Recipe for Disaster

How climate change threatens
British-grown fruit and veg

The Climate Coalition

This report marks the launch of The Climate Coalition's annual Show The Love campaign which aims to raise awareness of climate change and all it threatens, and encourage people to show their support for action to address it.

The Climate Coalition is the UK's largest group of people dedicated to action on climate change and limiting its impact on the people, places, and life we love at home in the UK and around the world, including the world's poorest countries. The coalition is made up of over 130 organisations with a combined supporter base of 15 million, including WWF, National Trust, RSPB, Christian Aid, CAFOD, The Women's Institute, and Oxfam. Together we want a future where the UK no longer contributes to climate change, within a generation.

Find out more at showthelove.org.uk

Priestley International Centre for Climate

Providing research to underpin robust and timely climate solutions is the USP of the Priestley International Centre for Climate. The University of Leeds centre is unique in bringing together world leading expertise in all the key strands of climate change research.

One of the University's flagship strategic investments, the Priestley Centre aims to provide international solutions to the global challenge of climate change through new interdisciplinary research partnerships that better link our physical, technological, economic, and social understanding of climate change with strategies for mitigation and adaptation.

Find out more at climate.leeds.ac.uk

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Foreword

—Hugh Fearnley-Whittingstall

I am utterly convinced that eating more veg and fruit is the best way to boost our own health and that of our environment. And thanks to the hard work and ingenuity of British farmers, even at this dark and chilly time of year, we can all still load up our plates with fantastic home-grown produce –from earthy roots and sweet squashes, to crisp apples and lush, tasty greens. Seasonal British produce never fails to please and it's a simple matter to roast, blitz, spice, sauce or soup these superb ingredients into delicious dishes.

But this ever-changing seasonal bounty is under threat from climate change. As this timely report from The Climate Coalition shows, UK farmers are already struggling to cope with the increasing frequency of extreme and unpredictable weather, with late frosts, droughts and heavy rainfall having a serious–sometimes devastating–impact on crops.

How do we address this alarming situation? The answer is we have to do all we can to limit climate change. As luck would have it, that is a built-in consequence of sustainable, ethical eating anyway. If you shop locally and eat seasonally you are already doing your bit. If you prioritise organic produce and limit your consumption of animal foods, you're doing even more.

Farmers and food retailers have a major part to play too, of course, and there are some brilliant examples in this report of some of them doing just that, working to ensure that the food we eat is grown and brought to our plates in the most sustainable way. Some are cutting carbon emissions; others are promoting local and seasonal produce, or helping to cut food waste by selling so-called 'wonky' vegetables that would otherwise be dumped. We must support them.

But climate change has to be tackled at the very top. If we are to protect our fantastic British fruit and veg for future generations, then the food industry and our Government have got to step up and make the kind of major changes–reducing emissions, cutting waste, supporting green energy, for example –that will have a profound effect. This is how we'll ensure that the delicious, healthy, homegrown produce we enjoy today is still available for our children and grandchildren. The alternative doesn't bear thinking about.

"Last year's drought is indicative of the impact of climate change. Farming can only be made sustainable if we **prioritise improving soil qualities, water management, and encourage pollinators.**

—David Drew MP, Shadow Minister, Environment, Food and Rural Affairs

I commend The Climate Coalition for highlighting the impacts of climate change on our world-leading horticultural sector. High-quality, locally-grown fruit and veg are a crucial component of British diets. Yet, as we saw with last year's drought, this nutritious food, and the livelihoods of the hard-working farmers who grow it, are increasingly threatened by more extreme weather and increased pests and diseases as a result of climate change.

This Government is committed to supporting fruit and veg producers to meet this challenge. We will use powers in the Agriculture Bill to reward farmers who reduce their emissions and adapt to the effects of climate change through our new Environmental Land Management scheme. We are also taking steps to end the environmental, economic and moral scandal of food waste through our Resources and Waste Strategy.

— Rt Hon Michael Gove MP

Secretary of State for Environment, Food and Rural Affairs

“Locally sourced fresh fruit and vegetables play a starring role in many of our signature dishes and are absolutely vital to the British food industry. Without these wonderful ingredients, like carrots, strawberries and even the humble potato, we would lose so many incredible flavours and such variety from our menus. It is really crucial that we do everything we can to protect these crops from climate change. As chefs and restaurateurs, we must step up and play our part: reducing emissions, and wasting less food, so that we can ensure there’s enough good food for future generations to enjoy.”

—Raymond Blanc OBE

President of the Sustainable Restaurant Association

Summary

Our supplies of British-grown potatoes, vegetables and fruit are at risk as growers struggle to cope with extreme and unpredictable weather, made more likely by climate change.

New analysis released by The Climate Coalition and the Priestley International Centre for Climate says the UK can expect more frequent extreme weather events, including longer-lasting and more intense heatwaves and a one in three chance of record-breaking rainfall hitting parts of England each winter. The 2018 summer heatwave was made about 30 times more likely than it would be normally by climate change[1].

The climate extremes of the past few years–including the snowfall and freezing temperatures of February and March 2018 and one of the driest June months in England and Wales since 1910[2]–have been devastating for UK fruit and vegetable farmers. More than half of all farms in the UK say they have been affected by a severe climatic event, such as flooding or a storm in the past 10 years[3].

Apple growers lost around 25% of their harvest in 2017 due to unexpectedly late frosts[4,5]. Carrot yields (down a reported 25-30%)[6,7,8] and onion yields (reportedly down 40% on a normal year)[9] were hampered in 2018 by warmer than average temperatures. Potato yields were down on average 20% in England and Wales in 2018 compared to the previous season[10], making it the fourth smallest harvest since 1960[11]. For consumers, the lack of water and extreme heat of 2018 was reported to have cut more than one inch off the size of the average chip[12].

Other parts of Europe and countries which provide us with fruit and vegetables face greater climate risks–with more severe consequences for farmers in developing countries, particularly Africa, South America and the Caribbean[13]. Early 2017 saw UK supermarkets suffering shortages of courgettes and spinach and rationing lettuce due to bad weather in Spain and Italy.

Professor Tim Benton, the UK's former 'Food Security Champion', said previously optimistic-sounding forecasts now need to be re-evaluated. "My gut suspicion is we're in a regime that is much less reassuring than the older projections that we'll benefit from longer growing seasons and carbon dioxide."[14]

The extreme and unpredictable weather has hit British growers hard. "This year made it seem like an impossible job. It's really hard work growing fruit and vegetables, but erratic and extreme weather pushes you over the edge. I'd be devastated if I had to deal with this year again," said Matt Smee, co-founder of The Natural Veg Men, a vegetable growing and delivery service in Cheshire.

Lee Abbey, head of horticulture at the National Farmers' Union (NFU), said, "A lot of growers will have come out of this year with sore heads and not much income. Farmers and growers are used to dealing with fluctuations in the weather but if we have two or three extreme years in a row it has the potential to put growers out of business."

The challenge for everyone–and not just the food and farming sector–is to work to reduce climate emissions to help protect we love for future generations. While the UK's greenhouse gas emissions were 43% below 1990 levels in 2017, it is not currently on track to meet its future targets, legally binding under the Climate Change Act 2008[15].

However, within the food sector, there are positive examples of farmers, food retailers and restaurants working to reduce their climate impact and safeguard British-grown fruit and vegetable production.

Farmers have made new commitments to reduce their climate emissions, with the NFU setting out an ambition in January 2019 for UK farming to become net zero in its greenhouse gas emissions by 2040 at the latest. Between 2014 and 2017, the installation of renewable energy on-farm by NFU members grew from more than a quarter of farmers and growers to nearly two-fifths (39%)[16].

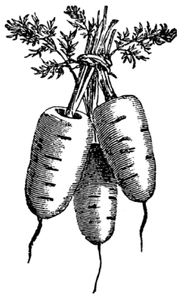
In the food retail and service sector, Tesco has switched over to renewable electricity in its UK stores and aims to reduce the environmental impact of the average UK shopping basket by 50%[17,18]. Restaurant chain Wahaca has gone carbon neutral and is boosting its vegetarian options for customers[19]. "The strength of the vegetarian dishes will become more and more important for restaurants. We need to eat less meat so we [restaurants] need to offer choices for people to do that," said founder Thomasina Miers[20].

The British public is also ready to act. Three-quarters of all respondents to a YouGov survey commissioned by The Climate Coalition said they would be willing to buy more misshapen fruit and vegetables, while 62% would buy more locally-sourced food and 57% more seasonal food to help achieve a more environmentally-friendly diet[21].

