison and Irvine, Katherine N. and Sims,Victoria and Gaston, Kevin J. (2009) A national scale inventory of resource provision for biodiversitywithin domestic gardens. Biological Conservation, 142 (4). pp. 761-771. ISSN 0006-3207

70 HTA/YouGov, consumer survey of 2000 GB adults June 2020

as parks is not counted in this figure and is assessed in chapter one). The difference between these two scenarios for domestic garden space in terms of direct GDP contributions to the UK economy is £498m per year in direct GDP. This is delivered through increased economic activity in the supply and retail of plants and goods for these spaces, as well servicing the additional space through garden landscaping and maintenance activity. The following table summarises the difference in economic impact to the UK economy in 2030 between the upper and lower case scenarios for the extent of domestic garden space.

Table 15: the difference in economic contributions between upper and lower case scenarios for the industry based on projected expansion or contraction of domestic garden area by 2030[71]

	Difference between 2030 upper and lower scenarios
Direct GDP contributions (£m)	£498
Indirect GDP contributions (£m)	£202
Induced GDP contributions (£m)	£286
Total GDP contributions (£m)	**£986**
Direct employment	13,799
Indirect employment	3,024
Induced employment	3,663
Total employment	**20,487**
Direct tax revenue (£m)	£97
Indirect tax revenue (£m)	£46
Induced tax revenue (£m)	£79
Total tax revenue (£m)	**£222**

Moreover, greater engagement with gardening in all its forms will also generate macro health benefits for the nation.[72] Indeed, plants in offices, exercise in gardens and access to nature all have a quantifiably positive effect on the lived experience of UK citizens. In offices, staff with plants recorded "reductions in stress levels and negative feelings of a magnitude of 30 to 60%". Researchers measuring diurnal cortisol found that individuals who interacted with plants had a quantified change in indicators of health. Increasing access to gardens and green space can cut healthcare costs for the NHS while opening up alternative ways for individuals to interact and learn about their environment. This growth of knowledge and learning could significantly accentuate actions and concern for nature, and galvanise a response to climate change. Estimates for the contribution these garden spaces make to the UK's natural capital value are detailed in chapter 1 of this report.

Rising house prices, a lack of availability of housing stock and the paving over of gardens has exacerbated the ability for UK consumers – especially younger ones – to see the health and wellbeing benefits from interactions with plants and nature. If the current trend of paving over and shrinking the size of gardens continues, the UK could see significant health and economic costs. The gardening sector pulls through consumer spending into a wide array of other sectors: continued restricted access to gardens will consequently have negative knock-on effects beyond just the ornamental horticultural and landscaping sector.

Local and national government support in preserving or expanding the area of domestic gardens and the extent to which they include greenery through the planning system has the potential to drive economic growth and to mitigate rising healthcare costs. This may include ensuring adequate garden space is designed for housing developments, as well as encouraging and enabling green roofs and walls and regreening front gardens.

71 Upper case scenario is based on 711,000 hectares, lower case scenario based on 655,000 hectares

72 For instance see: Chalmin-Pui LS, Griffiths A, Roe J, Heaton T & Cameron R (2021) Why garden? – Attitudes and the perceived health benefits of home gardening. Cities, 112, 103118-103118; Chalmin-Pui LS, Roe J, Griffiths A, Smyth N, Heaton T, Clayden A & Cameron R (2020) "It made me feel brighter in myself"- The health and well-being impacts of a residential front garden horticultural intervention. Landscape and Urban Planning, 205; De Bell S, White M, Griffiths A, Darlow A, Taylor T, Wheeler B, Lovell R. (2020) Spending time in the garden is positively associated with health and wellbeing: Results from a national survey in England. Landscape and Urban Planning, Vol 200

In this chapter we examine upper and lower case scenarios based on the potential outcome of two key drivers influencing the growth potential of the ornamental horticulture and landscaping industry: the extent to which our homes, domestic gardens and other spaces evolve to benefit our social, mental and physical health and wellbeing, and the UK's changing demographics and participation in gardening to 2030. Below we describe each driver. In Section 2, we examine the combined impact of these two drivers on the UK in 2030. In Section 3 we describe the upper and lower case scenarios, developed from the evidence presented in Section 2. Finally, in Section 4, we provide details of the economic modelling undertaken to describe the potential impact of such scenarios on the potential contribution of the UK ornamental horticulture and landscaping industry to the UK economy.

Section 1: The Key Drivers

Below we outline a summary of two key drivers that will shape the future contribution of the UK ornamental horticulture and landscaping industry to the UK economy, as well as the primary features of each driver that will propel such growth potential.

Driver 1 – Demographic change in the UK and participation in gardening

- The UK's population is aging, and as consumers tend to increase spend on gardening as they age this favours growth in the industry to 2030
- However as the UK population grows older (by 2030, 22% of the UK population will be over 65[73]) – competing leisure sectors will target older consumers to meet their health and leisure needs, driving competition for participation
- These older consumers will spend more on gardening, pointing towards potential growth in demand by 2030
- Younger consumers tend to spend less money and time on gardening and their gardens than older consumers, but the recent sharp increase in participation in gardening borne out of the COVID-19 pandemic and lockdowns could be sustained into the future driving growth in demand

Driver 2 – Healthy Homes and Green Gardens

- The benefits of gardening for physical, social and mental health are substantial, with a variety of different improvements to health and wellbeing
- NHS cost savings from the health benefits conferred by gardening are potentially significant
- Mental health and wellbeing is improved substantially through gardening
- A variety of different benefits, including social cohesion and an attachment to nature can be gained through gardening from children to the elderly
- Inequality of health and social outcomes can be mitigated through access to gardens
- The care of office plants and indoor house plants can impact on areas as wide ranging as mental health, workplace productivity and air quality
- Gardens foster wellbeing across the UK, addressing a number of physical, social and mental health issues.
- Policy on house-building and urban development in the next ten years has the potential either to expand or constrain domestic garden area; the amount of garden area in 2030 could increase by up to 8% depending on new house building and urban development policies as well as consumer behaviour.
- The area and extent of domestic garden space is correlated with natural and social capital benefits, wellbeing, and the economic growth potential of the industry will be linked to the rate of increase or decrease in garden areas.

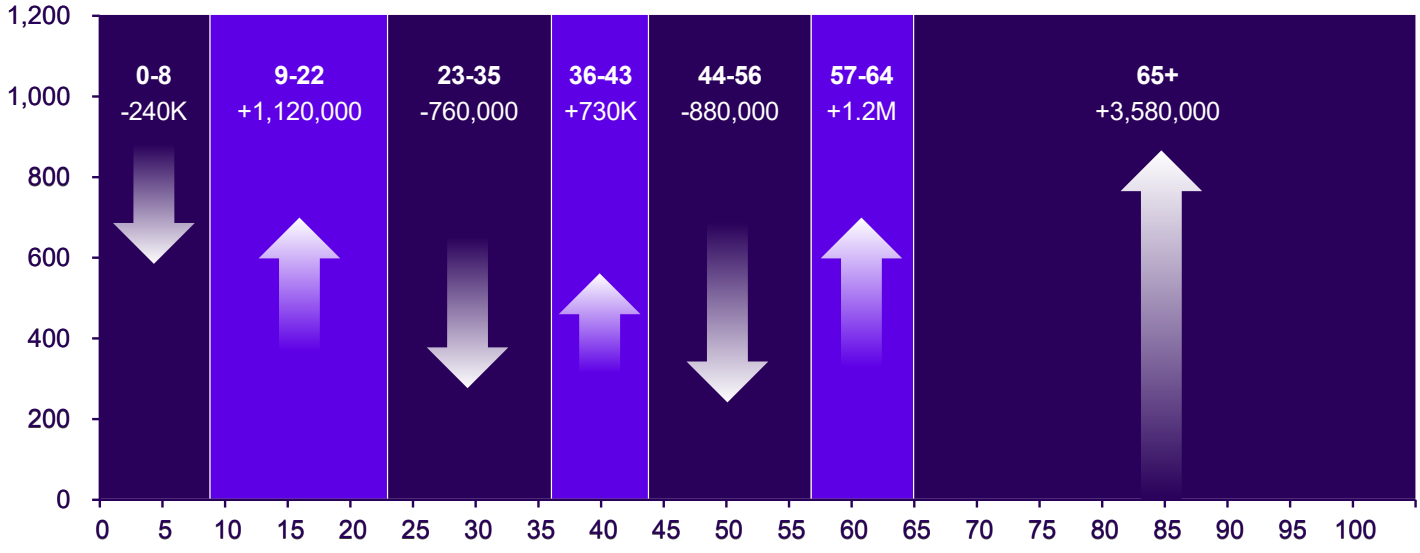
73 ONS, 2017b

Section 2: Joint Impact of the Drivers – Potential Positive and Negative Outcomes

Part 1: Potential Positive Outcomes

Recent decades have seen an increase in various issues related to urbanisation that have reached a significant level of detriment to wellbeing, health and environmental quality. Almost 84% of the UK population lives in an urban environment, a number forecast to grow by 2030.[74] Besides the drivers described in the previous chapters, the UK faces a number of transitions that are growing in intensity and impact: an aging population and the changing health and wellbeing needs this will bring. In 2008, 8% of women aged 18 to 24 suffered anxiety, rising to 30% in 2018; men in the same age cohort experienced a rise from 5% to 15%.[75] Concurrently, the average age of the UK population is rising: the average age was 35 in 1947, and was 40 in 2019.[76] Besides the generally ageing population, there are broad changes in the interests and hobbies of younger Britons. We are seeing an increase in sedentary lifestyles, and an increasing range of technological entertainment such as online gaming or TV that fosters a retreat to the indoors. Rising house prices, and a lack of availability of housing stock, has also restricted the purchase of homes with gardens, or gardens of comparable size to a generation ago for many. These factors have made it more difficult for many young people to develop gardens or gardening.[77]

Chart 4: UK Demographic Change: UK population by age: 2016 – 2030



74 World Bank, Databank, Urban Population as % of Total, United Kingdom, 2018 Revision
75 April Slee, Irwin Nazareth, Nick Freemantle and Laura Horsfall; Trends in generalised anxiety disorders andsymptoms in primary care: UK population-basedcohort study. The British Journal of Psychiatry (2020)Page 1 of 7. doi: 10.1192/bjp.2020.159
76 Ageing Fast and Slow, Resolution Foundation, 2019
77 FOR CHART: Source: ONS, 2016-based National Population Projections (Published October 2017) / Foresight Factory | Base: UK

In 2020 around half of British adults said that they tend to do gardening in their spare time.

Against this, a desire for better mental health, physical exercise and to make one's home more beautiful, UK consumers do look to their gardens and indoor plants to help improve their lives by reconnecting with nature when the availability of garden space allows. In 2020 around half of British adults said that they tend to do gardening in their spare time.[78] COVID-19 and a continuation of lockdown policies has energised uptake of gardening among younger consumers – 39% of 25–34 year olds report that they either started gardening for the first time, or were gardening more than when the outbreak began. Many of these individuals will, given encouragement and opportunity, likely continue to garden past the pandemic, as they want to maintain the project into which they've poured in so much hard work. 23% of 25–34 year olds intend to garden more after the pandemic is finished, rising to 37% of those aged 35–44.[79] Far from being a hobby exclusive to older consumers, there is an increasingly broader base of consumers experiencing the benefits of gardening and adopting it where possible.

While uptake of gardening has been significant over 2020, a lack of garden space and privately owned areas in which to plant a garden remains a significant limiting factor, especially among younger consumers. There is a significant correlation of garden space and health and well being benefits: "Compared to no garden access, access to a private garden was associated with better evaluative wellbeing, and people with access to a private space such as a balcony, yard or patio were more likely to meet physical activity guidelines... These findings indicate that domestic gardens are a potential health resource and are not necessarily substituted for by other natural environments, highlighting the importance of their provision alongside green space in urban policy and planning."[80]

The extent to which this situation improves or deteriorates to 2030 has a significant bearing on the growth prospects for the industry and the potential of gardening to deliver more social, environmental and health benefits to the UK. Achieving home ownership among millennials is notoriously difficult, and owning a home with a garden is even more so – only 31% of millennials owned their own home in 2017.[81] Older consumers therefore make up a significantly higher proportion of purchasing power in the gardening space.

The following table shows the proportion of spend in a given area of consumer spending on gardens which is accounted for by each age group. Garden spend goes up with age and socio-economic groups:[82]

Table 16: Proportion of garden spending accounted for by different consumer age groups

	15-24	25-34	35-44	45-54	55-64	65-74	75+
Garden products and garden buildings	6.6%	13.2%	14.4%	18.2%	18.9%	21.0%	7.7%
Landscaping and maintenance services	6.4%	10.6%	15.9%	15.7%	23.3%	18.3%	9.8%
Ornamental plants	4.3%	9.6%	11.1%	18.2%	21.0%	25.6%	10.2%

These older groups are vital for the gardening industry, but the potential growth in interest in gardening among younger consumers – the under 45s account for around a quarter of all spending on garden plants – is also extremely important.

Younger consumers are fast recognising the role and function of indoor plants, and, where possible, outdoor gardens. These hobbies provide a variety of different benefits, from indoor air purification to a boost in mental health and productivity, to the satisfaction of the instinct to nurture.

78 HTA Garden Industry Statistics. https://hta.org.uk/learn-develop/market-information/garden-statistics.html#
79 Source: Foresight Factory | Base: 1005 online respondents aged 16+, GB 2020 June
80 Spending time in the garden is positively associated with health andwellbeing: Results from a national survey in England Siân de Bella,☐, Mathew Whitea, Alistair Griffithsb, Alison Darlowc, Timothy Taylora, Benedict Wheelera, Rebecca Lovella
81 "Generation Buy", HSBC, 2017
82 HTA Garden Market Sizing – Market Update, Insight Edition

The more domestic gardens, roofs, walls, balconies, and windowsills with plants indoors and outdoors there are, the more economic activity that will pull through the supply chain there will be. This will be realised in terms of consumer purchasing of plants and garden products, and the domestic landscaping, arboriculture and garden services provided to service these spaces. The proportional increase in garden space will result in a direct increase in consumer demand for different products, providing a significant boon to the UK economy.

Staff who had plants placed in their offices showed reductions in stress levels and negative feelings of a magnitude of 30 to 60%.

Office plants are an area in which younger consumers have been able to implement change. A study by the National University of Sydney found that "staff who had plants placed in their offices showed reductions in stress levels and negative feelings of a magnitude of 30 to 60%, while those with no plants recorded increases in stress and negativity of 20 to 40%" – with just one plant needed to make the difference.[83] Air pollution is another significant area of improvement related to indoor plants.[84] Air purification is rapidly becoming a concern for many – even though NO2 has dropped within London by 40% over the last 4 years.[85] 20% of UK consumers owned an air purifier in 2019, rising to 27% of those aged 25 – 34 and a further 28% of UK consumers were interested in owning such a device.[86] These products, often expensive and requiring significant amounts of energy to work effectively, can be easily substituted for by specific houseplants, which often work just as well, and require almost no running cost. VOCs (volatile organic compounds) were reduced by 15% by pot plants in a study from 2016[87], and all plants remove some CO2 from the air and emit oxygen.

While indoor plants have connections to improvements in mental health, the much more significant benefits come from gardens, both in terms of mental and physical health. Public green spaces are usually the ones cited for significant benefits, with only 1% of urban green space and mental health studies[88] focusing on private gardens, but there have been important studies conducted recently[89] that display the ways in which gardens can have an outsized effect. In the UK, estimates of households that have a "garden" vary around the 85% mark, with some as high as 87%[90] – but recent studies suggest that only 62% contain vegetation, therefore providing significant potential for regreening

83 Nursery Papers, Greenlife Industry, Issue No. 6, July 2010
84 For instance see: Gubb C, Blanusa T, Griffiths A, Pfrang C. Can plants be considered a building service? Building Services Engineering Research and Technology. 2020;41(3):374-384. doi:10.1177/0143624419899519; Gubb, C., Blanusa, T., Griffiths, A. and Pfrang, C. (2018) Can houseplants improve indoor air quality by removing CO2 and increasing relative humidity? Air Quality, Atmosphere & Health, 11 (10). pp. 1191-1201. ISSN 1873-9318 doi: https://doi.org/10.1007/s11869-018-0618-9; Gubb, C., Blanusa, T., Griffiths, A. and Pfrang, C. (2019) Interaction between plant species and substrate type in the removal of CO2 indoors. Air Quality, Atmosphere & Health, 12 (10). pp. 1197-1206. ISSN 1873-9326 doi: https://doi.org/10.1007/s11869-019-00736-2
85 "Air pollution monitoring data in London: 2016 to 2020", Mayor of London Office, February 2020
86 Source: Foresight Factory | Base: 4397 online respondents aged 16+, GB, 2019 May
87 Margaret Burchett et al., Greening the Great Indoors for Human Health and Wellbeing, University of Technology Sydney, 2016
88 Wendelboe-Nelson, Kelly, Kennedy, & Cherrie, 2019
89 For instance see M Howarth, A Griffiths et al, Social prescribing: a 'natural' community-based solution, (2020)
90 Davies, Zoe G. and Fuller, Richard A. and Loram, Alison and Irvine, Katherine N. and Sims,Victoria and Gaston, Kevin J. (2009) A national scale inventory of resource provision for biodiversitywithin domestic gardens. Biological Conservation, 142 (4). pp. 761-771. ISSN 0006-3207

efforts and expanding UK natural capital; the London Environment Strategy cites the figure as 60% of land in London's gardens is actually green.[91] [92] In a landmark study conducted across 2017 and 2018, researchers performed a series of "garden interventions" – where they provided participants with materials (bins, soil, bulbs and seeds) to look after a small paved front garden – and monitored the results.[93] This study was concerned with introducing ornamental plants and greenery to front gardens. The responses were not solely self reported attitudinal outcomes but also physiological. Through measuring diurnal cortisol (an indicator of stress and general health) the researchers were able to determine a quantitative positive change in the participants health, and this was supported by perceived stress scale measures and data from the questionnaires used in the study. When asked, "100% of residents felt somewhat or extremely happy with their new front garden, and 100% also reported that their health or well-being had improved as a result of the intervention." 52% reported that the intervention had made them happier, and some residents with chronic depression claimed that the intervention made them feel "like a normal human being". Another claimed "it's just nice to see the different colours. Otherwise, it looks dead bare. It made me feel brighter in myself".

For the elderly, gardening offers a way to meet the recommended physical activity levels.

The RHS's flagship school gardening campaign now involves a big majority of primary and secondary schools

The benefits of gardens to physical health also abound. Dozens of studies have been undertaken that demonstrate the correlation between gardening and improved health; most importantly, gardening encourages physical activity that has a significant reduction in lifestyle related diseases such as obesity, heart disease and diabetes.[94] Seven different studies have found that daily gardening has a persisting influence on health, lowering both stress and BMI, as well as an increase in general health and life satisfaction.[95] According to a meta-analysis of studies, a significant strength of the research is that there is no difference in the characteristics or socio-economic status of the gardeners – regardless of who the individual is, they will see a benefit in gardening. A 2008 study showed that for the elderly, gardening offers a way to meet the recommended physical activity levels[96], while community and front gardens and allotments provide an opportunity to meet and engage with other members of local communities, fostering social ties and networks that transform disparate individuals into a community.[97] An increase in gardening in the UK can provide natural preventative health, thus the potential to significantly cut GPs and healthcare professionals' time, reduce waiting lists, increase recovery time and cut healthcare costs for the NHS while establishing a baseline for good health that will cut hospital visits and lifestyle diseases even more, saving money and time for focus on other unavoidable conditions. By fostering and encouraging a gardening community, the UK can see wide ranging benefits that can improve wellbeing across the entire nation.

The UK government is aiming for a net increase in housing of 300,000 homes a year by the mid 2020s[98], but there is significant uncertainty of whether these newbuilds will have gardens; many will be extensions of existing blocks of flats or shops, and increased garden space for many of these new homes will be unlikely without changes in planning policy and practice.[99] Thus far there has been difficulty in matching these targets set out by government, but there has been a substantial increase in new homes built: 178,800 homes were completed in 2019, a 9% increase compared to the

91 ONS, "Green Spaces in Residential Gardens", Bonham, 2019
92 "London Environment Strategy", Mayor of London Office, May 2018
93 Lauriane Suyin Chalmin-Pui, Jenny Roe, Alistair Griffiths, Nina Smyth, Timothy Heaton, Andy Clayden, Ross Cameron, "It made me feel brighter in myself"- The health and well-being impacts of a residential front garden horticultural intervention, Landscape and Urban Planning, Volume 205, 2021, 103958, ISSN 0169-2046, https://doi.org/10.1016/j.landurbplan.2020.103958.
94 Park, S., Shoemaker, C. A., & Haub, M. D. (2009). Physical and Psychological Health Conditions of Older Adults Classified as Gardeners or Nongardeners, HortScience horts, 44(1), 206-210. Retrieved Dec 8, 2020, from https://journals.ashs.org/hortsci/view/journals/hortsci/44/1/article-p206.xml
95 Soga, M., Gaston, K. J., & Yamaura, Y. (2016). Gardening is beneficial for health: A meta-analysis. Preventive medicine reports, 5, 92–99. https://doi.org/10.1016/j.pmedr.2016.11.007
96 Park, S., Shoemaker, C., & Haub, M. (2008). Can Older Gardeners Meet the Physical Activity Recommendation through Gardening?, HortTechnology hortte, 18(4), 639-643. Retrieved Dec 8, 2020, from https://journals.ashs.org/horttech/view/journals/horttech/18/4/article-p639.xml
97 van den Berg, A.E., van Winsum-Westra, M., de Vries, S. et al. Allotment gardening and health: a comparative survey among allotment gardeners and their neighbors without an allotment. Environ Health 9, 74 (2010). https://doi.org/10.1186/1476-069X-9-74
98 "Government Announces New Housing Measures", Ministry of Housing, Communities and Local Development, 2018
99 Ibid

previous year.[100] Part of the government solution to the housing shortage crisis is the expansion of garden towns and villages, including the creation of additional garden villages across the country.[101] These would offer green space, but not all the new homes would provide gardens.

It is clear that gardening lends itself well to the development of a variety of benefits, including mental, social and physical health, community and access to nature. A benefit not yet discussed, however, is education. Educating consumers and laypeople about plants, the environment, the ecosystem and, importantly, themselves can be extremely difficult. Through enthusing and education children and adults alike about how plants and gardens play a part in the ecosystem and how they work, the country will develop a newfound appreciation for one of the most important and overlooked facets of our planet. Moreover, educating consumers around how to garden in a sustainable manner – e.g. through watering responsibly and gardening in ways that will foster biodiversity, is another way in which the industry can contribute to positive environmental outcomes. Another feature of broader education is the increase in children's knowledge and understanding of the world, where their food comes from and how their lives are directly and indirectly influenced by nature. The RHS's flagship school gardening campaign now involves a big majority of primary and secondary schools, helping teachers to foster children's knowledge and understanding of the world. Outdoor fieldwork for science and geography curricula and initiatives such as the forest school enable children to have a revitalised relationship with the outdoors.[102] An early exposure to gardens and green habitats at a young age could be a significant driver towards developing the skills and excitement for horticulture and landscaping to increase levels of interest in the industry as a career.

Local and/or national government support in preserving or expanding the area of domestic gardens and the extent to which they include greenery through the planning system has the potential to drive economic growth, as well as delivering extra natural and social capital benefits (see chapter 1). This might include working to ensure adequate garden space is designed in to housing developments, as well as encouraging and enabling green roofs and regreening front gardens, for instance providing information, tax breaks, or grants for these types of home improvement similar to the ones for solar panel installation or loft insulations. The London mayor's office has published their own view on how development encroaches on green space[103] and has proposed that: "The Mayor will provide advice to householders about how gardens contribute to improving green infrastructure at a local level", as well as a number of other propositions to improve green space and its management in the capital.[104] Furthermore, local and national governments can discourage the further paving over of existing gardens – a trend that not only potentially causes

100 "House building; new build dwellings, England: December Quarter 2019", Ministry of Housing, Communities and Local Government, March 2020
101 "Housebuilding Targets", House of Commons Library, Number CDP 2019-0147, 10 June 2019
102 "Our 25 Year Plan to Improve the Environment", HM Government, 2018
103 Ibid
104 Ibid

harm to the occupants of the property, but the entire community, via the environmental damage that it sustains. Through these types of policy, stronger habitats and living spaces can be developed while adding environmental and economic benefit.

Part 2: Potential Negative Outcomes

The benefits of access to nature and plants have been well catalogued, but through a lack of education and public interest, many UK citizens have been unable and disinterested in pursuing them. As a result, many have paved their gardens and overlook nature's solutions to problems: examples are air purification machines to clean the air within their homes or computer games for stress relief. These problems can all be alleviated and helped through gardening, high quality gardens and greenery. But as distance from the natural world grows, it becomes increasingly difficult to pull people back again.

Only 21% of boys and 16% of girls aged 5-15 achieve recommended levels of physical activity.