The 2018 summer heatwave was made about **30 times** more likely than it would be normally by climate change

More than half of all farms in the UK say they have been affected by a severe climatic event in the past 10 years

Over just three years, the installation of renewable energy on farms by NFU members **grew to 39%**



"A lot of growers will have come out of this year with sore heads and not much income. Farmers and growers are used to dealing with fluctuations in the weather but if we have two or three extreme years in a row **it has the potential to put growers out of business."**

— Lee Abbey, head of horticulture at the NFU

Chapter 01

Our love of British-grown fruits and vegetables

French chef Raymond Blanc called it the British food revolution. Throwing off a reputation for indifference towards the origins of their dinner plate, British consumers want to know where their food comes from. And that extends to wanting to be able to buy and eat food grown in the UK, with 62% of UK adults saying they prefer to buy fruit and vegetables grown in the UK to help achieve a more environmentally-friendly diet, according to a YouGov survey commissioned by The Climate Coalition[22].

This love of British food has been captured by the growing popularity of local food markets, which allow producers to sell directly to consumers. In March 1998, there was only one farmers' market in England—in Bath. Today, there are more than 600 registered with The Farm Retail Association[23].

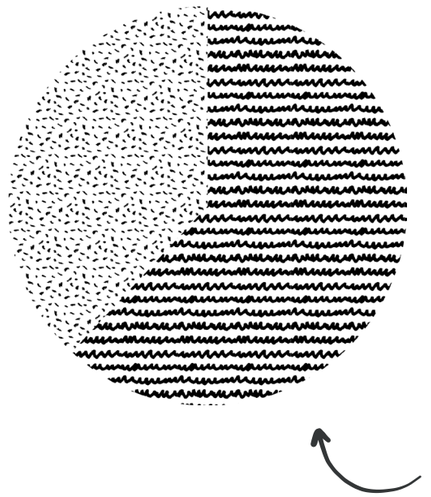
It is also reflected in the buying habits of major supermarkets. Sainsbury's vowed in 2014 to double the amount of British food it sold by 2020[24] while the Co-op is currently sponsoring the British Food Fortnight, which started in 2002 in a bid to promote and celebrate buying and eating home-produced food[25]

.One of our most popular foods is British-grown potatoes, which have been a part of our diets for hundreds of years. Food historian Colin Spencer says early potatoes were selling at a premium in the 18th century –450g cost more than a labourer's weekly wage—such was people's relish for eating the very first crop[26]. Around 15% of all meals include potatoes and potato crisps remain one of our favourite snacks[27,28].

Another favourite are carrots, which have found their way into a number of popular British dishes, including carrot soup and carrot cake. It was no surprise to see Great British Bake Off runner-up Ian Cumming tapping into that recipe with his colossal five-tier carrot cake in series 6 of the popular TV show.

A more recent addition to the British food and drink favourites has been English wine. A national body for winemakers was only established in 1967, but there are now more than 500 vineyards in England and Wales[29]. Together, they produce five million bottles a year, with another two million more on the way on the back of new vines planted over the past year[30]. The UK's sparkling wine trade has enjoyed rapid growth in the last five years with volume sales up 89%[31].

While the UK's climate makes it tough to produce quality red wine, the south of England has developed a reputation for white and, in particular, white sparkling wines. The Queen joined the trend by planting a vineyard in the grounds of Windsor Palace in 2010[32]. In the last 16 years English sparkling wines have won no fewer than 15 International Trophies in global competitions[33].



62% of respondents said they would buy more locally-sourced food*

*Respondents from a YouGov survey for The Climate Coalition, January 2019

Chapter 02

The what, how, and where of British fruit and veg production

The UK horticulture sector is comparatively small in terms of land use when set against the arable and livestock sectors. The growing of fruit and vegetables takes up around 3% of the cropped arable land in the UK, but that is enough to provide more than half (54%) of all the vegetables that we eat in the UK[34], producing £3.7billion worth of produce[35].

The UK is around 60% self-sufficient in terms of the food we eat being grown in Britain. But for carrots (93%), peas (96%), cabbage (92%), strawberries (67%) and raspberries (62%) we are able to grow enough to meet the vast majority of demand in the UK throughout the year[36].

More than 95% of fruit and vegetable production in the UK takes place in England. The biggest growing area is the East of England, including the counties of Bedfordshire, Essex, Cambridgeshire, Hertfordshire, Norfolk and Suffolk[37].

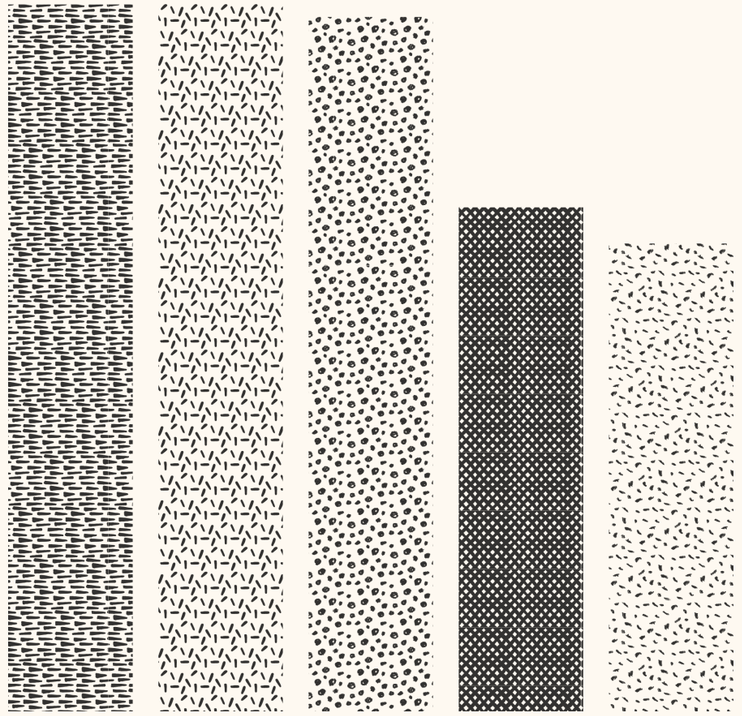
More than 80% of all the potatoes we eat are grown in the UK—now a £700m industry in Britain—putting the country in the top 20 potato producers in the world[38]. The East Midlands, East of England, Yorkshire and Humber and Scotland account for 75% of all potato production. The creamy white Maris Piper - great for chips, roast potatoes, mash or wedges - remains the most popular variety planted by growers in the UK[39].

The downside of so much of the UK's fruit and vegetable production being based in the East and South of the UK is its vulnerability to water shortages. With climate scientists now predicting stronger and longer-lasting heatwaves for the UK[40], growers are faced with increasing risks to their operations and survival.

The UK is one of the **top 20 potato producers** in the world

More than 80% of all potatoes we eat are grown in the UK

Potato production is a **£700 million** industry in Britain



93% 96% 92% 67% 62%

The **UK grows 60%** of the food it eats

Chapter 03

Climate change and the UK

What can we expect? A view from Kate Sambrook and Professor Piers Forster, from the Priestley International Centre for Climate

Global average surface temperatures have increased by 1°C since the 1850s and we are already seeing the consequences around the world: more extreme weather events such as floods and heatwaves, rising sea levels and diminishing Arctic sea ice are among some of the observed changes[41].

The latest climate change projections over the UK for the 21st century show an increased chance of milder, wetter winters and hotter, drier summers along with an increase in the frequency and intensity of extremes[42].

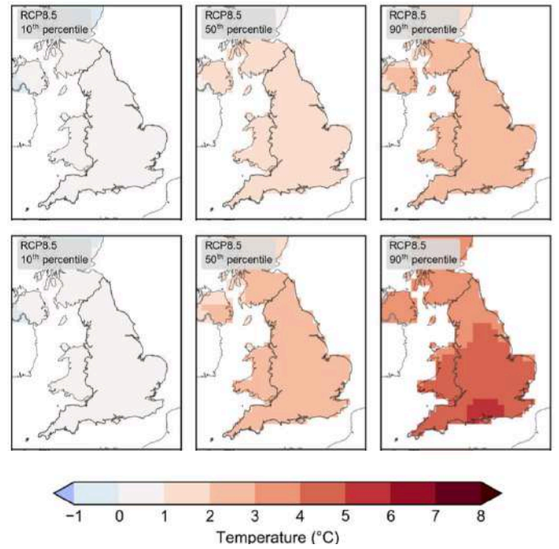


Figure 1: UKCP18 projections of average daily maximum summer temperature in England in the 2030s (top) and 2040s (bottom), relative to 1981-2000, using the high emissions scenario (RCP8.5). Results are shown at three percentiles: 10th (left), 50th (middle) and 90th (right), reflecting the likelihood of those temperatures occurring in the scenario. (Source: Met Office, 2018f)

Heatwaves:
Hotter, longer, more often

During the past few decades, the UK has seen increases in high temperature extremes[43].The summer of 2018 was notable for its record-breaking temperatures, with 35.6°C recorded at Felsham (Suffolk).[44] 24°C was the average maximum temperature across East Anglia and South East England, where some places experienced 58 'dry days' in a row[45,46]. 2018 was the joint hottest summer on record for the UK (tied with those of 1976, 2003 and 2006) and the hottest ever for England since records began in 1910[47]. The prolonged dry spell affected agricultural production across the country, with significant reductions in onion and carrot yields[48]. The 1981-2000 average daily maximum summer temperature in England ranged from 18 to 22°C. Projections by the Met Office under a high emissions scenario (RCP8.5) show this is likely to increase. By the 2030s, average daily maximum summer temperatures could be up to 4°C warmer, and up to 5°C warmer by the 2050s. The pattern of warming may not be the same everywhere, with Southern England experiencing the largest changes (Figure 1).