There is a significant problem with health and exercise in the UK. Only "21% of boys and 16% of girls aged 5–15 achieve recommended levels of physical activity"[105], and 19% of men and 26% of women are "physically inactive", doing no exercise at all.[106] Physical inactivity directly contributes to 1 in 6 deaths in the UK, the same proportion as smoking. An enormous number of problems result from inactivity: over half of UK adults are overweight or obese, 1 in 17 have diabetes (of which 90% have type 2, associated with lifestyle), and depression is growing rapidly (people who are inactive have three times the rate of moderate to severe depression of active people[107]). Physical inactivity is growing over the long term: we are 20% less active than in 1961, and if the trend continues, we will be 35% less active by the year 2030. This is an ongoing problem that has extensive ramifications for society, both in terms of healthcare costs and general quality of life – physical inactivity currently costs the NHS £7.2bn a year.[108] As the trend grows, the NHS will be put under increasing pressure and could bear increasing costs of managing the numbers of patients entering the health system with lifestyle related diseases. A decline in the space and quality of the UK's domestic gardens and a disinclination to garden has the potential to exacerbate these problems.

The number of gardens with no paving has halved in only 10 years.

While health risks can be mitigated by gardening, gardens are increasingly completely paved over: from 2005 to 2015, the rate of a 100% paved garden increased from 7% to 24%.[109] The number of gardens with no paving has halved in only 10 years – and nearly 54% of the total surface area of front gardens is grey. Three and a half times as many front gardens have no plants compared to ten years ago, and planting decreased 15% in 10 years.[110] London is the worst offender in the UK: half of all front gardens are paved, with a 36% increase from 2005 – 2015. There was a 500% increase in the number of front gardens with no plants in 2015 compared with 2005.

These are not easily solved problems. The UK faces a housing shortage and house prices continually increase every year.[111] Given the pressures to meet the UK's housing demand, there is evidence that some developers and planners tend to put in as much housing as possible without domestic gardens: "in the context of ever-increasing urbanisation and city densification, there is evidence that some city planners see residential gardens as a dispensable luxury."[112] Tahvonen and Airaksinen have found the same unfortunate reality: "Residential garden size is getting smaller, and some planners or developers are omitting gardens in new housing schemes completely."[113] Pressures to increase the UK's housing stock from limited available land, as well as the economic imperative on developers to generate a financial return from sales of new build houses creates a risk that garden space will diminish. This would have a consequential negative impact on the significant natural capital benefits from domestic gardens evidenced in this report. One of the most significant reasons why houseowners pave over their front gardens is to prepare more space for a car – once again contributing to a lack of exercise, and a lack of connection with nature.

105 "Everybody active, every day: Protecting and improving the nation's health: An evidence-based approach to physical activity" Public Health England, October 2014
106 Ibid
107 Weyerer S. Physical inactivity and depression in the community. Evidence from the Upper Bavarian Field Study. Int J Sports Med. 1992 Aug;13(6):492-6. doi: 10.1055/s-2007-1021304. PMID: 1428382.
108 "Everybody active, every day: Protecting and improving the nation's health: An evidence-based approach to physical activity" Public Health England, October 2014
109 "Why We All Need Greening Grey Britain", RHS
110 Ibid
111 PropertyData, House Prices 19/11/2020: https://propertydata.co.uk/charts/house-prices
112 Haaland & Konijnendijk van den Bosch, 2015
113 (Tahvonen & Airaksinen, 2018)

Residential garden size is getting smaller, and some planners or developers are omitting gardens in new housing schemes completely.

The potential negative outcomes of these long term trends by 2030 are becoming clear even now: a sedentary population with a rapidly growing set of lifestyle related diseases, an increasing number of whom have little to no contact with nature or plants, who are walking less and redesigning their urban environment to be more permanently grey and much less green. This outcome would have knock on effects: the environment more broadly would become strained, there would be less urban habitat for pollinators so ecosystems suffer, and communities would have less space to develop and cohere. Cities would become less and less liveable, and the only access many would have to plants at all is through publicly maintained green spaces, or street trees that the council maintains. Reduced access to plants and gardens would deprive individuals of an understanding of and connection with the natural world and the environment; children in particular would be at risk from this falling access to nature provided by domestic gardens. Through prioritising domestic gardens and regreening grey space, UK physical and mental health can be transformed. Indeed, rapid changes in behaviour during the lockdown periods of the COVID-19 pandemic included increasing participation in gardening, in visiting nature reserves, parks and beauty spots and walking in the outdoors. Evidence were it needed of our innate desire for nature should circumstances and the design of our local environment enable and facilitate it.

Section 3: The Upper and Lower Case Scenarios for 2030

As outlined above, the two drivers have direct and intertwined implications, potentially positive and negative. By taking these and examining upper and lower case outcomes, below we set out a vision of two scenarios that demonstrate the most positive and negative possible outcomes facing the UK in 2030.

Upper Case Scenario: Green Living

Gardens, indoor work and living spaces play a key part in solving different challenges. Gardens consistently alleviate stress and anxiety and provide settings for exercise and enjoyment. They offer aesthetic beauty, a rich source of urban biodiversity, and improve air quality and the environment. New housing developments and the incorporation of green spaces over the 2020s has created an extra 56,000 hectares of domestic gardens, green spaces and features such as green roofs, and allotments since 2020. This expansion in access to green space enables access to the benefits of plants even without accessing public outdoor space. Gardens play a broad part in delivering broad social, economic and environmental benefits, and a focus on preserving Britain's gardens (and garden culture) has reversed the trend for them being paved over for parking, which has meant that valuable green space has been safeguarded. For children, the exposure to the natural world through being able to play in gardens, the experience of plants in indoor

habitats, balconies and window-sills gives invaluable learning and fosters their knowledge and understanding of the world. Marketing from the ornamental horticulture and landscaping industry to maintain and increase participation of different demographics, such as the RHS School Gardening Campaign and Britain in Bloom, has widened participation in gardening. The industry is working in tandem with government targets and aspirations, and supports the use of gardens and green spaces across the country to support environmental, social and health targets for the UK. The government plays its part in this by ensuring adequate green space is provided and protected in housing, and encouraging the use and adoption of regreening: using green roofs, encouraging the regreening of front gardens and more, and incentivising these improvements in much the same way and for the same reasons as loft insulation or the installation of solar panels.

In this scenario of 2030:

- Physical health is improved immensely through access and participation in gardening, with exercise improving the health of the population.
- Mental, social and physical health is boosted as citizens take part in gardening
- Indoor air quality is improved by houseplants
- Regreening restores domestic garden space across the country and improves lives and the environment
- Promotions to expand participation in gardening from the horticulture industry combined with changing demographics increases consumer spending
- More people understand food production, the natural environment and are inspired to change their behaviour to help reverse climate change and protect the natural world to sustain future generations

Lower Case Scenario: Grey Lives

In this scenario for 2030, understanding and appreciation of gardening has declined due to falling access to gardens. This is especially so among the younger generation of adults whose housing has less and less gardening space, with more and more of it being paved over or extended upon. As a result, the quality and liveability of the UK's housing and urban communities increasingly lags behind that of other developed nations. Economic growth in the ornamental horticulture and landscaping industry has occurred to some small extent compared with 2017, but largely driven by overall population growth and spend from established older gardeners who own their own houses; the next generation of gardeners increasingly lack gardens. This comparative stagnation in gardens and gardening has hindered government aspirations to improve lives and communities – the chat over the garden fence is increasingly rare. This environment has made it a challenge for industry initiatives to encourage participation in gardening to take root, fuelling a dearth of consumer knowledge and experience of gardening. The lack of greenery exacerbates air pollution and urban warming, increasing health risks. A lack of access to domestic gardens and a lack of experience with plants further distances a growing proportion of the population from nature – with less healthy development and a diminished understanding of plants and the natural world taking hold in the next generation.

In this scenario of 2030:

- Public health worsens where garden availability and quality falls, with non-communicable and lifestyle related diseases diseases growing more prevalent
- Parts of the UK population are losing a connection with nature and the environment which are set to ripple through the generations
- Mental health problems such as anxiety and depression accelerate in areas deprived of gardens and greenery
- Further paving over of gardens and a lack of interest in planting out gardens limits the potential for biodiversity gain and climate change mitigation in our towns and cities
- In some communities where domestic gardens are a rarity, a generation of children is disconnected from nature
- The horticulture and landscaping industry fails to deliver on its growth potential to the UK economy as consumer interest and available space in which to garden curtails demand and garden retail and services spending
- Workplace productivity gains from the provision of office plants and greenery are not realised

Section 4: Economic Model

To model the impact of increased green space and participation on gardening, the following approach, data and assumptions were used. For the increase in domestic garden space projections for domestic garden area and allotments were made to 2030. In the lower case scenario, an estimate of 655,000 hectares of domestic gardens and allotments as of 2019 is used as a baseline, drawing on source data from the ONS and industry surveys of domestic garden space. Using historical house building data and government house building aspirations, we project a net addition to the UK's housing stock of 2.4 million by 2030. In the upper case scenario we assume that 85% of these new homes will have gardens, with an average area per garden of 226 square metres; this is the same as for the current housing stock. In the lower case scenario, we assume that in this new housing half the proportion of new houses have their own garden (42.5%) and that the gardens provided are half the size of the average for the current housing stock (108 square metres). Within the existing 2019 housing stock, in the upper case scenario we assume a 1.75% increase in garden area (for instance through re-greening paved over gardens and drives and including the potential for green roofs and walls) and vegetation over 10 years; in the lower case scenario we assume a 1.75% decrease in garden space by 2030 (for instance through continuing the trend to pave over gardens for drives and home extensions).

For context, within the existing housing stock, the upper case scenario equates to a gain in garden/vegetated space equivalent to a two-by-two metre square area per household. In developing this assumption, account was also taken of potentially 'greenable' domestic areas such as roofs and walls. For instance an assessment of domestic roof area that is appropriate for photovoltaic power generation estimated that in the UK there were 771,000 hectares of potentially usable roofs receiving enough sunlight to generate power (and we would assume photosynthesis). The availability of such space as well as greening of existing paved over gardens is provided as an additional check as to the feasibility of the assumptions used.

We have performed modelling to assess the impact of this increase in space on economic activity in the supply and maintenance of these gardens, but only in relevant sectors of the industry. Specifically, garden tourism and the sections of landscaping, arboriculture and ornamentals production that are associated with amenity or non-domestic demand are assumed to be unaffected by this driver. Within retail, only the proportion of retail spend that would realistically increase in proportion to expanded green space is affected in the model. For instance, categories such as garden furniture and barbecues are excluded as increases in space/vegetated areas would be unlikely to affect consumer spending in these categories. The following table shows the potential extra contribution to the UK economy that would be generated annually by 2030 were the upper case scenario to be achieved as opposed to the lower case scenario.

Table 17: the difference in economic value delivered by the industry depending on upper and lower case scenarios based on the extent of domestic garden space by 2030

	2019 (655,000 hectares)	2030 (lower case scenario: 655,000 hectares)	2030 (upper case scenario: 711,000 hectares)
Direct GDP contributions (£m)	£13,801	£17,355	£17,853
Indirect GDP contributions (£m)	£7,289	£8,966	£9,168
Induced GDP contributions	£7,725	£9,605	£9,892
Total GDP contributions (£m)	**£28,815**	**£35,927**	**£36,912**
Direct employment	420,038	439,129	452,928
Indirect employment	141,074	147,380	150,405
Induced employment	113,137	118,069	121,732
Total employment	**674,248**	**704,578**	**725,065**
Direct tax revenue (£m)	£2,473	£3,046	£3,143
Indirect tax revenue (£m)	£1,694	£2,087	£2,134
Induced tax revenue (£m)	£2,118	£2,633	£2,712
Total tax revenue (£m)	**£6,285**	**£7,767**	**£7,989**

Participation in gardening would, normally, be driven substantially by habit and good weather. The industry has tended to report relatively modest increases in consumer spending year-on-year, which is typical for markets in the maturity stage of their life cycles. However, as noted in this chapter the Covid-19 lockdown led to increased participation in gardening in the order of 10% to 15%, with around 3m UK adults more doing gardening in 2020 than in 2019. This suggests latent demand for gardening, with the potential for this to be energised by the trends described in this report. By contrast, we have also noted that consumer spending on gardening is concentrated in older age groups; this makes the industry potentially vulnerable to competition from other leisure sectors aggressively targeting the 'grey pound' as an opportunity for growth in the next decade.

However, we assume for this modelling that the vast majority of increased or decreased participation would be driven by factors outside of the control of the ornamental horticulture and landscaping industry collectively. Consequently we have modelled the potential effect of an additional 0.25% increase in gardening driven by sustained cross-industry activity and promotions, and a 1% decline in gardening due to increased competition from other leisure sectors. It should be noted that these figures refer to extra increases or

decreases in participation over and above that driven by factors described in this report. The assumptions used are deliberately conservative; many of the industry's most impactful initiatives to increase participation in gardening have been built up over decades. Conversely the ingrained gardening habits of millions of keen gardeners are likely to be difficult for competing sectors to win over to competing leisure pursuits. The following table shows the impact on the industry's contributions to the UK economy which would result from these comparatively modest assumptions.

Table 18: the difference in economic value delivered by the industry depending on increases or decreases in participation in gardening driven by industry activity or competition from other industries.

	2019	**2030 (lower case scenario: 1% fall in participation)**	**2030 (upper case scenario: 0.25% increase in participation)**
Direct GDP contributions (£m)	£13,801	£17,295	£17,370
Indirect GDP contributions (£m)	£7,289	£8,943	£8,972
Induced GDP contributions	£7,725	£9,573	£9,614
Total GDP contributions (£m)	**£28,815**	**£35,811**	**£35,955**
Direct employment	420,038	437,428	439,554
Indirect employment	141,074	147,033	147,467
Induced employment	113,137	117,646	118,175
Total employment	**674,248**	**702,107**	**705,196**
Direct tax revenue (£m)	£2,473	£3,034	£3,049
Indirect tax revenue (£m)	£1,694	£2,082	£2,089
Induced tax revenue (£m)	£2,118	£2,625	£2,636
Total tax revenue (£m)	**£6,285**	**£7,741**	**£7,773**

Chapter 4:

Research and development, science and biosecurity – key foundations and enablers of growth

Chapter summary

Biosecurity as well as research and development underpin all the other drivers in this report – without them the growth described in this report is unlikely to be fully achieved. For this reason the format of this chapter is different; there is no section with discrete economic modelling as the value of each driver is primarily in unlocking and enabling the other growth drivers described in this report. Biosecurity is a critical factor in ensuring that UK public green space, trees and forests, gardens and private land stays healthy and useful, and in mitigating the risk of a major pest or disease outbreak such as Xylella Fastidiosa which could cause huge immediate and lasting damage to the industry's contribution to the UK economy as well as natural and social capital. While a complex landscape, biosecurity policies can be divided into three main categories: improving efficiency, developing best practice protocols and using technology to improve resilience.[114] These different policies can be instrumental in both improving the resilience of the industry and reducing the risk of outbreaks: ash dieback alone is predicted to cost an estimated £14.8bn to the UK economy over the next hundred years.[115]

Just as integral to the success of UK green space, research and development underwrites the UK horticulture and landscaping industry's capability to design and deliver green spaces for improved plant, human and environmental health, while also breeding and producing the plants to populate such spaces in increasingly efficient and sustainable businesses. It is also critical in driving operational gains in productivity and sustainability throughout the supply chain, for instance in accelerating a transition away from peat in growing media, optimising water efficiency in irrigation, reducing wastes, and developing new equipment, technologies and automations across the supply chain. Climate change is fast approaching and the findings from new research could lead to new varieties of plants that could help to adapt to and mitigate the effects of climate change thereby saving lives – potentially developing growth opportunities in the breeding and marketing of plants that have been selectively bred and researched to be (for instance) climate resilient or drought resistant whilst providing enhanced eco-system services. However, without a clear drive towards better research and systems for effective knowledge transfer to practitioners and gardeners, the UK risks lagging behind: a decline in funding risks excluding the UK from opportunities for growth, and delivering on policy ambitions for the environment and green economic growth. There is a significant domestic need for functional plants and green city design services, but also a global one: the UK has the opportunity to be a global leader in knowledge and new technologies, plants and policies that transform the world's cities and urban spaces.

114 "The HIP Ornamental & Landscape Horticulture R&D Strategy 2015 – 2020" The Horticulture Innovation Partnership, 2015
115 University of Oxford, Fera Science, Sylva Foundation and the Woodland Trust, 2019

Biosecurity policies have included good practice and intentions to date, but there are opportunities to focus resources on species and situations of greatest risk. In addition, through better access to, and smoother collection of, traceability data – the UK can improve its biosecurity landscape, thereby maximising protections while minimising administrative processes such that they do not impede productivity unnecessarily. By combining more funding, better research and more dialogue with UK horticulture and landscape industries, the UK can avoid long term problems while becoming a global leader in plant science and urban greening.

In this chapter we examine upper and lower case scenarios based on the potential outcome of two key drivers influencing the growth potential of Ornamental Horticulture and Landscaping industry. The first driver is the extent to which the UK horticulture and landscaping industry is able to develop its scientific research and development capability relating to the industry's whole value chain. The second driver relates to the extent to which the industry and government succeed in maintaining effective biosecurity safeguards that facilitate domestic and international trade flows and operational efficiency and effectiveness. In section 1 summarise each of the drivers. In Section 2, we examine their potential impact and implications for growth in the ornamental horticulture and landscaping industry. In Section 3 we describe upper and lower case scenarios for the industry in 2030 based on potential outcomes of the drivers. As these drivers are essentially enablers of economic growth described elsewhere in this report, in this chapter we do not present data on additional jobs and taxes generated by research and development not on negative impacts that might result from a major biosecurity incident. However, we do present summary data on the potential economic impact of investment in plant breeders' rights, which have the potential to deliver growth in the UK and overseas.

Biosecurity policies have included good practice and intentions to date, but there are opportunities to focus resources on species and situations of greatest risk through better access to, and smoother collection of, traceability data

Section 1: The Key Drivers

Below we outline a summary of two key drivers that will shape the future contribution of the UK ornamental horticulture and landscaping industry to the UK economy, as well as the primary features of each driver that will propel such growth potential.

Driver 1 – Advancing horticultural and green space science

- Horticultural and landscaping science as part of the life sciences is set to continue to advance rapidly. There is potential for research into the beneficial nature-based traits of plants, and to develop nature-based solutions using cultivated plants and landscapes, and into breeding of plants with desirable aesthetic and environmentally beneficial traits
- New R&D into the science of public green spaces that mitigate the effects of climate change, foster biodiversity and deliver social, physical and mental health benefits is advancing.
- Life sciences, in particularly horticultural science research that enables pest and disease resistance could further amplify the potential benefits of other drivers discussed in this report, such as urban greening; new breeding techniques could enable plants to be grown in different ways and for different situations more easily and efficiently: e.g. for green roofs, or living walls.

Driver 2 – A bio-secure and plant healthy UK

- Biosecurity is a 'hygiene factor' for all the drivers covered in this report: without maintaining strong biosecurity protocols and policies, urban green space, urban trees and ornamental horticulture and landscaping as a whole will risk being continuously devastated by pests and disease; the damage to UK natural capital from such an incident has in the past been above £10bn.
- Strong policies that facilitate the smooth flow of trade to supply the anticipated expansion in green spaces need to be evolved, especially in the context of delays and additional costs to businesses that have occurred relating to cross-border trade and biosecurity in the immediate period after Brexit.
- Biosecurity best practice needs to be seamlessly integrated within businesses in order for them to prevent any problems from occurring, and to be able to react and respond agilely to changes or new problems.

Section 2: Joint Impact of the Drivers – Potential Positive and Negative Outcomes

Part 1: Potential Positive Outcomes

Horticultural and landscape science as part of the life sciences has delivered, and has the potential to deliver more, incredible feats in creating new breeds of plants and cultivated landscapes with optimised and beneficial environmental, human and plant health benefits. This will enable plants to be grown on roofs or other surfaces, or to be grown with more efficient use of inputs such as water, energy, growing media or chemicals by amateur gardeners or at a commercial scale.

The commercial benefits that investment in horticultural science can bring are far reaching. Plant breeders' rights, where income can be generated for plant breeders through 'royalties' on protected rights over plants bred for desirable traits, can be significant not only for breeders themselves, but onward through the supply chain where price premiums can be obtained for these desirable traits. The breeding of new plants is recorded and documented by the organisation UPOV (International Union for the Protection of New Varieties of Plants), and according to their data, they have seen an enormous leap in China's PBR applications – surpassing the EU in 2017 and more than doubling their applications by 2019.[116] The UK has little presence in this global system, but the potential for making significant inroads could be prompted by investment into plant science and R&D more generally.

In 2020, the HTA commissioned a consumer survey with YouGov into the additional price consumers would be prepared to pay for an ornamental plant that with traits such as drought tolerance, greater pollen production to support wildlife, and greater pest and disease resistance. Overall consumers valued these traits at 10% price premium. To provide a brief illustration of potential returns from investment in this type of intellectual property, we modelled the effect on the industry's contribution to the economy of being able to charge a 10% price premium on 5% of plants supplied to the UK in 2030. Whilst this is potentially generous and should be treated as indicative only, no account has been taken of potential international demand for plants with desirable aesthetic or functional traits. As the effects of climate change and the size of the global middle class increase over the next decade there is strong, but as yet unquantified potential demand that the UK industry could meet.

116 International Union for the Protection of New Varieties of Plants, Graphic 1: Top 10 UPOV members by number of PBR applications received (1998–2019)

Table 19: the difference in economic contributions between upper and lower case scenarios for the industry based on modelling of price premiums resulting from breeding plants with desirable aesthetic and environmental traits.[117]

	Difference between 2030 upper and lower scenarios
Direct GDP contributions (£m)	£78
Indirect GDP contributions (£m)	£31
Induced GDP contributions (£m)	£42
Total GDP contributions (£m)	**£151**
Direct employment	-
Indirect employment	452
Induced employment	509
Total employment	**1,010**
Direct tax revenue (£m)	£3
Indirect tax revenue (£m)	£7
Induced tax revenue (£m)	£11
Total tax revenue (£m)	**£22**

The alignment of government policy goals, academic and research institutions, and industry in an R&D programme is a clear opportunity for the UK. In The Netherlands, this is referred to as the "triple helix", where research is applied by industry without duplication, and with alignment with government policy delivery. Part of the core principle behind this structure is the development of a "proper working relationship and a common language"[118], with new development not straying into significantly ambitious territory (which would put it out of reach for SMEs) and innovation and ambition taking a tempered, measured approach, whereby knowledge is shared and co-production can be reached in a step by step manner. This can ensure that innovation is applicable in practice, that government has consistent conversations with both industry and R&D researchers, and that any policies that are put into place by government are formulated with the industry in mind.

Pests and disease are one of the biggest threats not only to ornamental horticulture and landscaping, but British wildlife and ecosystems as a whole. Ash dieback – the disease causing ash trees across the country to die – is predicted to cost £15bn to the UK economy over the next 100 years.[119] The cost of foot and mouth disease (in 2001) was £3bn to the agriculture and food chain, and about £3bn to the tourism industry[120]; ash dieback will cost many times more, and yet is much less well known. Another 47 known diseases and pests can enter the UK over the next decade that could cost an additional £1bn[121] – requiring action and policy development.

However, the potential costs of an outbreak can also be weighed against the costs to productivity of plant health measures so far implemented in the immediate wake of the UK's exit from the EU. At the time of writing this report the cost to the UK industry of the additional paperwork, inspections and overheads associated with customs declarations and bio-security controls was substantial, with businesses experiencing additional costs of approximately £200 per consignment of plants or plant material crossing into the UK.

The alignment of government policy goals, academic and research institutions, and industry in an R&D programme is a clear opportunity for the UK.

117 The lower case for 2030 scenario is based on no growth over a central growth forecast for the industry. The upper case scenario is based on being able to command a 10% price premium on 5% of plants sold in 2030 attributable to desirable genetic traits protected through plant breeders' rights.

118 Geerling-Eiff, Florentien A.; Hoes, Anne-Charlotte; Dijkshoorn-Dekker, Marijke. (2017). Triple helix networks matching knowledge demand and supply in seven Dutch horticulture Greenport regions, Studies in Agricultural Economics 119 (2017)1. - ISSN 1418-2106 - p. 34 - 40.

119 Louise Hill, Glyn Jones, Nick Atkinson, Andy Hector, Gabriel Hemery, Nick Brown. (2019). The £15 billion cost of ash dieback in Britain, Volume 29, ISSUE 9, PR315-R316, May 06, 2019. https://doi.org/10.1016/j.cub.2019.03.033

120 THOMPSON, D.K. & Muriel, P & Russell, D & Osborne, P & Bromley, A & Rowland, M & Creigh-Tyte, S & Brown, C. (2003). Economic Costs of the Foot and Mouth Disease Outbreak in the United Kingdom in 2001. Revue scientifique et technique (International Office of Epizootics). 21. 675-87. 10.20506/rst.21.3.1353.

121 Louise Hill, Glyn Jones, Nick Atkinson, Andy Hector, Gabriel Hemery, Nick Brown. (2019). The £15 billion cost of ash dieback in Britain, Volume 29, ISSUE 9, PR315-R316, May 06, 2019. https://doi.org/10.1016/j.cub.2019.03.033

Production quality standards such as The Ornamental Horticulture Assurance Standard provide assurance and risk mitigation around biosecurity and plant health.

Biosecurity and plant science can go hand in hand, but changes to the industry have to accompany any successes plant science may see. Advances in breeding for pest and disease resistance have been significant over the last decade, with many different techniques improving them considerably.

Production quality standards such as The Ornamental Horticulture Assurance Standard provide assurance and risk mitigation around biosecurity and plant health, whilst also helping to drive quality, sustainability and business efficiency, for instance.[122] This standard, among many different benefits, provides full traceability for products, a framework to manage staff and develop skills, and of course ways to certificate and ensure legal compliance for products. Through the development of this type of biosecurity standard, ornamental horticulture buyers in the UK can have assurance of safety, while the government and environmental bodies can also have confidence.