Climate change has already made the 2018 record-breaking UK summer temperatures about 30 times more likely than they would be normally[49]. If warming continues at its current rate, heatwaves will become more intense and longer-lasting and by 2050 could occur every other year[50]. Heatwaves with an average temperature of 40°C and a duration of 50 days are likely to occur more frequently by 2100[51].

Rainfall: Variable, more extreme

Seasonal differences in rainfall are likely to present risks to soils and agricultural production, especially in Eastern and Southern England[52]. During the past decade (2008-2017), average annual rainfall in England was 6% higher than the level seen in 1961-1990, with a marked increase in winter.[53] This is likely to get worse in the future, with a projected 20% increase in average winter rainfall by the 2030s, and up to 30-40% by the 2050s. The largest increases are shown to occur in Southern England, particularly around the coast (Figure 2).

Over the past 40 years, the intensity of winter rainfall in England has also increased, with more frequent spells of exceptionally wet weather.[54] The recent winters of 2013-2014 and 2015-2016 were notable for their record-breaking seasonal and monthly rainfall, which resulted in flooding in many parts of the country[55]. 2013-2014 was the wettest winter on record for the UK, with a total of 545mm; 67% more than the annual winter average[56,57]. Persistent rain in December 2015, resulted in a new monthly record of 219mm; 84% more rainfall than normal[58].

Extremely wet winters like the winter of 2013-2014 and 2015/16 will become more common in the future[59,60].Research on UK extreme rainfall has found that there is a one in three chance of record-breaking rainfall hitting parts of England each winter (October-March)[61]. The largest number of extreme rainfall events were found in December, suggesting that wet winters like the ones we have experienced lately could occur more frequently, increasing the risk of major flooding on farmland[62].

With the majority of agricultural production occurring in regions with limited water supplies, a main concern for farmers is a reduction in summer rainfall[63]. Despite a small overall increase in England, future projections show that this trend is unlikely to continue. In the next 20 years, average summer rainfall could reduce by up to 30% below average (1981-2000), and in the next 40 years by up to 50%, with the largest decreases in the South[64]. While there will still be wetter years, this suggests that dry summers like 2018 are likely to become more probable in the future[65]. In combination with higher temperatures, this could reduce the viability of some farming activities, due to increased soil erosion, aridity and water requirements[66].

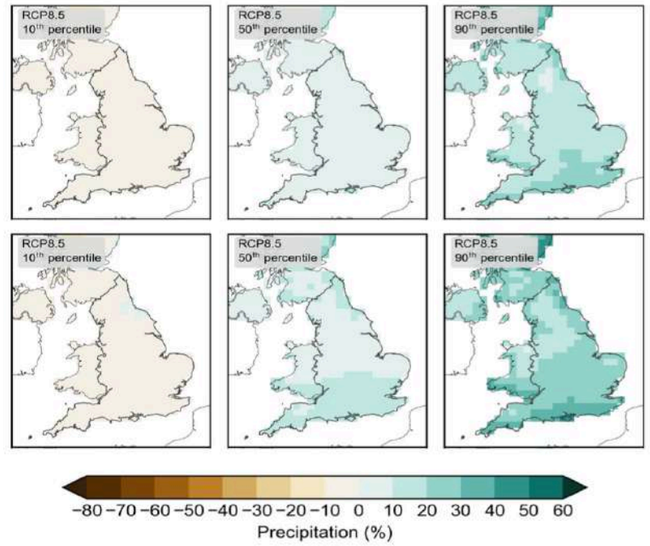


Figure 2: UKCP18 projections of winter rainfall anomaly changes in England for the 2030s (top) and 2040s (bottom) relative to 1981-2000, using the high emissions scenario (RCP8.5). Results are shown at three percentiles: 10th (left), 50th (middle) and 90th (right), reflecting the likelihood of those temperatures occurring in the scenario. (Source: Met Office, 2018f)

Chapter 04

Why climate extremes could wipe out specialist fruit and vegetable growers

A view by Dr. Nicola Cannon, Royal Agricultural University

"If extreme weather events continue, there is a big risk that **a run of challenging years could prove too much** for businesses to sustain."

— Dr Nicola Cannon, Royal Agricultural University

Much of the UK was engulfed in blizzard conditions and freezing temperatures for nearly 10 days in early March 2018. When temperatures finally rose and drier weather conditions prevailed, there was a big backlog of land preparation to catch up with, resulting in very late sowing/planting dates for many crops. Sowing crops late immediately gives them a disadvantage; they are still small when day lengths are greatest and therefore the plants are less effective at capturing sunlight by photosynthesis to generate energy and growth. However, 2018 still held another sting in the tail for growers as the late spring was immediately followed by very hot and dry conditions, which further inhibited plant growth.

Potatoes, a staple food crop in the UK, reported low yields and some quality issues. Many farmers did not start planting potatoes until the first week in May when normal planting dates are early-mid March-April. Potatoes require a great deal of land preparation prior to planting, often including ploughing, secondary cultivations and then bed formation. This intensive cultivation regime quickly dried out soils due to unseasonably high temperatures recorded during planting. Potato growers who did not have irrigation on their farms suffered reduced growth due to moisture stressed plants, resulting in low yields and poor quality due to poor skin finish with small and cracked tubers. Growers with irrigation fared somewhat better, but many of them ran out of stored water as the dry spell continued. Extreme weather conditions that affect saleable crop yield and value can have severe impact on specialist growers (businesses which have invested in equipment around production of a specific fruit/vegetable) if they fail to receive sufficient income to pay the business costs. These growers are often the innovators of the industry and have acquired debt to invest in technology, machinery and labour to meet the market demands as well as having to pay high land rental values for their expanding businesses. Even though potato and many other fruit and vegetable values have seen high prices in 2018 in many cases, it is not sufficient to cover the shortfall in production. If extreme weather events continue, there is a big risk that a run of challenging years could prove too much for the businesses to sustain.

Many farmers and growers are already trying to plan to make their businesses more resilient to climate change and extreme weather events. Some strategies include new production techniques to conserve moisture, water storage, improved irrigation application and greater monitoring of soil moisture. A vital step for all growers is enhancing soil organic matter so that soils can better retain nutrients and cope with extreme rainfall events better by improved water retention, which is then beneficial when or if drought conditions develop.

"My gut suspicion is we're now **experiencing a regime that is much less reassuring than the older projections that we'll benefit from longer growing seasons and carbon dioxide.** So blocking patterns in summer (like this year) or winter (like the stream of severe winter storms in 2015-2016; or long cold-snaps) are likely to impede yields—even if in an average year yields might notionally improve. Add in new pests and diseases, and more over-winter survival of pests and diseases and **I wouldn't be complacent.**"

— Professor Tim Benton, professor of population ecology at the University of Leeds, and the UK's former 'Food Security Champion'

Chapter 05

The climate risks facing growers

There have been positive-sounding news stories about global warming benefiting UK fruit and vegetable production in terms of an extended growing season. But extreme temperatures, water availability, and new pests and diseases pose a major risk to growers[76,77].

The past twelve months have been a warning sign of what growers might face with a rise in frequency of extreme weather events, due to climate change. Farming groups warned consumers to expect smaller and fewer popular British vegetables including carrots, onions, potatoes and leeks, because of last year's cold spring and heatwave limiting crop growth[78].

"In season, the bulk of our vegetables come from UK growers. In a normal year you'd see British onions on the market for 48-50 weeks of the year. This year a higher proportion will be imported," said Jack Ward, CEO of the British Growers Association.

Consumers have already had to deal with smaller potatoes and chips due to the lack of water and extreme heat in 2018. "They were 3cm shorter on average in the UK. Chips are made by cutting the potatoes, they are not reformed so smaller potatoes means smaller chips because the length is reduced," said Cedric Porter, editor of World Potato Markets.

NFU President Minette Batters called the heatwave and drought of the summer of 2018 a "wake-up call", saying it had caused unpredictable crop yields and lower quality fruit and vegetable harvests[79]. While Ben Raskin, head of horticulture at the Soil Association, said as well as damaging individual crops, extreme and unpredictable weather was "causing long-term soil damage".

NFU Deputy President Guy Smith said, "The reason why 1976 was so damaging to yields was because of a dry 1975. 2018 came after a wet 2017– and a wet spring in 2018 too– so it could have been a lot worse. If we see the patterns we are now seeing with a dry January then there won't be residual rainfall in the soil for growers this year."