Biosecurity policies can be divided into three main sections: improving efficiency, developing best practice protocols, and using technology to improve resilience.[123] These different policies can be instrumental in both improving the resilience of the industry and reducing the risk of outbreaks. The UK has a number of biosecurity strategies, and through disseminating policies that it has developed and educating the different parties about their nuances, future outbreaks and other problems can be avoided. However, even if the strategies are in place, these strategies need to be embraced by businesses. The ideal, in many instances, would be that resource and cost – both for industry and the public purse – would be focused on areas of realistic threat, for example high risk species, and not the application of identical measures and resultant costs across all plants irrespective of risk. Through developing a program to enable proportionate focus on the highest risk species and situations, this has the potential avoid undue costs while still protecting the UK. Businesses faced with a constantly changing landscape of policies face a risk of significant financing problems and potentially can take a longer period of time to implement them properly. Better availability and analysis of data on plant movements, for instance on trade flows of higher risk species and/or species could enable much of this. As data and information technology advances over the next decade, the potential to automate the collection and transfer of data on plant movements through the supply chain will increase, in turn helping to reduce costs associated with manual record keeping and duplicating information submissions by businesses on goods moving through the supply chain.

The ideal, in many instances, would be that resource and cost – both for industry and the public purse – would be focused on areas of realistic threat, for example high risk species.

Tracing plant movements, especially across borders, could allow the industry and inspectors to have a better idea of which plants are present in which areas in real time, as well as where they've been and originated from. Use of and access to such data has the potential to determine which of the areas in the supply and distribution chain are the highest risk, and can focus efforts on those particular areas. Open access to such data could also provide business insights for the UK industry, helping to build competitive advantage over competing industries through improved insights into demand and potential supply chain efficiencies. Analysis can also lend itself to the prediction of outbreaks or other problems. New research has proposed a big data analysis platform via cloud computing that enables the

122 HTA OHAS Compliance: https://hta.org.uk/assurance-compliance/ohas.html
123 "The HIP Ornamental & Landscape Horticulture R&D Strategy 2015 – 2020" The Horticulture Innovation Partnership, 2015

prediction of hot spots on farms, preventing damage from setting in and destroying plants.[124] This strategy, when used in conjunction with biosecurity strategies and analytics that determine the origin and travel path of different plants, could enable all parties involved to be more aware of the different threats well in advance of their arrival.

In chapter 2 we noted the potential for the industry to deliver sustainable productivity growth through R&D. One specific area of potential in in the transition away from peat-based to more sustainable growing media. Such a transition, particularly in ornamental crop production, will rely on research into the performance and management of peat-alternatives to maximise yields. There is also potential for research into paludiculture, both as a means of producing sphagnum moss as a peat alternative and also in restoring of former peat extraction sites.

Through a careful adoption of and through further investment in horticultural and landscape science, facilitating the development of local and home grown ornamental plants and a strong adherence to extant and improved biosecurity protocols, the UK can substantially mitigate biosecurity risks while strengthening its native industry. Even if outbreaks still occur, policies and protocols in place can mitigate their damage and contain them to a specific location, reducing the risk of problems on the scale of ash dieback.

Part 2: Potential Negative Outcomes

A continued reduction in R&D funding coupled with inadequate biosecurity funding would trace a steep decline in the competitiveness of the British ornamental horticulture and landscaping industry coupled with disastrous and expensive issues with pests and disease outbreaks. The UK biosecurity policy has some significant challenges, but the vast majority of actors are able to operate within the policies and protocols laid out. Should the maintenance, costs and burdens become unenforceable or unsustainable for the public purse or industry, the economic and environmental harm could be devastating.

The conclusion from the review was that investment had fallen from around £14m in 1985 to around £3m in 2015.

Horticultural science funding in the UK is declining – but "the number of applications to study aspects of fundamental plant science is declining at a faster rate"[125]. In 2018, RHS and AHDB conducted a review of scientists working in ornamental horticulture and their publications. This enabled estimates of the level of historical investment in R&D in ornamental horticulture to be made. The conclusion from the review was that investment had fallen from around £14m in 1985 to around £3m in 2015. The withdrawal from the EU could accelerate this further, with a sharp decrease in funding from the European Research Council. In a review of plant science funding, the organisation GARNet has claimed that a decrease in funding leads to a decline in the willingness of researchers to engage in the review and selection process – which in turn leads to reduced funding. As a result, the UK could see a dearth of new findings, especially when these new findings have the potential to be so important. Climate change will have an effect on every country on earth, and the findings from new research could lead to climate resistant species that could save lives – and potentially develop a new industry of plants that have been selectively bred and researched to be resistant. Through this decline in new research and funding, the UK could be potentially completely excluded from this process, and any benefits that come with it.

By failing to compete globally in terms of R&D and its funding, much of the required research to provide nature-based solutions to environmental and social issues will be conducted late or not at all.

A lack of innovative and well researched green space design, with the loss in natural and social capital value as a result, will be a further result of a lack of R&D funding. Quality adjusted life years will be lost unnecessarily through pollution or climate change related issues, natural capital losses have the potential to be in the billions compared with the upper case scenario. Also, the UK will miss out on the opportunity of being a global leader in the development of the science required to make the world's cities liveable in the future. By failing to compete globally in terms of R&D and its funding, much of the required research to provide nature-based solutions to environmental and social issues will be conducted late or not at all. This will mean that the UK horticulture and landscaping industry will be at a disadvantage compared

124 Li, Cecil & Dutta, Ritaban & Smith, Daniel & Das, Aruneema & Aryal, Jagannath. (2015). Farm biosecurity hot spots prediction using big data analytics. Proceedings - International Conference on Data Engineering. 2015. 101-104. 10.1109/ICDEW.2015.7129555.
125 "Support for Basic Plant Science", GARNet, 2018

with its global competitors in terms of growth, and ability to support government in realising its policy ambitions for the environment. Looking beyond the UK, without adequate investment in R&D the industry will be in a significantly weaker position with respect to global opportunities presented by rising international demand for plants and managed urban green spaces.

The result of an outbreak such as Xylella fastidiosa would result in the mandatory destruction of all plants in a certain radius of the outbreak, and a total plant movement ban which would force many horticultural businesses to close.

Biosecurity is pertinent to most opportunities for potential growth identified in this report. For instance, London's mayor has committed to increasing the tree canopy of the city by 10% by 2050[126] – an enormously valuable idea that will serve a variety of different functions. However, pests or diseases could, in the worst cases cause such damage as to severely impact this aspiration. The fungus Ceratocystis platani specifically infects plane trees, which although only makes up 4% of London's trees, makes up almost 10% of the leaf area, and so provides significant benefit to the urban population.[127] A loss of these trees (which can be destroyed by pests in less than a decade) would reduce the amount of CO2 sequestered (London Plane, composes just 1.4% of the tree population but stores 6% of the total carbon[128]). The loss of these trees would also severely impact shading and reducing mitigation of urban heat islands, as well as noise pollution. The value of tree stored carbon in Greater London alone is estimated at £142 million[129] – a substantial loss if these trees were destroyed by pests.

The other significant effect of an outbreak would be the devastation of UK horticulture, landscaping, and trade: other markets would be reticent to purchase UK grown plants. More qualitatively, the damage to that part of UK's global image among tourists as a nation of beautiful parks and gardens would suffer significant and lasting harm. The result of an outbreak such as Xylella fastidiosa would result in the mandatory destruction of all plants in a certain radius of the outbreak, and a total plant movement ban which would force many horticultural businesses to close, and potentially become insolvent.[130] By protecting biosecurity in the UK in the present, and consistently improving the already positive and powerful protocols and policies that are already in place, the UK can ensure the safeguarding of the other nascent policies across other areas, while also defending other sectors such as agriculture.

126 "Tree Canopy Cover Map", Mayor of London Office
127 "Valuing London's Urban Forest", Results of the London i-Tree Eco Project, 2015
128 Ibid
129 "Valuing London's Urban Forest", Results of the London i-Tree Eco Project, 2015
130 "Pest Specific Plant Health Response Plan", Xylella fastidiosa, DEFRA, May 2019

Section 3: The Upper and Lower Case Scenarios for 2030

As outlined above, the two drivers have direct and intertwined implications, potentially positive and negative. By taking these and examining the best- and worst-case outcomes, below we set out a vision of two scenarios that demonstrate the most positive and negative possible outcomes facing the UK in 2030.

Upper Case Scenario: Bio-secure and Blooming

Where R&D flourishes and biosecurity regimes are implemented in a manner sympathetic to growth, we see the ornamental horticulture and landscaping industry playing a major part of the UK's global lead in the life sciences. Commissioning, delivery and knowledge transfer of research findings is co-ordinated to deliver policy, commercial growth, and environmental benefit to the UK. In this scenario, by 2030 the UK's approach to biosecurity has developed and is embedded into the value chain from production standards to logistics and international trade flows. Far from restricting growth, standards and policies drive business best practice and facilitate trade. One example of this is in readily available data on plant movements that requires a minimum of data entry and administration for businesses in the supply chain. This has enabled planning and productivity gains to be identified by the industry, and real-time insights on bio-security risk to be available to government. The UK industry's leading position in these respects amplifies the benefits that the other market drivers described in this report touch upon.

By 2030 in this scenario, significant growth has been underpinned by research and development. The UK's production of plants is more water and energy efficient, and has transitioned away from peat-based growing media to more sustainable alternatives. Evidence-based guidance for urban planners has been developed to inform the optimum configuration and design of urban green spaces to maximise natural capital benefits. An already strong position in plant science has developed to position the UK as a leader in plant breeding, and UK scientists are recognised as being at the forefront of breeding plants that are at the centre of nature-based solutions to the effects of climate change. The knock-on effects of this type of plant breeding, including the increased effectiveness and natural capital value derived from our urban green space will help to accentuate and drive the other positive scenarios. Government and industry collaboration and funding of R&D has been the cornerstone of growth over the 2020s enabling the industry to be a global leader in 2030.

In this scenario of life in 2030:

- The UK is a world leader in the prevention of biosecurity threats, and sets the standards that other countries to follow
- UK horticultural science as part of the life sciences has expanded to create new ways for plants to be used in urban environments, such as green roofs or walls, and becomes a world leader in innovation
- Growers in the UK are able to use new and expanded greenhouses with more rain-water harvesting and reservoir capacity, enabling a much broader variety of products to be produced locally
- Local growers see a substantial rise in popularity as plants that could formerly be grown only overseas are grown in the UK.
- Increased GDP contributions to the UK economy accrue from plants for aesthetic and environmental purposes, UK and globally from the intellectual property generated on plant science and expertise in urban green space design and maintenance.

Lower Case Scenario: Isolated and Uncompetitive

With a continuing reduction in R&D funding, in 2030 the UK ornamental horticulture and landscaping industry has fallen behind international competitors. At the same time, reduced funding leads to UK being less competitive, and less able to produce and develop plants and design effective green spaces into its towns and cities as effectively as other countries. This impacts on the economic contribution of the industry, and the relative quality of life of UK citizens in comparison with citizens of other nations. The UK's life sciences are disadvantaged in global competitive terms by the UK's position as a follower rather than a leader in developments in horticultural and landscape science. Plants with desirable aesthetic and environmental traits are increasingly supplied by overseas growers and breeders. Inefficient and expensive biosecurity regimes create administrative burdens and costs across supply chains for government and businesses alike. Opportunities to use data to focus inspections on species and points in the trade network that carry the greatest biosecurity risks are missed, driving costs and inefficiencies for government. Inspection resources are spread too thin in the absence of data on plant movements, increasing the risk posed by biosecurity events. Due to the lack of investment in plant breeding science, the UK's position in terms of global exploitation of plant breeder's rights is almost non-existent. In this version of 2030 a vicious circle exists with regard to green spaces: a lack of knowledge and evidence on their benefits and optimisation leads to their relative decline, creating less liveable cities with resulting natural capital value loss, impacts on the environment, health and biodiversity.

In this scenario of life in 2030:

- UK R&D is underfunded and uncoordinated and falls short of its potential to deliver knowledge to underwrite social and environmental policy ambitions and industry growth
- Biosecurity arrangements in the UK are cumbersome, with 'one-size-fits-all' approaches prevailing that creates a heavy administrative burden for government and business alike whilst missing opportunities to identify and focus resources on areas of highest risk
- New techniques and ways of increasing efficiency aren't undertaken, leaving demand satisfied by overseas competitors for the supply of plants for the UK's green spaces and the professional services related to their landscaping, maintenance and design.

Appendix one: Data by sector and nation of the industry on the impact of the key growth drivers to 2030

As part of the modelling for the overall industry, more detailed evaluation of the potential growth of the different sectors of ornamental horticulture and landscaping has been performed. In summary, a central growth projection for each sector of the ornamental horticulture and landscaping sector was prepared on the assumption that the sector would grow in-line with forecasts for similar areas of the UK economy. The impact of each driver of growth covered in this report (with the exception of biosecurity and research and development which are enablers of the other drivers) was plotted for each sector of the ornamental horticulture and landscaping industry.

Not every driver has an effect on every sector. For instance, expansion in non-domestic green spaces has no effect on garden retail as it is not concerned with the supply of plants or products to government, corporate or amenity customers. The drivers can also drive either a positive or negative variation away from the central growth forecast. For instance, the upper-case scenario on labour supply is the same as the central growth projection for each sector, as adequate labour supply is essential for achieving even this growth. The lower-case scenario – based on potential shortfalls in labour supply – falls short of this central case forecast. By contrast productivity gains provide 'upside' to the central growth forecast.

The following tables show the detailed results of the scenario modelling for each of the UK nations and sectors of the industry. Four tables are provided. The first shows an assessment of economic contributions by sector and nation in 2019. The second, third and fourth tables show respectively the economic contributions generated in 2030 in the lower, mid-case, and upper-case scenarios that were modelled. As noted in the commentary to this report and the appendix on methodology, upper and lower-case scenarios were developed based on the outcomes of the different drivers explored in this report. The assessments for the UK nations have been prepared based on an assessment of the macro-economic relationships between different industries and sectors across the different nations of the UK; separate modelling of the different drivers (for instance productivity/capacity gain or expansion or contraction of green space) has not been performed at sub-UK levels. Tourism contributions are not provided at sub-UK levels due to a lack of data on garden tourism at the level of individual nations within the UK. As elsewhere in the report, all figures in the tables are presented in constant 2019 prices.

Table 20: 2019 Economic contribution of the ornamental horticulture and landscaping industry split by nation and sector.

Nation	Indicator	Type	Units	Garden goods	Ornamental Plants	Landscape services	Arboriculture	Retail	Wholesale	Domestic Tourism	International Tourism
UK	GVA (£m)	Direct	£m	£511	£882	£7,646	£590	£2,156	£565	£361	£1,091
UK	GVA (£m)	Indirect	£m	£415	£244	£2,549	£615	£752	£389	£585	£1,740
UK	GVA (£m)	Induced	£m	£394	£521	£3,179	£933	£1,204	£403	£282	£808
UK	Employment (Persons)	Direct	Persons	11,309	17,798	238,114	18,529	86,850	9,556	11,536	26,347
UK	Employment (Persons)	Indirect	Persons	6,665	5,316	46,448	11,230	11,662	7,083	15,519	37,151
UK	Employment (Persons)	Induced	Persons	5,773	7,635	46,562	13,660	17,639	5,907	4,133	11,827
UK	Taxes (£m)	Direct	£m	£123	£142	£1,063	£146	£532	£135	£87	£245
UK	Taxes (£m)	Indirect	£m	£96	£49	£626	£131	£165	£96	£139	£394
UK	Taxes (£m)	Induced	£m	£108	£143	£873	£253	£331	£111	£77	£221

Table 20 (continued)

Nation	Indicator	Type	Units	Garden goods	Ornamental Plants	Landscape services	Arboriculture	Retail	Wholesale	Domestic Tourism	International Tourism
Scotland	GVA (£m)	Direct	£m	£72	£13	£936	£140	£169	£51		
Scotland	GVA (£m)	Indirect	£m	£58	£3	£312	£146	£59	£35		
Scotland	GVA (£m)	Induced	£m	£55	£7	£389	£221	£94	£37		
Scotland	Employment (Persons)	Direct	Persons	1,173	344	28,771	4,222	6,888	996		
Scotland	Employment (Persons)	Indirect	Persons	692	103	5,612	2,559	925	739		
Scotland	Employment (Persons)	Induced	Persons	599	147	5,626	3,113	1,399	616		
Scotland	Taxes (£m)	Direct	£m	£17	£2	£130	£35	£42	£12		
Scotland	Taxes (£m)	Indirect	£m	£13	£1	£77	£31	£13	£9		
Scotland	Taxes (£m)	Induced	£m	£15	£2	£107	£60	£26	£10		
Northern Ireland	GVA (£m)	Direct	£m	£10	£55	£169	£13	£49	£17		
Northern Ireland	GVA (£m)	Indirect	£m	£8	£15	£56	£13	£17	£12		
Northern Ireland	GVA (£m)	Induced	£m	£7	£33	£70	£20	£27	£12		
Northern Ireland	Employment (Persons)	Direct	Persons	265	1,289	5,823	440	2,314	355		
Northern Ireland	Employment (Persons)	Indirect	Persons	156	385	1,136	266	311	263		
Northern Ireland	Employment (Persons)	Induced	Persons	135	553	1,139	324	470	220		
Northern Ireland	Taxes (£m)	Direct	£m	£2	£9	£24	£3	£12	£4		
Northern Ireland	Taxes (£m)	Indirect	£m	£2	£3	£14	£3	£4	£3		
Northern Ireland	Taxes (£m)	Induced	£m	£2	£9	£19	£5	£7	£3		
Wales	GVA (£m)	Direct	£m	£22	£27	£290	£84	£95	£10		
Wales	GVA (£m)	Indirect	£m	£18	£8	£97	£88	£33	£7		
Wales	GVA (£m)	Induced	£m	£17	£16	£120	£133	£53	£7		
Wales	Employment (Persons)	Direct	Persons	302	678	11,402	3,387	3,770	224		
Wales	Employment (Persons)	Indirect	Persons	178	202	2,224	2,053	506	166		
Wales	Employment (Persons)	Induced	Persons	154	291	2,230	2,497	766	138		
Wales	Taxes (£m)	Direct	£m	£5	£4	£40	£21	£24	£2		
Wales	Taxes (£m)	Indirect	£m	£4	£2	£24	£19	£7	£2		
Wales	Taxes (£m)	Induced	£m	£5	£4	£33	£36	£15	£2		
England	GVA (£m)	Direct	£m	£407	£786	£6,251	£354	£1,843	£486		
England	GVA (£m)	Indirect	£m	£331	£218	£2,084	£368	£643	£335		
England	GVA (£m)	Induced	£m	£314	£465	£2,599	£559	£1,030	£347		
England	Employment (Persons)	Direct	Persons	9,568	15,488	192,118	10,480	73,877	7,980		
England	Employment (Persons)	Indirect	Persons	5,639	4,626	37,475	6,351	9,920	5,916		
England	Employment (Persons)	Induced	Persons	4,885	6,644	37,568	7,726	15,004	4,933		
England	Taxes (£m)	Direct	£m	£98	£126	£869	£88	£455	£116		
England	Taxes (£m)	Indirect	£m	£76	£44	£512	£78	£141	£82		
England	Taxes (£m)	Induced	£m	£86	£128	£714	£152	£283	£95		

Table 21: 2030 lower-case economic contribution of the ornamental horticulture and landscaping industry split by nation and sector.

Nation	Indicator	Type	Units	Garden goods	Ornamental Plants	Landscape services	Arboriculture	Retail	Wholesale	Domestic Tourism	International Tourism
UK	GVA (£m)	Direct	£m	£443	£837	£9,052	£701	£2,347	£615	£358	£1,154
UK	GVA (£m)	Indirect	£m	£375	£234	£3,041	£736	£828	£429	£584	£1,855
UK	GVA (£m)	Induced	£m	£335	£497	£3,776	£1,111	£1,313	£439	£280	£857
UK	Employment (Persons)	Direct	Persons	8,455	15,575	219,381	17,126	90,107	9,914	10,290	25,114
UK	Employment (Persons)	Indirect	Persons	5,190	4,682	43,065	10,445	12,214	7,426	13,931	35,637
UK	Employment (Persons)	Induced	Persons	4,227	6,709	43,078	12,678	18,337	6,137	3,702	11,321
UK	Taxes (£m)	Direct	£m	£107	£135	£1,263	£174	£581	£147	£87	£260
UK	Taxes (£m)	Indirect	£m	£87	£47	£747	£156	£181	£105	£138	£420
UK	Taxes (£m)	Induced	£m	£92	£137	£1,037	£302	£361	£121	£77	£235
Scotland	GVA (£m)	Direct	£m	£62	£12	£1,108	£166	£184	£56		
Scotland	GVA (£m)	Indirect	£m	£53	£3	£372	£174	£65	£39		
Scotland	GVA (£m)	Induced	£m	£47	£7	£462	£263	£103	£40		
Scotland	Employment (Persons)	Direct	Persons	877	301	26,507	3,903	7,147	1,034		
Scotland	Employment (Persons)	Indirect	Persons	539	90	5,203	2,380	969	774		
Scotland	Employment (Persons)	Induced	Persons	439	130	5,205	2,889	1,454	640		
Scotland	Taxes (£m)	Direct	£m	£15	£2	£155	£41	£46	£13		
Scotland	Taxes (£m)	Indirect	£m	£12	£1	£91	£37	£14	£10		
Scotland	Taxes (£m)	Induced	£m	£13	£2	£127	£71	£28	£11		
Northern Ireland	GVA (£m)	Direct	£m	£8	£53	£200	£15	£53	£19		
Northern Ireland	GVA (£m)	Indirect	£m	£7	£15	£67	£16	£19	£13		
Northern Ireland	GVA (£m)	Induced	£m	£6	£31	£84	£24	£30	£14		
Northern Ireland	Employment (Persons)	Direct	Persons	198	1,128	5,365	406	2,401	369		
Northern Ireland	Employment (Persons)	Indirect	Persons	122	339	1,053	248	325	276		
Northern Ireland	Employment (Persons)	Induced	Persons	99	486	1,054	301	489	228		
Northern Ireland	Taxes (£m)	Direct	£m	£2	£8	£28	£4	£13	£5		
Northern Ireland	Taxes (£m)	Indirect	£m	£2	£3	£17	£3	£4	£3		
Northern Ireland	Taxes (£m)	Induced	£m	£2	£9	£23	£6	£8	£4		
Wales	GVA (£m)	Direct	£m	£19	£26	£343	£100	£104	£11		
Wales	GVA (£m)	Indirect	£m	£16	£7	£115	£105	£37	£8		
Wales	GVA (£m)	Induced	£m	£15	£15	£143	£159	£58	£8		
Wales	Employment (Persons)	Direct	Persons	226	593	10,505	3,131	3,911	232		
Wales	Employment (Persons)	Indirect	Persons	139	178	2,062	1,909	530	174		
Wales	Employment (Persons)	Induced	Persons	113	255	2,063	2,318	796	144		
Wales	Taxes (£m)	Direct	£m	£5	£4	£48	£25	£26	£3		
Wales	Taxes (£m)	Indirect	£m	£4	£1	£28	£22	£8	£2		
Wales	Taxes (£m)	Induced	£m	£4	£4	£39	£43	£16	£2		

Table 21 (continued)

Nation	Indicator	Type	Units	Garden goods	Ornamental Plants	Landscape services	Arboriculture	Retail	Wholesale	Domestic Tourism	International Tourism
England	GVA (£m)	Direct	£m	£353	£747	£7,400	£420	£2,007	£529		
England	GVA (£m)	Indirect	£m	£299	£209	£2,487	£441	£708	£369		
England	GVA (£m)	Induced	£m	£267	£443	£3,087	£666	£1,122	£378		
England	Employment (Persons)	Direct	Persons	7,153	13,554	177,004	9,686	76,648	8,280		
England	Employment (Persons)	Indirect	Persons	4,391	4,074	34,747	5,907	10,389	6,202		
England	Employment (Persons)	Induced	Persons	3,577	5,839	34,756	7,170	15,598	5,125		
England	Taxes (£m)	Direct	£m	£86	£121	£1,032	£104	£497	£127		
England	Taxes (£m)	Indirect	£m	£69	£42	£611	£94	£155	£91		
England	Taxes (£m)	Induced	£m	£73	£122	£848	£181	£309	£104		

Table 22: 2030 central growth scenario for economic contribution of the ornamental horticulture and landscaping industry split by nation and sector.