Climatic events and their impacts on crops

Heavy Rainfall

Waterlogged land prevents access and harvest; reduced yields; increased disease risks

Drought

Reduced yields; increased demand for irrigation but water supplies may not be available

Flooding

Soil erosion; kills plants; long-term yield loss and an increase in susceptibility of roots to disease

Heatwave

Crop losses, reduced yield/ quality

Storms

Loss of leaves/blossom; crop damage from hail or wind; supply chain disruptions

Frosts

Warmer winters could hasten flowering in fruit crops leading to greater susceptibility to late spring frosts

Taken from From WWF's 'Food in a warming world: The changing foods on the British plate'[67], and 'UK Fruit and Vegetable Production – impacts of climate change and opportunities for adaptation'[68]

Summary of what we know

Apples

In 2017, apple growers reported losing around 20% of their expected harvest due to a very late and severe frost in May[75]. Production concentrated in the south of England which is predicted to see an increased frequency of drought.

Wine grapes

Late spring in April or May can damage vine shoots, as can rainfall at flowering stage in July. Both will damage growth and yields.

Cauliflower

Flower quality and yields reduced by warmer winter temperatures, with cauliflower varieties grown in UK requiring a colder overwinter. Expectation of more pests, such as the diamond-back or cabbage moth, which do not currently survive UK winters in large numbers.

Lettuce & salad crops

Production mostly outdoors. Vulnerable to long periods of drought especially around planting and early stages of growth. Production likely to be hampered in the south and east of England.

Carrots

Growth restricted by higher temperatures.

Summary of what we know

Potatoes

Production now heavily dependent on irrigation with rainfed production likely to be limited in the future. Growers reported smaller potato size and yields (down on average 20% in England and Wales) after the summer heatwave of 2018[69]. Also increased risk from pests and diseases migrating and benefiting from warmer climate[70].

Strawberries & soft fruits

Competition for water supplies. Between 70% and 80% of tree fruit and soft fruit production takes place in areas classified as being under water stress[71]. Heavily reliant on irrigation but production is concentrated in areas of high public, industrial and agricultural water demands. Less water per capita in the south east of England than some parts of the Mediterranean. Abstraction rates in major fruit growing areas (south, east and west Midlands) are already unsustainable and set to rise by 30% by 2050[72]. Milder winters may cause blackcurrant crops to flower later in the year and produce less fruit[73].

Onions

Late plantings in 2018 due to cold spell in spring. Growth restricted by higher summer temperatures. Yields for 2018 were reportedly down 40% on 2017[74].

Heatwaves and droughts

Average UK temperatures have risen by 0.8°C over the last 40 years, with nine of the ten warmest years for the UK occurring since 2002[80]. The prolonged spell of hot and dry weather in June and July across the UK saw the summer of 2018 become the joint hottest on record. Average temperatures (15.6°C for the UK and 17.2°C in England) were 1.5°C above the long-term average[81].

The higher summer temperatures damaged the growth of onions and carrots, whose optimum temperature is lower. The British Onion Producers' Association said yields were down 40% on last year. The reduced growth was worse because some growers were up to six weeks late in planting due to the 'Beast from the East' cold weather spell in spring[82].

Strawberry growers in the UK are acutely at risk from the current climate prediction is of more frequent spells of drought. Production is now heavily reliant on irrigation, but is concentrated in areas of high public, industrial and agricultural water demands. They will have to compete with rising competition and charges for using public water supplies and face possible restrictions on abstraction in the summer[83].

> "Last year's drought meant our costs of production went up [higher water and labour costs] and the yield went down so we were left with less produce to sell. With the low winter rainfall that we've had so far, our reserves are not yet restored. So as a grower do I commit to growing a crop that I don't yet have enough water for, or just plant what I have enough for, i.e. less? Extreme weather events are not good for UK agriculture as buyers will start to look elsewhere for supplies."
>
> Mark Bowyer, grower of herbs and leafy vegetables across Surrey, Berkshire and Buckinghamshire

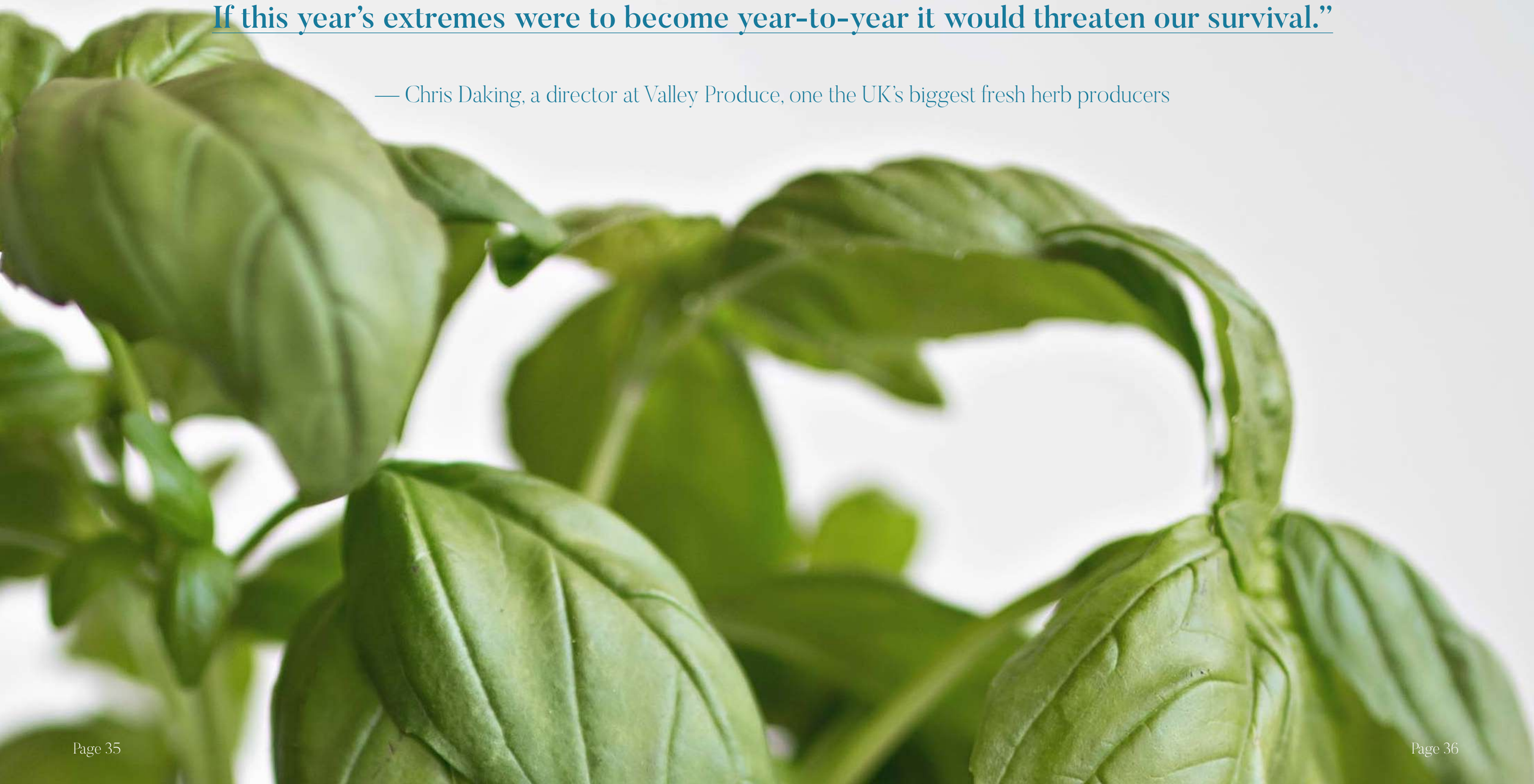
Between 70% and 80% of tree fruit and soft fruit production takes place in areas that are classified as being under water stress. Abstraction rates in major fruit growing areas (south, east and west Midlands) are already unsustainable and set to rise by 30% by 2050[84,85].

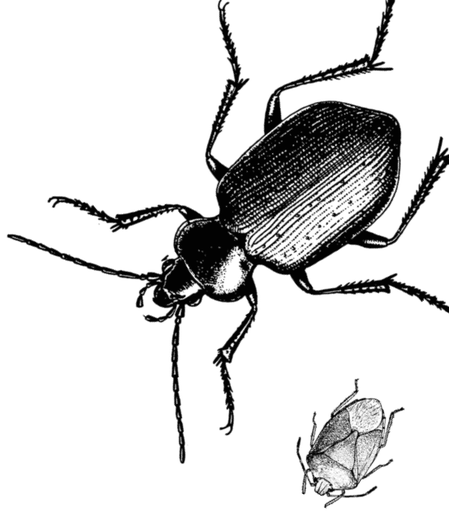
For all vegetable production in the East of the UK, any expected benefits from an extended growing season will be counteracted by reduced water availability, particularly given the competing human and industrial water demands[86]. Even those with irrigation will be hit as these systems rely to a large extent on water abstraction on-farm, which will be affected by reduced surface and groundwater[87].

"All last year's (2018) crops went in very wet and cold soil. We were 2-3 weeks behind. I've never known it as late as this in 18 years working at this business. **We lost probably £200,000-£250,000 worth of sale** from those lost weeks. We could then only harvest minimal volumes to fulfill contracts during the extreme heat. We rely on being able to produce UK crops for 26 weeks a year.

If this year's extremes were to become year-to-year it would threaten our survival."

— Chris Daking, a director at Valley Produce, one the UK's biggest fresh herb producers





Pests, diseases, and weeds

The advent of milder winters and warmer summers, more typical currently of some other parts of Europe, will mean new pests and diseases spreading from warmer climates, faster growing weeds and the likelihood of more plant pathogens surviving through the winter, and potentially an increase in pesticide use[88].

The hot weather of the summer of 2018 brought increased incidence of pests for all fruit and vegetable growers in the UK. The resistance of plants to attack can break down under temperature extremes, leading to increased crop losses[89].

British lettuce production was especially damaged by caterpillars last summer, with insects developing rapidly when temperatures are high and when they are not 'knocked-back' by periods of rainfall[90].

In 2012, higher than normal temperatures in the UK were linked to £11million of losses for UK onion production from a soil-borne fungus called Fusarium Basal Rot (FBR). FBR is forecast to worsen with climate change projections for warmer and wetter conditions[91].

The UK is currently the largest producer and consumer of frozen peas in Europe, but scientists have warned that milder winters will increase the risk from pests; like the pea beetle whose range is expected to extend further north from France to the UK. Higher temperatures and dry weather will also bring risk of an increase in root disease and powdery mildew[92].

Insect pollinators, particularly honeybees and wild bees, are vital to maximising yield and quality in a number of horticultural crops producing fruit. With populations under considerable pressure from other stressors such as parasites and pathogens, it is hard to predict what the effect of the combination of these factors and climate change will be[93].

Extreme weather events

> “This year made it seem like an impossible job. It’s really hard work growing fruit and vegetables, but **erratic and extreme weather pushes you over the edge.”**
>
> — Matt Smee, co-founder of The Natural Veg Men

The extreme rainfall in the summer of 2007, winter of 2013-2014 and December 2015 saturated farmland, causing high financial losses for both fruit and vegetable producers from crop loss and waterlogged fields that reduced yields[94,95]. The intense period of storms and rainfall between mid-December 2013 and February 2014 led to a 10% reduction in yield for potatoes and root crops[96].

Aside from flooding, other extreme weather risks include late spring frost, severe drought or prolonged soil wetness, all of which may cause crop failure or a substantial reduction in yield and quality of both fruit and vegetable crops[97]. Earlier flowering time might make crops more vulnerable to late frosts and also cause asynchrony with the normal pollinators, resulting in poor fertilisation[98]. Over half of all farms in the UK say they have been affected by a severe climatic event in the past 10 years[99]. The negative impacts on our soils, water, vegetation and wildlife are likely to be “significant”, according to the UK’s Committee on Climate Change[100].

“This year made it seem like an impossible job. It’s really hard work growing fruit and vegetables, but erratic and extreme weather pushes you over the edge. I’d be devastated if I had to deal with this year again,” said Matt Smee, co-founder of The Natural Veg Men, a vegetable growing and delivery service in Cheshire.

"In August 2015, a five-minute **hailstorm with a mini tornado destroyed my entire crop of apples.** The crop was almost ready to be picked and then within a few days of the hail the entire crop was rotten."

— Ali Capper, chair of NFU horticulture board

Chapter 06

Case study: Potatoes

Outdoor crops such as potatoes are particularly sensitive to changes in rainfall, temperature and soil. Potatoes are a water-thirsty crop so rainfed production is likely to be severely limited in the future in the UK. By the 2050s, the area of land that is currently well-suited for potatoes would decline by 74% under climate projections[102]. However, getting approval for irrigation will be limited, with 43% of growers on catchments defined as being over-licensed or over-abstracted[103].

The combination of sub-zero temperatures in the early months of 2018, followed by a wet spring and the summer heatwave saw a 3% fall in the area planted with potatoes last year[104]. The combination of late planting and stalled tuber growth due to the hot and dry weather led to a 20% drop in the total harvest of potatoes in 2018 in Great Britain compared to the previous season[105].

It was the fourth smallest potato harvest since 1960, with only 1975, 1976 and 2012 smaller[106]. While 1975 and 1976 were exceptionally dry years, growers were affected by persistent and prolonged rainfall around the growing and harvesting periods in 2012[107].

"Growers were battling a shortage of water this year; the combined June and July period was one of the driest on record," said Sector Strategy Director at AHDB Potatoes, Dr Rob Clayton. "We won't run out of potatoes. We didn't in 2012, and we won't in 2018. But what consumers will notice is a wider range of shapes and sizes in the bag they bring home to cook with."

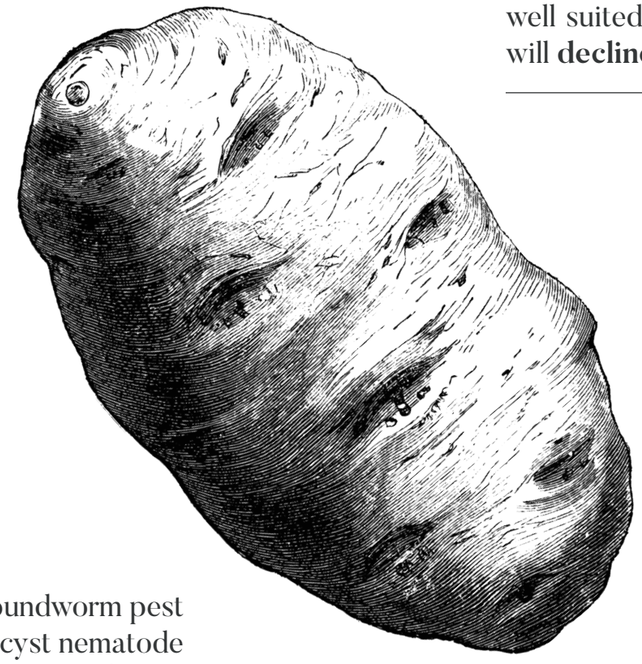
Aside from water, the biggest threats to growers are pests and diseases. The roundworm pest potato cyst nematode already causes losses of approximately £50 million per year to UK growers. That figure is predicted to rise with the pest benefiting from warmer soil and air temperatures due to climate change. UK growers have, up until now, escaped the deadly Colorado Potato Beetle which can destroy the entire crop. Although widespread in continental Europe, there have been only a few UK cases. But with a warmer climate it is feared this beetle will become a much greater pest for UK producers[108].

"Un-irrigated potatoes really suffered this year so in the future I suspect we'll see a reduction if the extreme droughts are repeated. In 2018, it was meeting specification (size and skin finish) that has been the issue. The supply chain has been able to relax specification to accommodate what has been produced, but if the quality is low buyers could start to look elsewhere," said Dr Nicola Dunn, scientist at the Agricultural & Horticultural Development Board.

There are now concerns about how potato growers will fare this year, according to Cedric Porter, editor of World Potato Markets. "People are worried about the winter so far as we've had a dry January, especially on the eastern side where most potatoes are grown. The danger is when we now have the rain. We don't want it in the growing season in March or April; we need it over the next month or so," he said.

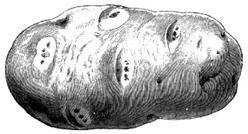
Potato is **number one in the top 10 most wasted** food & drink items in UK homes (that could have been eaten)[101]

By the 2050s, the area of land that is currently well suited for potatoes will **decline by 74%**