Nation	Indicator	Type	Units	Garden goods	Ornamental Plants	Landscape services	Arboriculture	Retail	Wholesale	Domestic Tourism	International Tourism
UK	GVA (£m)	Direct	£m	£511	£1,051	£10,280	£793	£2,379	£623	£390	£1,327
UK	GVA (£m)	Indirect	£m	£415	£292	£3,427	£827	£830	£429	£632	£2,115
UK	GVA (£m)	Induced	£m	£394	£622	£4,275	£1,254	£1,329	£445	£305	£982
UK	Employment (Persons)	Direct	Persons	9,744	19,546	249,060	19,381	91,289	10,044	11,215	28,850
UK	Employment (Persons)	Indirect	Persons	5,743	5,838	48,583	11,746	12,258	7,446	15,087	40,680
UK	Employment (Persons)	Induced	Persons	4,974	8,385	48,703	14,288	18,540	6,209	4,018	12,951
UK	Taxes (£m)	Direct	£m	£123	£169	£1,429	£197	£587	£149	£94	£298
UK	Taxes (£m)	Indirect	£m	£96	£59	£842	£176	£182	£106	£150	£479
UK	Taxes (£m)	Induced	£m	£108	£171	£1,174	£341	£366	£122	£83	£269
Scotland	GVA (£m)	Direct	£m	£72	£15	£1,258	£188	£186	£57		
Scotland	GVA (£m)	Indirect	£m	£58	£4	£419	£196	£65	£39		
Scotland	GVA (£m)	Induced	£m	£55	£9	£523	£297	£104	£40		
Scotland	Employment (Persons)	Direct	Persons	1,011	377	30,093	4,416	7,240	1,047		
Scotland	Employment (Persons)	Indirect	Persons	596	113	5,870	2,677	972	776		
Scotland	Employment (Persons)	Induced	Persons	516	162	5,885	3,256	1,470	647		
Scotland	Taxes (£m)	Direct	£m	£17	£2	£175	£47	£46	£13		
Scotland	Taxes (£m)	Indirect	£m	£13	£1	£103	£42	£14	£10		
Scotland	Taxes (£m)	Induced	£m	£15	£2	£144	£81	£29	£11		

Table 22 (continued)

Nation	Indicator	Type	Units	Garden goods	Ornamental Plants	Landscape services	Arboriculture	Retail	Wholesale	Domestic Tourism	International Tourism
Northern Ireland	GVA (£m)	Direct	£m	£10	£66	£227	£17	£54	£19		
Northern Ireland	GVA (£m)	Indirect	£m	£8	£18	£76	£18	£19	£13		
Northern Ireland	GVA (£m)	Induced	£m	£7	£39	£95	£27	£30	£14		
Northern Ireland	Employment (Persons)	Direct	Persons	228	1,415	6,091	460	2,433	373		
Northern Ireland	Employment (Persons)	Indirect	Persons	135	423	1,188	279	327	277		
Northern Ireland	Employment (Persons)	Induced	Persons	117	607	1,191	339	494	231		
Northern Ireland	Taxes (£m)	Direct	£m	£2	£11	£32	£4	£13	£5		
Northern Ireland	Taxes (£m)	Indirect	£m	£2	£4	£19	£4	£4	£3		
Northern Ireland	Taxes (£m)	Induced	£m	£2	£11	£26	£7	£8	£4		
Wales	GVA (£m)	Direct	£m	£22	£32	£390	£113	£105	£11		
Wales	GVA (£m)	Indirect	£m	£18	£9	£130	£118	£37	£8		
Wales	GVA (£m)	Induced	£m	£17	£19	£162	£179	£59	£8		
Wales	Employment (Persons)	Direct	Persons	260	744	11,926	3,543	3,963	235		
Wales	Employment (Persons)	Indirect	Persons	153	222	2,326	2,147	532	174		
Wales	Employment (Persons)	Induced	Persons	133	319	2,332	2,612	805	145		
Wales	Taxes (£m)	Direct	£m	£5	£5	£54	£28	£26	£3		
Wales	Taxes (£m)	Indirect	£m	£4	£2	£32	£25	£8	£2		
Wales	Taxes (£m)	Induced	£m	£5	£5	£44	£49	£16	£2		
England	GVA (£m)	Direct	£m	£408	£938	£8,405	£475	£2,034	£536		
England	GVA (£m)	Indirect	£m	£331	£260	£2,802	£495	£709	£369		
England	GVA (£m)	Induced	£m	£314	£555	£3,495	£751	£1,136	£383		
England	Employment (Persons)	Direct	Persons	8,244	17,009	200,950	10,962	77,654	8,388		
England	Employment (Persons)	Indirect	Persons	4,859	5,080	39,198	6,643	10,427	6,218		
England	Employment (Persons)	Induced	Persons	4,209	7,297	39,295	8,081	15,771	5,186		
England	Taxes (£m)	Direct	£m	£98	£151	£1,168	£118	£502	£128		
England	Taxes (£m)	Indirect	£m	£76	£52	£688	£105	£156	£91		
England	Taxes (£m)	Induced	£m	£86	£152	£960	£204	£313	£105		

Table 23: 2030 upper-case scenario for the economic contribution of the ornamental horticulture and landscaping industry split by nation and sector.

Nation	Indicator	Type	Units	Garden goods	Ornamental Plants	Landscape services	Arboriculture	Retail	Wholesale	Domestic Tourism	International Tourism
UK	GVA (£m)	Direct	£m	£634	£1,282	£12,343	£954	£2,534	£640	£425	£1,513
UK	GVA (£m)	Indirect	£m	£489	£351	£4,067	£982	£874	£436	£680	£2,384
UK	GVA (£m)	Induced	£m	£500	£757	£5,120	£1,504	£1,412	£456	£331	£1,117
UK	Employment (Persons)	Direct	Persons	12,133	20,738	253,508	19,796	97,368	10,330	12,266	33,016
UK	Employment (Persons)	Indirect	Persons	6,748	7,010	57,424	13,899	12,855	7,534	16,187	45,665
UK	Employment (Persons)	Induced	Persons	6,296	10,189	58,255	17,110	19,676	6,358	4,363	14,712
UK	Taxes (£m)	Direct	£m	£153	£183	£1,471	£200	£623	£152	£102	£339
UK	Taxes (£m)	Indirect	£m	£113	£71	£999	£209	£192	£107	£161	£540
UK	Taxes (£m)	Induced	£m	£137	£208	£1,406	£408	£389	£125	£91	£306
Scotland	GVA (£m)	Direct	£m	£89	£18	£1,511	£226	£198	£58		
Scotland	GVA (£m)	Indirect	£m	£69	£5	£498	£233	£68	£40		
Scotland	GVA (£m)	Induced	£m	£70	£11	£627	£356	£111	£41		
Scotland	Employment (Persons)	Direct	Persons	1,259	400	30,631	4,511	7,723	1,077		
Scotland	Employment (Persons)	Indirect	Persons	700	135	6,938	3,167	1,020	785		
Scotland	Employment (Persons)	Induced	Persons	653	197	7,039	3,899	1,561	663		
Scotland	Taxes (£m)	Direct	£m	£21	£3	£180	£47	£49	£14		
Scotland	Taxes (£m)	Indirect	£m	£16	£1	£122	£49	£15	£10		
Scotland	Taxes (£m)	Induced	£m	£19	£3	£172	£97	£30	£11		
Northern Ireland	GVA (£m)	Direct	£m	£12	£81	£273	£20	£57	£20		
Northern Ireland	GVA (£m)	Indirect	£m	£9	£22	£90	£21	£20	£14		
Northern Ireland	GVA (£m)	Induced	£m	£9	£48	£113	£32	£32	£14		
Northern Ireland	Employment (Persons)	Direct	Persons	284	1,501	6,200	470	2,595	384		
Northern Ireland	Employment (Persons)	Indirect	Persons	158	508	1,404	330	343	280		
Northern Ireland	Employment (Persons)	Induced	Persons	148	738	1,425	406	524	236		
Northern Ireland	Taxes (£m)	Direct	£m	£3	£12	£33	£4	£14	£5		
Northern Ireland	Taxes (£m)	Indirect	£m	£2	£4	£22	£4	£4	£3		
Northern Ireland	Taxes (£m)	Induced	£m	£3	£13	£31	£9	£9	£4		

Table 23 (continued)

Nation	Indicator	Type	Units	Garden goods	Ornamental Plants	Landscape services	Arboriculture	Retail	Wholesale	Domestic Tourism	International Tourism
Wales	GVA (£m)	Direct	£m	£28	£40	£468	£136	£112	£12		
Wales	GVA (£m)	Indirect	£m	£21	£11	£154	£140	£39	£8		
Wales	GVA (£m)	Induced	£m	£22	£23	£194	£215	£62	£8		
Wales	Employment (Persons)	Direct	Persons	324	790	12,139	3,619	4,226	242		
Wales	Employment (Persons)	Indirect	Persons	180	267	2,750	2,541	558	176		
Wales	Employment (Persons)	Induced	Persons	168	388	2,789	3,128	854	149		
Wales	Taxes (£m)	Direct	£m	£7	£6	£56	£28	£28	£3		
Wales	Taxes (£m)	Indirect	£m	£5	£2	£38	£30	£8	£2		
Wales	Taxes (£m)	Induced	£m	£6	£6	£53	£58	£17	£2		
England	GVA (£m)	Direct	£m	£506	£1,144	£10,092	£571	£2,166	£551		
England	GVA (£m)	Indirect	£m	£390	£313	£3,325	£588	£747	£375		
England	GVA (£m)	Induced	£m	£398	£675	£4,186	£901	£1,207	£393		
England	Employment (Persons)	Direct	Persons	10,265	18,046	204,538	11,196	82,825	8,627		
England	Employment (Persons)	Indirect	Persons	5,709	6,100	46,331	7,861	10,935	6,292		
England	Employment (Persons)	Induced	Persons	5,327	8,867	47,002	9,677	16,737	5,310		
England	Taxes (£m)	Direct	£m	£122	£164	£1,203	£120	£533	£131		
England	Taxes (£m)	Indirect	£m	£90	£63	£817	£125	£164	£92		
England	Taxes (£m)	Induced	£m	£109	£186	£1,149	£245	£332	£108		

Appendix two: Key dependencies of growth

There are several key dependencies and assumptions which are not modelled in detail in this report, but which are nonetheless essential to achieving growth. A lengthy exposition of the dependencies is beyond the scope of this research, however they have been identified through engagement with the industry and are noted in the following table for completeness.

Dependency	Summary explanation
Water availability and strategic planning	The green spaces and crops described in this report are reliant on water, whether for the production of the plants or the maintenance of the green infrastructure with the potential to add value to the UK's natural capital. In order for this value chain to continue to function, continuity of access to water is assumed, though we note that there are dependencies on this use being accounted for in regional water resilience planning.
Coronavirus pandemic recovery	Because of the time frame of this analysis, we have assumed over the coming decade that the industry and society will return to a broadly 'steady state' over the coming decade and that fluctuations in supply chains, fluxes in seasonal lockdown spending, and the wider economy will not become the norm. 2020 trade data in the garden industry has not been used as the foundation for our economic modelling for this reason, though where trends have been accelerated or accentuated by the pandemic these have been noted.
Continuity of growing media supply	At the time of writing this report Defra is in the process of consulting on peat removal from growing media in horticulture. Growing media is used by commercial growers to produce plants for retail and amenity customers, and by gardeners in hanging baskets, pots, tubs and containers. This drives substantial linked-sales and economic value in garden retail and the supply parts of the value chain. Our modelling assumes continuity of supply of enough growing media to enable production growth and to supply demand, and no modelling has been performed on the economic impact of shortage of growing media caused either by regulation that restricts use of components like peat, or other factors that might cause a shortfall, for instance a shortfall in the availability of peat alternatives like wood fibre or coir.

Appendix three: Methodology

1. Identifying drivers with the potential to affect the ornamental horticulture and landscaping industry

To identify the range of potential issues that are set to affect the industry over the coming decade, Foresight Factory went through a four phase process.

Phase 1: 'The Big Review'

A comprehensive review of all available research and insights across internal Foresight Factory data, research and trends content – as well as externally available insights and internal OHRG research/knowledge was conducted through autumn 2021.

The Big Review aimed to uncover the structural and agency drivers that will be most influential in shaping the future economic contribution of the UK horticulture sector by 2030. The structural drivers are the political, economic, demographic, technological and environmental forces that are going to shape the future world the sector will be operating in. The agency drivers are the consumer trends that dictate how people will be thinking and acting differently within this future world. The data gathering for this involved:

- A review of Foresight Factory's trend database
- A macro-environmental PESTLE analysis
- An audit and scanning of technological innovations and patents affecting the industry
- A literature review of published and OHRG research into the industry, its history and trends
- Depth interviews with experts in the industry representing its different sectors
- Depth interviews with experts from outside the industry, including futurists, government officials, and specialists from the tourism and town planning sectors

The key output of this stage was a prioritised list of drivers to take forward to phase 2 of the research – a working session with the OHRG to define and develop the critical uncertainties against the drivers prioritised.

Phase 2: OHRG workshop

A workshop was conducted with members of the OHRG to refine, explore and prioritise the drivers identified at stage one. The drivers were assessed for scale of potential impact, certainty or uncertainty, and the potential impacts for the industry of each were explored and refined. The positive and negative impacts of each driver based on its potential outcome(s) were assessed to develop insights into the potential opportunities and threats each outcome of the drivers presented to the industry's growth. Eight key drivers emerged from this phase of the research.