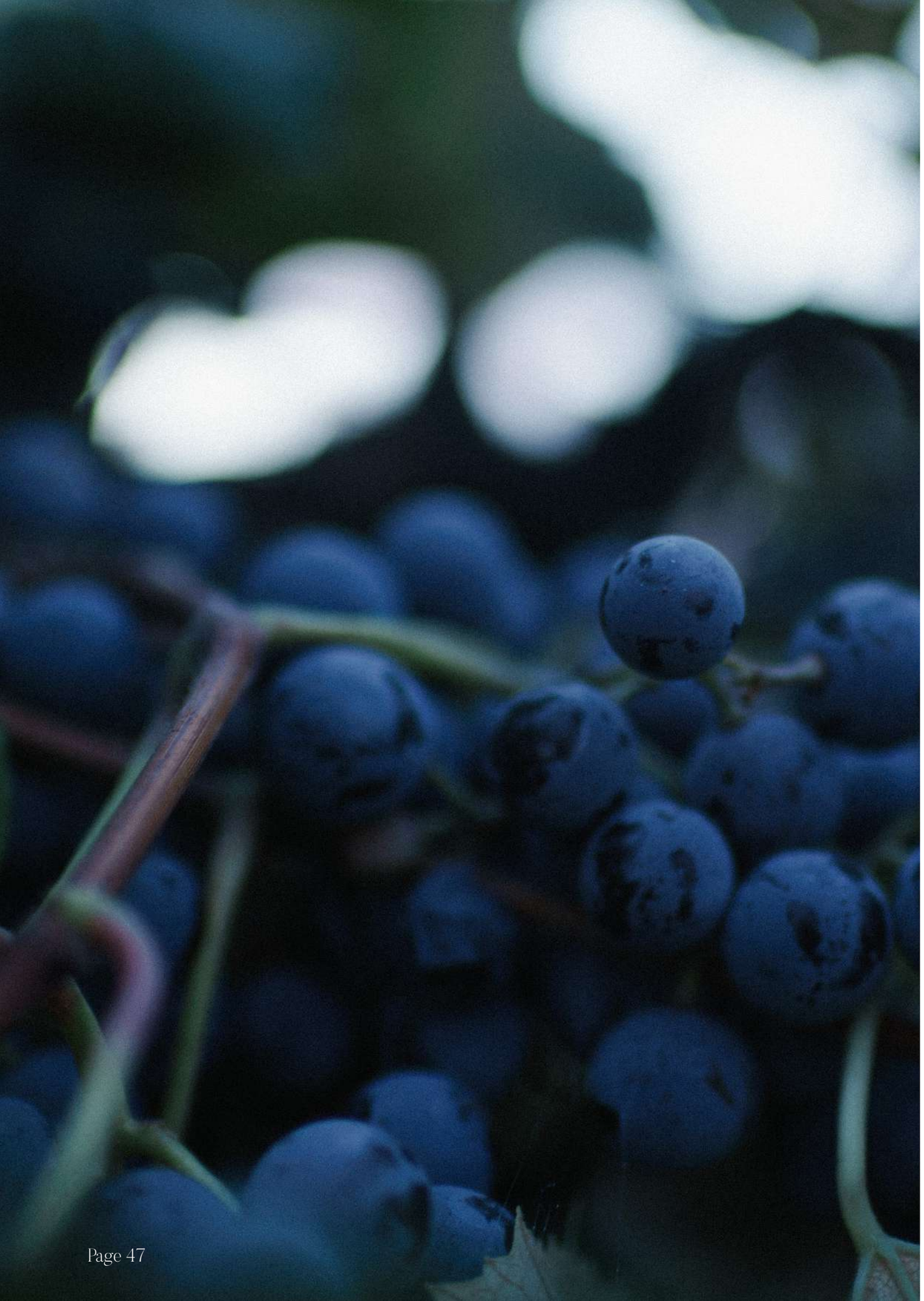
The roundworm pest potato cyst nematode already causes losses of approximately **£50million per year** to UK growers

The combination of late planting and stalled tuber growth due to the hot and dry weather led to a **20% drop in the total harvest of potatoes** in 2018 in Great Britain compared to the previous year



"The exceptionally cold and late spring meant the crop went in late and then we suffered torrential rain in late May that caused severe erosion in some fields and lost crops. That was followed by the prolonged heatwave, which meant yields were down 20-25%. I'll be reducing my acreage next year because **I can't afford to take the risk of planting more potatoes**."

— Richard Thompson, potato grower, Staffordshire



> “Warm weather at the tail end of winter when you’re not expecting it gets the vine shoots growing when they should normally be shut down.”
>
> — Cameron Roucher, Rathfinny Estate

Chapter 07

Case study: Wine

When it comes to the burgeoning English wine industry, the UK is at the climate margins of suitability for viticulture. There has been an expectation that global warming will make it possible to regularly ripen grapes in a UK climate. Parts of England are now enjoying the climate that the Champagne region of north-east France did 20 years ago[109]. The climate in the southeast and south central UK has reliably exceeded a 13°C growing season temperature since the early 1990s.

For UK growers, the unseasonal spring frost in late March 2017 was particularly devastating. It had followed a period of warmer weather meaning vine shoots had started to grow and were therefore particularly vulnerable. Some vineyards reported up to 75% of crops being damaged by late spring frosts in 2017[110].

“Some producers may have lost half their crop from it,” says Cameron Roucher, estate manager of the Rathfinny Estate, East Sussex. “Warm weather at the tail end of winter when you’re not expecting it gets the vine shoots growing when they should normally be shut down. If you then get a late frost it really messes them up.”

Chapter 08

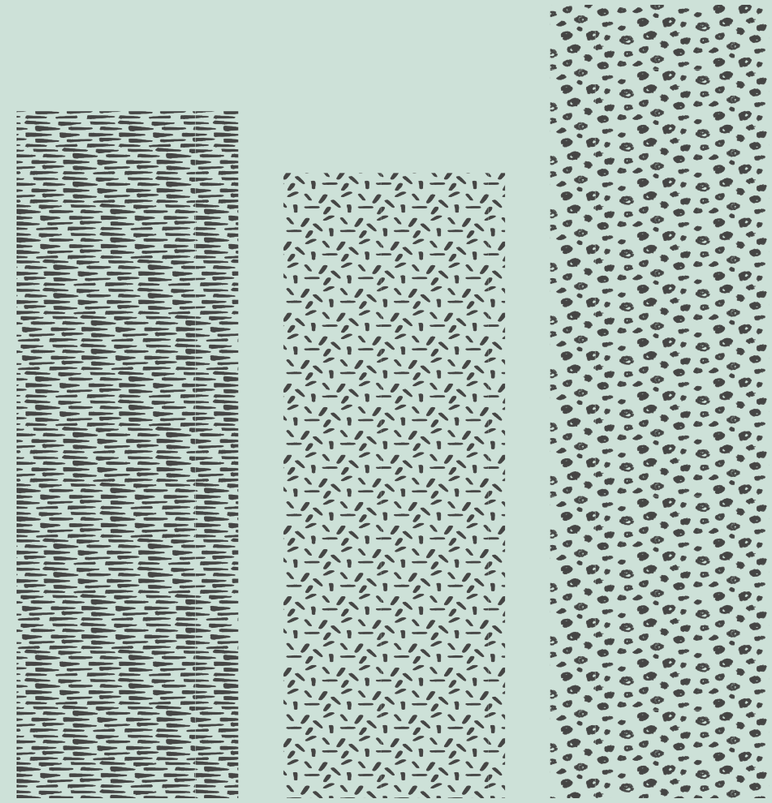
Saving British fruits and vegetables: what can we do?

The growing interest from consumers, retailers and chefs in sourcing British ingredients has been a boon to fruit and vegetable growers. But if this British success story is going to continue, then everyone—and not just the food industry —will need to do their bit to reduce their climate impact to help protect British-grown fruit and vegetable production.

As well as adapting and making their farms more resilient to climate change, there are some brilliant examples of the work that farmers and food retailers are doing to reduce climate emissions and promote British-grown produce. This has included installing renewables, increased woodland planting, prioritising the sourcing of local and seasonal produce, and helping to cut food waste by selling so-called wonky vegetables that would otherwise be dumped.

Consumers are also ready to do their bit.Three-quarters of respondents to a YouGov survey commissioned by The Climate Coalition said they would be willing to buy more misshapen fruit and vegetables, 62% more locally-sourced food and 57% more seasonal food to help achieve a more environmentally-friendly diet[111].

Everyone has to do their bit



62%

Willing to buy more local food

57%

Willing to buy more seasonal food

75%

Willing to buy more misshapen food

Reducing climate emissions

The food system in the UK contributes around 19% of our total emissions, with 40% of those originating from agriculture[112]. But meeting the UK's 2050 target to reduce emissions by at least 80% of 1990 levels will require reductions from across the economy[113]. Those targets will also need to be accelerated in light of the Paris Agreement to pursue efforts to limit global warming to 1.5°C[114]. The UK government asked its climate advisors in October 2018 for advice on setting a date for achieving net zero greenhouse gas emissions from across the economy, including transport, industry and farming.[115]

In January 2019, the NFU set out its aspiration for UK farming to become net zero in its greenhouse gas emissions by 2040 at the latest. "It's ambitious. I see it as us continuing to produce food in this country, but that is sustainable in the future," said NFU president Minette Batters[116]. An increasing number of farmers and growers across the UK are already investing in renewables. Between 2014 and 2017, the uptake of renewables among NFU members grew from more than a quarter of farmers and growers to nearly two-fifths (39%). "Farm businesses are seeing the benefits of contributing to the decarbonising of the economy and diversifying their income streams through renewable energy production," said Dr Jonathan Scurlock, Chief Adviser, Renewable Energy and Climate Change at the NFU. The most popular is solar PV, installed by nearly one-third of NFU members.[117] The rising numbers of electric cars—and tractors soon—on the road could also create opportunities for farmers to host battery charging stations, say the NFU.

Across the retail and food service sector there have been investments in reducing climate emissions. Tesco has switched over to renewable electricity for all its stores and distribution centres in the UK, with a long-term plan to be zero-carbon by 2050[119]. The renewables push helped the UK's biggest supermarket chain reduce its operational emissions by 13% in 2017[120]. Sainsbury's cut its emissions by 8% in 2017.

The supermarket Waitrose has helped to support a network of farmers and researchers working together on ideas to help reduce the climate impact of farming, including switching to cover crops, reducing fertiliser use and trialling agroforestry to reduce climate emissions[121]. The Soil Association has set a target of agroforestry on 50% of all farms by 2030[122], with the Committee on Climate Change having highlighted afforestation as a key contributor to the UK meeting its climate targets[123,124,125]. Organic vegetable delivery company Riverford has a seven-acre agroforestry site on its farm in Devon mixing fruit trees and vegetable crops.

On-farm, the government has made much of the value of so-called precision farming, where technology is used to enable targeted use of chemical inputs like fertilisers[126]. This enables growers to reduce their use of energy-intensive and environmentally-harmful inputs. There are also plans to develop carbon neutral farms in the UK, where emissions are minimised and offset through on-farm energy generation including biogas and solar panels or agroforestry and the planting of trees to absorb carbon[127,128,129]. David Drew MP, shadow DEFRA Minister, said, "This year's drought is indicative of the impact of climate change and a reminder of the need to recognise how farming can only be made sustainable if we prioritise improving soil qualities, water management and encourage pollinators."

Cutting food waste

Large quantities of the UK's fruits and vegetables are thrown away before they reach our dinner plates. This comes at a huge climate cost, with food waste responsible for 8% of global greenhouse gas emissions[130]. In Europe, the climate change impact of growing wasted food is equivalent to the carbon emissions of almost 400,000 cars[131]. Fruit and vegetables already have the highest wastage rates of any food because of their perishability - estimated at more than 30% across the UK and Europe[132].

Food can be lost at farm level due to climatic damage such as heavy rainfall or pests and disease. But more than one-third of farmed fruit and vegetables never reaches supermarket shelves largely because it is misshapen or the wrong size[133]. Farmers contracted to supermarkets typically grow more food than they are obliged to supply to allow for a proportion that they know will be deemed to be unfit to sell.

Growers are very much at the mercy of supermarket buying decisions. Kent-based grower Geoff Philpott reported 100,000 cauliflowers going to waste after his buyer dramatically reduced their order at the same time as a big glut occurred[134]. Following a Feedback campaign to bring Geoff's story to public attention, several supermarkets including Tesco and Aldi committed to marketing cauliflowers during the glut, to absorb some of the surplus produce. Tesco sold 220,000 extra cauliflowers at 79p each and Aldi sold 500,000 extra cauliflowers at 29p each—a total of 720,000 cauliflowers saved[135,136].

The majority of the UK's supermarkets responded to the extreme weather of 2018 by lowering standards to prevent food waste and keep up supplies of British-grown produce. "Reports of the crop being smaller with blemishes and skin defects would normally mean it wouldn't meet supermarket specifications to make sure they could sell as much British produce as possible," said Lee Abbey, head of horticulture at the NFU. In response to food waste campaigns, a number of retailers have also started selling more imperfect produce, so-called wonky fruit and vegetables. Tesco claims to have sold more than 15,000 tonnes of 'perfectly imperfect' fruit and veg in the UK and removed best before dates from more than 180 products to help stop edible foods, including apples, being thrown away before necessary[137].

Away from fields and supermarket shelves, there is a huge amount of waste by the food service sector and consumers. One million tonnes of food is wasted every year by the hospitality and food service sectors[138]. UK households are binning £13billion worth of edible food each year, with incorrect storage a major reason[139]. In the food service sector, more than 900 JD Wetherspoon pubs across the UK are sending zero waste to landfill, with food waste segregated and sent for anaerobic digestion[140]. Ice cream company Ben & Jerry's use their own food waste to fuel a biodigester at their European factory in Hellendoom, the Netherlands - meeting around half the factory's annual energy requirements[141].

Image credit: Feedback

A restaurant in Brighton, Silo, has proclaimed itself the UK's first zero-waste food outlet through a combination of recycling, composting food scraps and deliveries taken in reusable containers direct from producers. It also brews its own beer in the basement[142]. And in Bristol, a consumer awareness campaign managed to achieve a 16% rise in food waste recycling rates among local residents[143].

In the spotlight:
Rubies in the Rubble

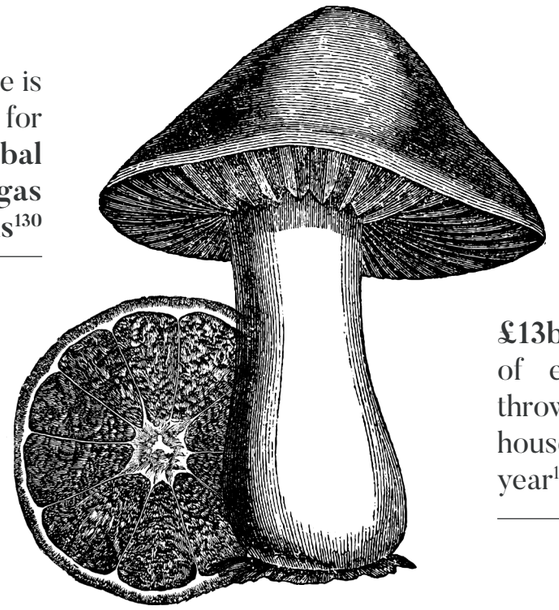
Rubies in the Rubble creates ketchups, chutneys and other condiments from surplus fruit and veg that would otherwise go to waste. They partner with farms in the UK to buy surplus wonky veg that the supermarkets don't want. By the end of 2018 Rubies had saved nearly 4.5 million fruit and vegetables from going to waste on British farms[144]. However, even Rubies has seen supply affected due to extreme weather. "Harvests and yields have been worse than usual over the past year which has resulted in fewer surplus crops for us to use and the quality has been less usable than previous years," said Joanna Vierod, Head of Retail at Rubies in the Rubble.

"I see a huge uptake in public awareness and a big investment in companies tackling food waste. The hope lies in the fact that **in a short space of time food waste has gone from a non-issue to a place where you cannot be a big company without having a food waste strategy.**"

— Tristram Stuart, food waste campaigner, author of 'Waste', and founder of 'Toast Ale' which makes beer from surplus bread

900,000 meals end up in the bin at the end of the day because they haven't been sold[145]

Food waste is responsible for **8% of global greenhouse gas emissions**[130]



£13billion worth of edible food is thrown out by UK households each year[146]

1.4 million bananas are thrown out every day[147]

Adaptation

British growers are already trying to plan to make their farms more resilient to climate change and extreme weather events, with water shortages highlighted as a particular problem area in the UK's most recently published climate adaptation strategy. The strategy promises to work to restore natural processes within river systems to enhance water storage capacity and reduce water leakages[148].

Solutions being trialled by growers include installing new production techniques to conserve moisture, water storage, improved irrigation application and greater monitoring of soil moisture, said Dr Nicola Cannon, Royal Agricultural University. "A vital step for all growers is enhancing soil organic matter so that soils can better retain nutrients and cope with extreme rainfall events better by improved water retention, which is then beneficial when or if drought conditions develop," she added.

Many potato farmers are installing reservoirs to give their crops a supply of water during droughts and shortages. Potato supplies to major chip and crisp brands McCain, Tyrrells and Walkers have been safeguarded in the past with the use of reservoirs[149]. "We encourage farmers to look at the option of building on-site storage reservoirs to reduce the need for water abstraction," said a spokesperson for the Environment Agency. Producers can also experiment with alternative varieties, such as drought-tolerant peas, which may be more resilient to the effects of climate change[150].

Improving soils, more varied rotations, addition of dedicated habitat such as pollen and nectar mixes and reservoirs designed with nature in mind benefit wildlife too[151]. This can potentially help boost production by providing reservoirs of natural predators to combat pest outbreaks and boost pollinator numbers[152].

An alternative to traditional outdoor fruit and vegetable production is vertical farming. It offers the prospect of more efficient use of land and water, greater control against pests and, if indoors, greater resilience to extreme weather and climate change[153]. However, indoor farms require a replacement for sunlight, with lettuces grown in a vertical farm reported to need fourteen times more energy than those grown in a traditionally heated greenhouse in the UK[154].

Image credit: Riverford

credit: Rootlabs

In the spotlight:
Riverford organic veg box delivery

"The summer 2018 drought cost us £250,000 by July in lost production. We are probably going to build another new reservoir on the assumption that the weather is going to be more unpredictable. We're in a high rainfall area with steep slopes so we are also trying hard to protect soil loss with grass strips between crops and cover crops during winter like rye or clover. We have a seven-acre site with agroforestry, mixing a cider orchard with artichokes and other crops. We're not on massively fertile soils so we'd struggle to grow commercial crops without access to animal manure, but we are experimenting [to reduce reliance on livestock] with a compost project using food waste."

—Guy Watson, farmer and owner of the Riverford organic veg box delivery company

In the spotlight:
London's climate-proof farms

Farmbus is a London double-decker bus using aeroponics to grow strawberries. It is protected from the changing climate, recycles its use of water and uses LED lighting[155]. Growing Underground is based 30m below the streets of Clapham in South London and produces products including salad, garlic, chives, broccoli, wasabi and pea shoots. The plants are grown using a hydroponic system with recycled water and LED lights[156].