Phase 3: Scenario development

The third phase involved Foresight Factory taking the eight critical uncertainties and drivers developed at the previous stage and building descriptions of projections of the potential futures for UK horticulture and landscaping industry. Each driver was paired with another, and the positive and negative potential outcomes of each was used to develop scenarios describing potential outcomes for the industry. This produced four upper case scenarios based on positive outcomes for the drivers, and the inverse lower case scenarios based on negative outcomes for the drivers. This work involved working to identify actions today with potential to support or constrain industry growth and wider prosperity for the UK economy and society.

Phase 4: Finalised scenario descriptions for economic modelling

Each of the drivers was developed in such a way that it can be linked to impacts on economic or natural capital gain or loss, so that as well as providing a narrative description of the drivers and scenarios, estimates of economic impact can be assigned to individual drivers. As well as the eight scenarios developed in phase 3, summary upper and lower case scenarios were developed for the summary of this report, for which overall economic impact assessments could be developed by Oxford Economics.

2. Estimating the economic impact of the ornamental horticulture and landscaping industry in 2019

To estimate the economic impact of the ornamental horticulture and landscaping sector in 2019, Oxford Economics utilised data from a wide range of sources. The analysis is conducted on a gross basis, which does not take into account any displaced or counterfactual economic activity, in the absence of the ornamental horticulture and landscaping sector. Below we list out the various datasets used to estimate the economic contributions of each sub-sector within ornamental horticulture and landscaping:

Garden goods manufacturing

To estimate the direct impact of garden goods production, we used PRODCOM data accessed via ONS and Eurostat. This is a dataset that records detailed production statistics across 3,900 different types of manufactured products. We identified a list of ornamental horticultural products from these data, and used these as the starting point for our analysis.

For certain products, that could be used for either horticultural or agricultural purposes, we adjusted total production to isolate ornamental horticultural demand. This adjustment drew upon data from the ONS' input-output tables, that records the extent to which different goods and services are consumed by various sectors of the economy. This allowed us to estimate the demand for (e.g.) agrochemicals that was contributed by households and landscape services firms, and to compare this with demand from the agriculture sector and food manufacturers. The resultant GDP contributions are estimated using the ONS' Annual Business Survey (ABS). The employment impact of this production is estimated using Annual Business Survey data on manufacturing employment.

Ornamental plant production

The production value of ornamental plants is sourced from DEFRA's Horticulture Statistics bulletin. We estimate the GDP impact of this production using a ratio drawn from the Annual Business Survey. Employment is estimated using Annual Population Survey (APS) figures for the plant propagation sector.

Landscape services

The direct impact of landscape services first uses ABS data on the landscape services industry. This provides estimates of the turnover, GDP and employment that arises through their activities. To account for additional employment in the sector, not included in the ABS, we incorporate the estimated 'unregistered' employment using data from the APS. This encompasses self-employed and own-account workers, whose activities are not at a scale that necessitates VAT/PAYE registration, and thus do not appear in official business register-based statistics.

We estimate turnover per person among this workforce using a factor drawn from BEIS' Business Population Estimates (BPEs). This provides turnover estimates for unregistered workers within the broader sector, 'services to buildings and landscape'. We calculated the ratio of turnover per worker among unregistered and registered workers in this broader sector. This ratio was then applied to turnover per worker as suggested in the ABS data, to estimate the average turnover that is accrued by unregistered landscape service workers.

Garden retail

To understand the impact of garden goods retailing, we draw data from the Annual Spending Survey on household spending on horticulture-related items and ABS figures for turnover among specialist garden centres and pet stores (that are presented in aggregate within the ABS).

Once we estimated how much of households' ornamental horticultural spend flowed to garden centres, we assigned the rest to non-specialist retailers (i.e. supermarkets). We then used ABS data on general retailers' output, employment and productivity to quantify how many employees this spending supported; and how much GDP was generated as a result. The employment and GDP of garden centres were then estimated, again using ratios from the ABS. Our estimates only included retail margins to ensure that we do not double-count: retailers accrue only that revenue that is attributable to their retail services (i.e. their margin); and manufacturers accrue the revenue that is attributable to the value of the goods.

Wholesale of garden goods

Our estimates for wholesaling begin with ABS figures for GDP and employment among the sector 'wholesale of flowers and plants'. This describes the direct economic contribution of specialist wholesalers of flowers, plants and bulbs.

To estimate the impact that the trade of ornamental horticulture products supports among non-specialist wholesalers, we began with our estimates of domestic production of garden goods. We then included the value of imported garden goods (via trade data from HRMC and Eurostat), to arrive at an estimate of the total supply of ornamental horticulture products to the UK market. To this value, we apply average wholesale margins for non-specialist wholesalers, as indicated by ABS. These margins form wholesalers' output, and allow us to derive the GDP and employment contributions sustained by this activity.

Arboriculture

Our estimates for arboriculture draw on ABS data for the sectors 'silviculture and other forestry activities' and 'support services to forestry'. We adjusted this latter sector, to exclude the estimated proportion of support services that are focused on logging activity. We also incorporate APS-based estimates of employment within forestry and arboricultural occupations, that fall outside of the forestry sector itself.

Garden tourism

Our methodology for ornamental horticulture's tourism impact follows an approach developed by VisitBritain, that is intended to establish what proportion of UK tourism activity is motivated by various visitor attractions.

For domestic visitors, their method uses the Great Britain Tourism Survey and the Great Britain Day Visits Survey. This involves quantifying the total value of tourist spending that includes an activity, before measuring the numbers of activities undertaken during these trips, before estimating the extent to which individual activities motivated the trip, using survey evidence. For international passengers, International Passenger Survey (IPS) data on the activities undertaken during inbound visits is used. The total spending of tourists who undertook only visits to parks and gardens is undiscounted, while the spending of tourists who undertook other activities in addition is divided by the number of activities undertaken (i.e. for an inbound tourist that visited parks and gardens as well as three other activities, only 25% of their spending is used in the calculation). Inbound visitors' spending is then discounted again, according to their stated 'trip purpose' in the IPS. This is combined with Tourism Economics' estimates of spending by domestic and international tourists to derive the latest estimates for ornamental horticulture's tourism impact.

3. Baseline forecast on the economic impact of ornamental horticulture and landscaping in 2030

To develop a baseline forecast in 2030 for each sector, we utilised forecasts of macroeconomic indicators from Oxford Economics. For each sub-sector of horticulture and landscaping, we identified the most relevant corresponding sector, for which forecasts of GDP and employment are available:

Garden goods manufacturing

For this sector, the weighted average growth rate of GVA of the following sectors were used: pesticides and agrochemicals; basic chemicals and fertilisers; furniture manufacturing; wood and wood products; mechanical engineering; non-metallic metals; other manufacturing; manufacture of fabricated metal products. To develop an employment forecast, we drew from productivity growth of the manufacturing sector, as employment data is not available for more granular sub-set of the manufacturing sector.

Ornamental plant production

The growth in the ornamental plant production is estimated using forecasted growth in the GVA of 'agriculture, fisheries and forestry' and historical trends on ornamental plant production (data from DEFRA/ONS). We used a basic econometric model to estimate a correlation between ornamental plant production and value-added of the agriculture sector, which was then used to develop a forecast of value-added for ornamental plant production. This methodology was used to disentangle the growth trends in ornamental plant production, from the more aggregated group of sectors under 'agriculture, fisheries and forestry'. To estimate employment, we drew from forecasted productivity growth of the agriculture sector, in the absence of more granular data.

Landscape services and arboriculture

In consultation with HTA, we have identified the construction sector, as the most relevant proxy sector to estimate the value and employment in landscape services and arboriculture. This was applied under the assumption that the demand for landscape services and arboriculture tended to change in line with changes in demand for the construction sector. As such, to develop a forecast on GVA and employment of landscape services and arboriculture, we applied the forecasted growth rates of the construction sector.

Garden Retail and wholesale

For the retail and wholesale of garden goods sectors, we developed a forecast based on forecasted growth rates for the overall retail and distribution sector.

Garden tourism

For both domestic and inbound tourism, we utilised a range of sources to develop a forecast for the GVA and employment or these sectors. We drew from data on forecasted spending by domestic and inbound tourists, as available from Tourism Economics (part of Oxford Economics). Data on tourism's contributions to employment and GDP in the UK, from Tourism Economics, was used to estimate employment supported by domestic and inbound tourism (linked to ornamental horticulture).

4. Estimating the impact of future scenarios

Aggregated lower and upper scenarios

The 'combined scenario' results presented were generated by combining the proportional increases in economic impact (relative to our baseline projection) that are implied by each detailed driver. This is intended to give a sense of scale for the potential enhanced economic significance of the horticultural industries, should several favourable macroeconomic and policy developments coincide.

To account for the fact some of our driver definitions have shared characteristics, or involve similar dynamics of (e.g.) investment, productivity growth and sectoral expansion; we introduce a crude discount factor to arrive at this combined scenario. This means we combine just half (50%) of the percentage difference from baseline that is implied by each additional driver. We note that this assumed 50% factor is not an empirical estimate of the extent of displacement, leakage and substitution involved with merging the scenarios under analysis (deadweight is accounted for by expressing each scenario's impact as relative to our baseline projection). Rather, it is intended to account for the uncertain extent of overlaps between drivers, while still acknowledging that greater economic benefits could accrue to the UK, should multiple positive outcomes for the sector accumulate. As such, while we feel this 'combined scenario' is conservative, it is nonetheless a crude estimate and subject to the limitations detailed here.

Driver analysis

Oxford Economics' analysis generated estimates for each individual driver, using our suite of UK economic impact models and our in-house macroeconomic projections. The analysis is undertaken on a gross basis, so no account is taken of the economic activity displaced from elsewhere, or the alternative uses to which the labour and other resources might be put, in the absence of the ornamental horticulture and landscaping sector's activities.

The modelling details for each driver are listed below:

DRIVER	MODELLING DETAILS
The extent and quality of public, private and other non-domestic green spaces	The model assumes that the economic impact of the sector changes linearly with changes in availability of public green spaces. We apply adjustments to take into account the fact that this driver has an impact only on the amenity portion of horticultural sectors. The model also accounts for backward linkages between the ornamental plant, landscape services, arboriculture sectors and the garden goods sectors through the inputs they provide.
Healthy Homes and green gardens	The model assumes that the economic impact of the sector changes linearly with changes in the availability of domestic green spaces. We apply adjustments to take into account the fact that this driver has an impact only on the consumer-related demand of horticultural sectors. The model also accounts for backward linkages between the ornamental plant, landscape services, arboriculture sectors and the garden goods sectors through the inputs they provide. Further adjustments are applied to account for the fact that the demand for certain garden goods sold by retail such as BBQs and garden furniture will grow at a slower rate than the expansion in domestic green space.
Demographic change in the UK and participation in gardening	As forecasted demographic changes are implicitly taken into account in the baseline model, here the modelling assesses the impact of changing preferences for horticultural goods and services for different demographics as a result of increased marketing efforts from the industry. Similar to others, the model assumes that the economic impact of the sector changes linearly with changes in preferences for horticulture-related products and services. We apply adjustments to take into account the fact that this driver has an impact only on the consumer-related portion of horticultural sectors. The model also accounts for backward linkages between the ornamental plant, landscape services, arboriculture sectors and the garden goods sectors through the inputs they provide.
Access to labour	The model is designed to capture the impact of a shortage of labour required by the horticulture sector. The model assumes that the economic impact of the sector changes linearly with changes in the availability labour. The model also accounts for backward linkages between the ornamental plant, landscape services, arboriculture sectors and the garden goods sectors through the inputs they provide.
Sustainable business productivity growth	Here we assume that productivity of horticulture grows in line with productivity growth that is implicit in the baseline model, plus an additional 1.6% CAGR. To model the productivity growth, we assume that employment in the sector remains constant while output changes. The model also accounts for backward linkages between the ornamental plant, landscape services, arboriculture sectors and the garden goods sectors through the inputs they provide.
Advancing horticultural and green space science	The economic impact of just one aspect of this this driver is illustrated through a price premium to horticultural products as a result of improved research and development, passed on to consumers. The model assumes that employment and procurement of inputs by the sector remain constant, while an increase in the price of products are reflected in increased revenue and wages in the horticulture sector. The model also accounts for backward linkages between the ornamental plant, landscape services, arboriculture sectors and the garden goods sectors through the inputs they provide.

Modelling of national variations within the UK

To estimate how the economic impact of ornamental horticulture and landscaping was distributed across the nations of England, Wales, Scotland and Northern Ireland, we used data from the ONS Family Spending Survey, the Annual Business Survey and the Business Register and Employment Survey, which provides a national breakdown for various indicators. For 2030 national results, forecasted growth rates of granular horticulture and landscaping sectors at the UK level is taken into account, along with the different composition of these sectors in each nation's economic activity, to disaggregate projected/potential impact of ornamental horticulture and landscaping in 2030 by each nation.

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