"The great news is that **choosing a diet rich in home-grown, locally-produced British fruit and veg is one of the best, and most delicious, ways we can help protect our climate** and landscapes while improving our health and wellbeing."

— Carina Millstone, Executive Director of Feedback

Buying local and seasonal foods

Consumer, retail and food service sector support for local, seasonal production is essential for the survival of British producers. It will also reduce climate emissions, according to the UN[157]. Our trade deficit on fruit and vegetables is approaching £10billion[158], yet other parts of Europe and countries which provide us with fruit and vegetables face greater climate risks, particularly southern Europe, Africa, South America and the Caribbean[159,160]. Early 2017 saw UK supermarkets suffering shortages of courgettes and spinach and rationing lettuce due to bad weather in Spain and Italy[161].

Poco tapas bar in Bristol sources the majority of its ingredients from within 50 miles of the restaurant and ensures that two-thirds of its dishes celebrate vegetables[162]. "Buying local and seasonal produce from agro-ecological farms and global producers who practise care in their approach to farming and the industry is literally the most significant way we can mitigate climate change," says Poco co-founder Tom Hunt. Wahaca founder Thomasina Miers puts together seasonal recipes for the chefs in the 25 branches of the Mexican-styled restaurant chain currently open in the UK.

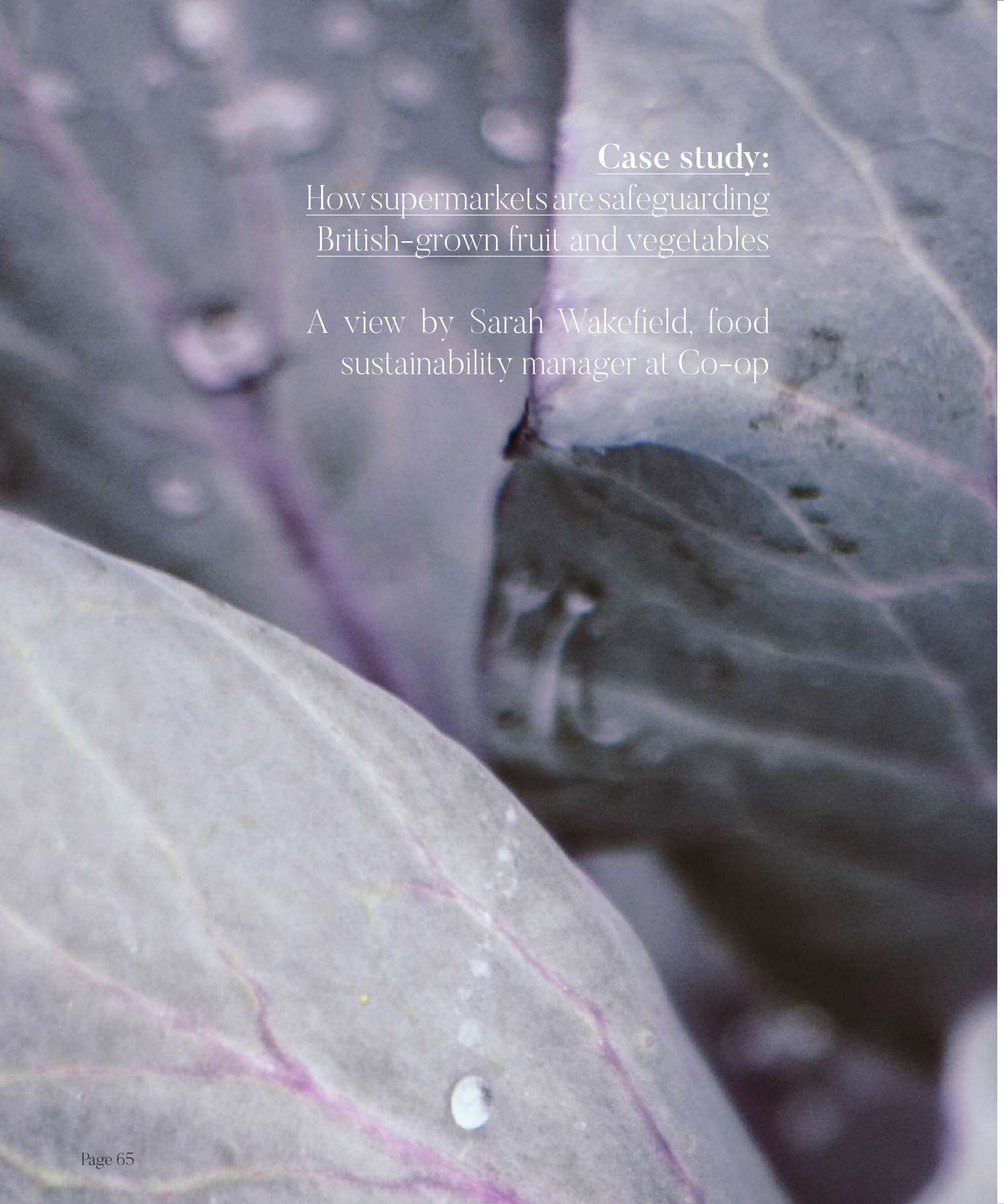
Shifting diets towards more fruit and veg

The UK government and food service sector could help reduce the climate emissions associated with our diets by helping people to eat and enjoy more fruit, vegetables and pulses, as the UN advises[163,164,165]. Miers, founder of Wahaca, says the food service sector is starting to be judged by its vegetarian offerings. "From the word go our menus have a 40-45% vegetable balance, which makes it easy to offer a cheaper and low-carbon option to customers. The strength of the vegetarian dishes will become more and more important for restaurants. We need to eat less meat so we [restaurants] need to offer choices for people to do that," she said[166].

The government could also do more to support UK fruit and vegetable growers, said Kath Dalmeny, CEO of Sustain: "This could include support for more research and development to help improve and diversify production in the UK; facilitating better access to land for growers to expand or to cultivate new producers; and fair trading standards to ensure growers can make a decent living and are treated fairly by powerful supermarkets."

"There is such an opportunity in the UK to eat more fresh **produce**—we're still miles away from eating five-a-day of fruit and veg. There is huge potential to increase the diversity and choice of what we grow in the UK."

— Caroline Drummond, CEO of LEAF



Case study:
How supermarkets are safeguarding British-grown fruit and vegetables

A view by Sarah Wakefield, food sustainability manager at Co-op

On extreme weather

Climate change and extreme weather are affecting how and where our food is grown and at Co-op we are focusing on the most at risk and important ingredients, prioritising how we take care of them. During the summer heatwave, on a small number of lines we saw differences in weights and size of some items, such as potatoes and broccoli.

On reducing climate emissions

Food and drink are large contributors to greenhouse gas emissions, so it's so important that we do our part to reduce emissions throughout our supply chain—from land and fertiliser use to transportation and refrigeration. We've reduced greenhouse gas emissions in our own operations by 50%, three years earlier than planned.

On renewables

We use 100% renewable electricity across all our stores. We're a founding partner of Manufacture 2030 which is our special platform for joining up suppliers to reduce energy, waste and water together throughout our supply chain.

On food waste

Over half of our stores will be partnered with local charities through Co-op Food Share by 2020. We will report publicly on food waste in our operations in 2019. In addition to this, our surplus food is used to make meals for people in need all over the UK. Since 2013, we've redistributed over 3 million meals through a partnership with Fareshare.

On supporting British growers

Supporting British farmers is important to Co-op members and customers. When in season, we always try to increase the proportion of British flowers, fruit and vegetables that are available for consumers to buy.

This report has documented the impacts that extreme and unpredictable weather are having on British-grown fruit and vegetables. The new data from the Priestley International Centre for Climate shows that these impacts are in line with climate trends that will continue if we don't act on climate change.

We believe in a future where the UK no longer contributes to climate change

We welcomed the UK Government's decision to ask the Committee on Climate Change (CCC) for advice on a net zero emissions target, with the aim of bringing our greenhouse gas emissions reduction target in line with the Paris Agreement. Given the existing advice from the CCC, the conclusions of the Intergovernmental Panel on Climate Change report, and that other countries have set net zero targets with dates between 2030 and 2050, including France, Norway, Sweden, Iceland and New Zealand, we believe this must be a target of net zero for greenhouse gases by 2045 at the latest.

Show The Love

Show The Love is an annual celebration of all that we love but could lose to climate change. Each February since 2015, organisations, institutions and millions of people have harnessed the power of green hearts to show they care about climate change and its impacts on the things we care about. Every one of us can be part of this movement.

The Show The Love campaign aims to get people talking about how the things we love are affected by climate change. Start by having conversations about the findings in this report. Talk about your own experiences of being affected by increasingly extreme weather. Talk about what you care about and how it will be affected by climate change. Help make climate change a part of the national conversation. Then together we can work to find and call for the steps that will help to get our climate back in balance.

Show The Love 2019 will build on the momentum of the last four years. Green hearts will kick off conversations about the things we love and the future we want for our children. From the WI crafternoons to Premier League football clubs, from pubs to primary school playgrounds, we can all show that we care.

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